Biotechnology for Zero Waste

Emerging Waste Management Techniques

Edited by Chaudhery Mustansar Hussain and Ravi Kumar Kadeppagari

WILEY-VCH

The Editors

Professor Chaudhery Mustansar Hussain

Department of Chemistry & Environmental Science New Jersey Institute of Technology Newark New Jersey, 07102 USA

Professor Ravi Kumar Kadeppagari

Centre for Incubation Innovation Research and Consultancy Department of Food Technology, Jyothy Institute of Technology Tataguni Estate Bengaluru, Karnataka, 560082 India

Cover Design: Wiley **Cover Image:** © Pixabay All books published by **WILEY-VCH** are carefully produced. Nevertheless, authors, editors, and publisher do not warrant the information contained in these books, including this book, to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate.

Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.d-nb.de>.

© 2022 WILEY-VCH GmbH, Boschstr. 12, 69469 Weinheim, Germany

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form – by photoprinting, microfilm, or any other means – nor transmitted or translated into a machine language without written permission from the publishers. Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Print ISBN: 978-3-527-34898-5 ePDF ISBN: 978-3-527-83205-7 ePub ISBN: 978-3-527-83207-1 oBook ISBN: 978-3-527-83206-4

Typesetting Straive, Chennai, India Printing and Binding

Printed on acid-free paper

 $10 \hspace{0.1 cm} 9 \hspace{0.1 cm} 8 \hspace{0.1 cm} 7 \hspace{0.1 cm} 6 \hspace{0.1 cm} 5 \hspace{0.1 cm} 4 \hspace{0.1 cm} 3 \hspace{0.1 cm} 2 \hspace{0.1 cm} 1$

| 4.5 | Conclusion | 63 |
|-----|------------|----|
| | References | 63 |

5 Bioremediation of Heavy Metals 67

Tanmoy Paul and Nimai C. Saha

- 5.1 Introduction 67
- 5.2 Ubiquitous Heavy Metal Contamination The Global Scenario 68
- 5.3 Health Hazards from Heavy Metal Pollution 69
- 5.4 Decontaminating Heavy Metals The Conventional Strategies 71
- 5.5 Bioremediation The Emerging Sustainable Strategy 72
- 5.5.1 Intervention of Metal Contamination by Microbial Adaptation 72
- 5.5.1.1 Genetic Circuitry Involved in Microbial Bioremediation 74
- 5.5.1.2 Different Heavy Metal-Resistant Mechanisms 74
- 5.5.2 Plant-Assisted Bioremediation (Phytoremediation) 75
- 5.5.3 Algae-Assisted Bioremediation (Phycoremediation) 77
- 5.5.4 Fungi-Assisted Bioremediation (Mycoremediation) 77
- 5.6 Conclusion 78 References 79

6 Bioremediation of Pesticides Containing Soil and Water 83

Veena S. More, Allwin Ebinesar Jacob Samuel Sehar, Anagha P. Sheshadri, Sangeetha Rajanna, Anantharaju Kurupalya Shivram, Aneesa Fasim, Archana Rao, Prakruthi Acharya, Sikandar Mulla, and Sunil S. More

- 6.1 Introduction 83
- 6.2 Pesticide Biomagnification and Consequences 84
- 6.3 Ill Effects of Biomagnification 84
- 6.4 Bioremediation 85
- 6.5 Methods Used in Bioremediation Process 86
- 6.5.1 In Situ Method 87
- 6.5.1.1 Bioaugmentation 87
- 6.5.1.2 Bioventing 87
- 6.5.1.3 Biosparging 87
- 6.5.1.4 Biostimulation 87
- 6.5.2 Ex Situ Methods 87
- 6.5.2.1 Composting 87
- 6.5.2.2 Land farming 88
- 6.5.2.3 Biopiles 88
- 6.5.2.4 Bioreactors 88
- 6.6 Bioremediation Process Using Biological Mediators 88
- 6.6.1 Bacterial Remediation 88
- 6.6.2 Fungal Remediation 89
- 6.6.3 Phytoremediation 89
- 6.7 Factors Affecting Bioremediation 90
- 6.7.1 Soil Type and Soil Moisture 90
- 6.7.2 Oxygen and Nutrients 90

5

Bioremediation of Heavy Metals

Tanmoy Paul¹ and Nimai C. Saha²

¹DNC College, Department of Zoology, Murshidabad, West Bengal 742201, India
²The University of Burdwan, Fishery and Ecotoxicology Research Laboratory (Vice-Chancellor's Research Group), Department of Zoology, Burdwan, West Bengal, 713104, India

5.1 Introduction

Human habitable ecosystems are rich in heavy metals since ancient time; it is the effect of spontaneous geogenic and modern-day anthropogenic activities, which are responsible for contemporary environmental heavy metal contamination [1]. Heavy metals could also be derived from both direct sources such as sludge dumping, industrial effluents, and mine trailing and indirectly through highway runoffs, which in turn lead toward the exploration of metal–microbe interactions that could recover or stabilize heavy metals in soils and effluents. In recent times, the heavy metal contamination caused biomagnifications that ultimately resulted in a major human health hazard globally.

Essential heavy metals, for instance, iron, zinc, and copper, are required by living organisms in trace amounts, but their presence above a threshold concentration often observed to be toxic. Among the heavy metals, cadmium (Cd), chromium (Cr), and arsenic (As) are reported to act as a carcinogen as designated by the International Agency for Research on Cancer (IARC) and the US Environmental Protection Agency (USEPA) [2]. It has also been observed that various metals such as iron (Fe), zinc (Zn), nickel (Ni), and copper (Cu) are considered essential metals for growth and other functions, if their level remains within the threshold level [3].

There are an array of techniques, for instance, filtration, chemical precipitation, reverse osmosis, membrane technology, oxidation and reduction, ion exchange, and electrochemical treatment, for the removal of heavy metals from a contaminated environment. However, these techniques have some serious demerits associated with them. The most important one is their inability to remove heavy metals found at lower concentration ($\leq 100 \text{ mg/l}$) [4]. These traditional techniques are expensive and require energy sources and still often alter the properties of soil without complete removal of metal contaminants. Furthermore, the pollutant may also be displaced to other sites in the environment where they can accumulate and may cause the same issue. The presence of an array of traditional decontamination

Science and Technology: A Concise History and Evolution

Editors:

Ajahar Islam Joyesh Rajguru Dr. Sasadhar Majhi Md Moniruddin Sk Dr. Sumit Kumar Mondal



KUMUD PUBLICATIONS DELHI-110053

Published by :

KUMUD PUBLICATIONS K-129, 3-1/2 Pusta Main Road, Near Shiv Om Jewellers Gautam Vihar, Delhi-110053 Phone : - 9811281638, 9953918120 E-mail: kumudbooks@gmail.com

Science and Technology: A Concise History and Evolution

© Reserved

First Edition 2020

ISBN: 978-81-945060-3-4

All rights reserved no part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the Publisher.

PRINTED IN INDIA

Published by Dinesh Kumar Yadav for Kumud Publications, Delhi-53. Printed at Sachin Printers, Delhi-53.

| 9. | Many Medieval Science-centric Issues Deviate from Factual Truth –Dr. Mohammed Iqbal Ahmed Farhat | e 108 |
|--------------|---|----------|
| 10. | Muslim Science Enthusiasts in The Middle East (7th C.E. to 10th C.E) -Nasiruddin Molla | 114 |
| 11. | Science and Technology in Mughal India -Sk Nawaj Sharif | 121 |
| 12. | The Practice of Science During the Abbasid Caliphate -Wasim Akram | 126 |
| 13. | Drug Discovery and Development-A Lucid Approach -Dr. Sasadhar Majhi | 135 |
| <u>,</u> 14. | Beginning of Journey of Some Pioneering Science Research Institutes in Bengal -Dr. Sekhar Pal | 149 |
| 15. | Jagadish Chandra Bose: An Indian Scientist -Abdur Razzaque | 156 |
| 16. | Materialization of Science in India During Colonial Period: Contribution of Indian Scientists -Smt. Prodipta Bose | 167 |
| 17. | Sir Jagadish Chandra Bose: An Exceptional Gem of Science -Joyesh Rajguru | 172 |
| 18. | Public Health, Epidemics and Reaction of the Indigenous People – A Discourse on Sanitation Based on the Colonial Health Journals –Tinni Goswami & Shrimanti Ghosal | 184 |
| 19. | History of Computers and Associated Technology (1940-2020) -Nadim Ahmed | 190 |

Beginning of Journey of Some Pioneering Science Research Institutes in Bengal

-Dr. Sekhar Pal

Introduction

The impact of the Western developments in literature, politics, philosophy, and science began to be felt in India, particularly in Colonial Bengal in the late 18th century. The impact gave rise to the so-called Bengal Renaissance¹ (Roy et al 2010). Bengali scientists' concern for the decaying life under the colonial rule and using science to stop the process may be traced to the emergence of the idea of swadeshism (self-help with indigenous resources)² (Sarkar, 1973). Spirit of swadeshi era was already manifesting in economic nationalism. These developments, together with the influences of the ongoing

Assistant Professor, Microbiology, Kulti College.



PROCEEDING OF THE 1ST INTERNATIONAL E-CONFERENCE

ON

"REVISITING STRATEGIES FOR SUSTAINABLE

DEVELOPMENT"

13TH-14TH JUNE 2020



EDITOR IN CHIEF

Dr. Amitava Basu

EDITORS

Dr. Sudipta Das, Mr. Rajarshi Das Mr. Kajal Maji, Mr. Shashi Kr. Shaw, Dr. Nimai Chand Saha, Dr. Sayantan Paria Dr. Aniruddha Adhikari, Dr. Amit Tribedi

e-ConSus 2020

by: Dr. Amitava Basu, Dr. Sudipta Das, Mr. Rajarshi Das, Mr. Kajal Maji, Mr. Shashi Kr. Shaw, Dr. Nimai Chand Saha, Dr. Sayantan Paria, Dr. Aniruddha Adhikari, Dr. Amit Tribedi

RED'SHINE PUBLICATION PVT. LTD.

Headquarters (India): 88-90, REDMAC, Navamuvada, Lunawada, India-389 230 Contact: +91 76988 26988 Registration no. GJ31D0000034

In Association with,

RED'MAC INTERNATIONAL PRESS & MEDIA. INC

India | Sweden | UK

Text © EDITOR, 2021 Cover page ©RED'SHINE Studios, Inc, 2021

All rights reserved. No part of this publication may be reproduced or used in any form or by any meansphotographic, electronic or mechanical, including photocopying, recording, taping, or information storage and retrieval systems- without the prior written permission of the author.

ISBN: 978-93-90937-61-5 ISBN-10: 93-90937-61-2 ISBN-A: 10.93/90937612 DIP: 18.10.9390937612 DOI: 10.25215/9390937612 Price: ₹ 800 July, 2021 (First Edition)

The views expressed by the authors in their articles, reviews etc. in this book are their own. The Editor, Publisher and owner are not responsible for them. All disputes concerning the publication shall be settled in the court at Lunawada.

www.redshine.co.in | info.redmac@gmail.com Printed in India | Title ID: 9390937612

| 27 | Shift Of Millennium Development Goals Towards Sustainable Development Goals For Sustainable Future Supriti Mukherjee | 272 |
|----|--|-----|
| 28 | Microorganisms and Sustainable Development: A Special Emphasis on Bioelectricity Dr Sekhar Pal | 280 |
| 29 | A Theoretical Study of an All Optical Digital COMPARATOR By Using Hyper Secant Soliton Pulse Chinmoy Mukherjee, Abhijit Sinha | 289 |
| 30 | Accelerated Diels-Alder Reactions in Presence of Water Dr. Snigdha Roy | 297 |
| 31 | Engineering Law, Strategies and Managerial Economics for Sustainable Infrastructural Development in Nigeria Oluwadare Joshua OYEBODE | 310 |
| 32 | ১৯ শতকের বাংলা : নারী ইতিহাসে রানী রাসমনি <i>ড. শমালী ভট্টাচার্য্য</i> | 318 |
| 33 | A Prediction Based on Recent Trends in Eco-Friendly Sciences Swapan Kole, Tarun Ghosh | 326 |
| 34 | Narratives of Anti-Dam Movements in Northeast India Miss Roja Ahmed | 335 |
| 35 | Optimization Approach for Sustainable Development Dalbinder Kour | 345 |
| | | |

.



Microorganisms and Sustainable Development: A Special Emphasis on Bioelectricity

Dr Sekhar Pal

ABSTRACT:

Population growth, urbanization, industrialization have put significant pressure on natural resources and global ecosystems. 'Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. As a consequence, sustainable development goals are exceptionally diverse, encompassing environmental, economic and social aspects, making it highly complex. Microbes are the predominant form of life on the planet, both in numbers and total biomass. Their ubiquity throughout the biosphere and the diversity of their activities make them pivotal agents of planetary and ecosystem functioning. They mediate and regulate biogeochemical cycles, recycling of biological materials and waste, constitute key regulator of greenhouse gases and are thus important determinants of climate change, play essential roles in soil structure and fertility, and in the quality and productivity of land, seas, lakes and rivers. This article reviews various aspects of microorganisms in sustainable development, with special emphasis on bioelectricity as an alternative source of energy.

Keywords: Sustainability, Bioelectricity, Biofuel, Energy resource

Introduction:

The concept of sustainable development is very much relevant in today's world. This concept is not delimited to a particular field, rather its scope encompasses vast areas of environmental studies, economic and social aspects, and beyond. Highly polluted environment can be an indicator of inefficient use of natural resources. Any development that reduces pollution in production processes must be considered as a win-win situation for the environment and economy (Porter et al, 1999). A good society always values the natural resources including less polluted air, water etc. Nature itself provides us various opportunities which can be utilized

- Yong, XY, Feng J, Chen YL, Shi DY, XuYS, Zhou J, Wang SY, Xu, L, Yong YC, Sun YM, et al. 2014b. Enhancement of bioelectricity generation by cofactor manipulation in microbial fuel cell. Biosens Bioelectron. 56:19-25.
- Zahir, Z. A., Munir, A., Asghar, H. N., Shaharoona, B., and Arshad, M. (2008). Effectiveness of rhizobacteria containing ACC-deaminase for growth promotion of pea (Pisum sativum) under drought conditions. J. Microbiol. Biotechnol. 18, 958–963.
- Zhang X, He W, Zhang R, Wang Q, Liang P, Huang X, Logan BE, Fellinger TP. (2016). Highperformance carbon aerogel air cathodes for microbial fuel cells. ChemSusChem. 9(19):2788-2795.
- Zhang, R., Xu, X., Chen, W., and Huang, Q. (2016). Genetically engineered Pseudomonas putida X3 strain and its potential ability to bioremediate soil microcosms contaminated with methyl parathion and cadmium. Appl. Microbiol. Biotechnol. 100, 1987–1997.
- Zhao G, Maa F, Wei L, Chua H, Chang CC, Zhang XJ. 2012. Electricity generation from cattle dung using microbial fuel cell technology during anaerobic acidogenesis and the development of microbial populations. Waste Manage. 32:1651–1658.

About the Author(s) Dr Sekhar Pal

Assistant Professor in Microbiology, Ramakrishna Mission Vivekananda Centenary College, Rahara. Khardaha, West Bengal 700118 e-mail address: sekhar.bio@gmail.com

Applications in **Plant Biotechnology**

Focus on Plant Secondary Metabolism and **Plant Molecular Pharming**

Editors Abdullah Makhzoum





CHAPTER 1

Withania somnifera: A Future Pharma Factory

Tarun Halder, Subrata Kundu and Biswajit Ghosh*

Plant Biotechnology Laboratory, Post Graduate Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata-700118, India Emails: tarunhalder13@gmail.com; subratakundu83@gmail.com

* Corresponding author: ghosh_b2000@yahoo.co.in

Introduction

Humans have used plants accessible within their territory for diet and curative purposes since their civilization began. This traditional system of medicine based on belief and practices has been used as a therapy for most human ailments for over hundreds of centuries (Winters 2006; Kulkarni and Dhir 2008, Mirjalili et al. 2009a, Rayees et al. 2012, 2013). Irrespective of the progression in drug development methods, several species of plants are unparalleled as major ingredients of current medicine. Due to our existing industrialized lifestyle, we are continuously exposed to an over abundance of chemicals and different environmental pollutants that ultimately intensified the incidence of complicated neurodegenerative, cardiovascular diseases, and cancers. Perceptible antagonistic effects of modern drugs used in the management of complicated ailments ultimately resulted in renewed attention towards herbs and medicinal plants as an alternative source.

Withania somnifera (L.) Dun, is one of the important medicinal plants in India belonging to the Solanaceae family. It is commonly known as 'Ashwagandha', Winter Cherry, Indian ginseng. In the monographs of the World Health Organization (WHO), Ashwagandha has been considered as one of the important medicinal plants and also has been included in the list of top thirty two prime concerned medicinal plants by the National Medicinal Plant Board of India (http://www.nmpb.nic.in) owing to its huge demand in both domestic and international markets (Mirjalili et al. 2009a, Singh et al. 2015). In Ayurveda and other traditional systems of medicine, it is one of the most valued medicinal plants and it has been in use for more than 3000 years. It is widely used in traditional Indian medicine systems for curing a variety of

Saikat Gantait Sandeep Kumar Verma Amit Baran Sharangi *Editors*

Biotechnology of Anti-diabetic Medicinal Plants



In Vitro Exploitation of Medicinal Plants for Continuous Supply of Antidiabetic Bioactive Compounds

Subrata Kundu, Sk Moquammel Haque & Biswajit Ghosh

Chapter | First Online: 13 November 2021 359 Accesses

Abstract

Diabetes mellitus, a complex metabolic disorder with multiple etiology, is one of the key health problems among different countries all over the world. The disruption of blood sugar homeostatic enforces profound consequences and affects different organs including heart, eye, and kidney. Numerous classes of drugs associated with antidiabetic potential with diverse mode of actions are available in the market. The inexhaustible range of secondary metabolites of medicinal plants has been extensively used as natural remedies against different ailment, Regardless of the remarkable advancement in antidiabetic drugs, acceptance of medicinal plants as an alternative source has increased worldwide due to comparative inexpensive nature and less adverse side effect. Plant tissue culture techniques serve as substitution to entire plants for large-scale synthesis of medicinally important secondary metabolites round the year regardless of the geographical and environmental barriers. These advantages open an avenue for the implementation of callus culture to induce the accumulation of therapeutic compounds. Nevertheless, enrichment of secondary compounds with antidiabetic activity in suspension cultures through elicitation is also a beneficial approach. The advent of high throughput genomics and metabolomics tools, along with upgraded recombinant technology, explored exciting possibilities for elicitation of antidiabetic therapeutic compounds. The present chapter enlightened the current progress of plant tissue culture, specifically callus culture for the scaled-up accumulation of antidiabetic compounds.



Sustainable **Bioresource Management**

Climate Change Mitigation and Natural Resource Conservation



- Ratikanta Maiti | Humberto González Rodríguez
- Ch. Aruna Kumari | Debashis Mandal
- ditors Narayan Chandra Sarkar







Chapter

Assessment of Plant Genetic Resources of Chili Germplasm

By Anupam Das, Subrata Kundu, Biswajit Ghosh

Book Sustainable Bioresource Management

| Edition | 1st Edition |
|-----------------|----------------------|
| First Published | 2020 |
| Imprint | Apple Academic Press |
| Pages | 48 |
| eBook ISBN | 9780429284229 |

S

ABSTRACT

The capsicum species, commonly known as chili peppers are pharmaceutically and economically important plants belonging to the Solanaceae family. Although domesticated in the Americas, the peppers have been distributed throughout the world and integrated into the world cuisine and food products. The chili fruits are vital to the human being as they are commonly used as vegetables, spices, and for therapeutic purposes. It possesses a wide range of pharmacologically important secondary metabolites including carotenoids, flavonoids, and vitamins that are beneficial to human health. These compounds have been reported to possess anticancer, antioxidant, anti-inflammatory, and antimicrobial properties. The exclusive metabolites present within the capsicum are the alkaloids capsaicinoids that make peppers pungent and are sequestered mainly in the placenta of the fruits. The nutritional content, as well as pungency of pepper, exhibit incredible diversity among different pepper types. The analysis of plethora of genetic resources of capsicum is pivotal for screening beneficial traits present within the enormous size of germplasm as well as for improved utilization in breeding programs. Therefore, in this chapter, we have emphasized on morphological, chemical, genetic, as well as disease diversity in different capsicum species cultivated in diverse geographical locations.



Sustainable **Bioresource Management**

Climate Change Mitigation and Natural Resource Conservation



- Ratikanta Maiti | Humberto González Rodríguez
- Ch. Aruna Kumari | Debashis Mandal
- ditors Narayan Chandra Sarkar







Chapter

Ex Situ Conservation of Chili (Capsicum spp.)

By Tarun Halder, Biswajit Ghosh

Book Sustainable Bioresource Management

| Edition | 1st Edition |
|-----------------|----------------------|
| First Published | 2020 |
| Imprint | Apple Academic Press |
| Pages | 39 |
| eBook ISBN | 9780429284229 |

ABSTRACT

Plant genetic resources are essential to check the diminishing of genetic erosion and for development of improved high-yielding commercial varieties that are a better response against biotic and abiotic stresses as well as combat new climatic conditions. Chili is an important vegetable and cash crop around the world. The genus Capsicum is mainly cultivated for its nonpungent (sweet pepper), pungent, and ornamental values. It is rich in bioactive compounds, which contribute to the improvement of human health. For future agricultural development and improvement of the food security program, plant genetic resources must be conserved in the form of seeds, plants, tissues, etc. Biotechnology approach involving plant tissue culture is a powerful technique that can be an alternative to conventional breeding and advance germplasm improvement. Several techniques are applied for conservation of Capsicum that are more effective, like seed bank, greenhouse, tissue culture, in vitro conservation, cryopreservation, etc. For long-term ex situ conservation of disease-free materials, the only in vitro conservation method can be adopted, it reducing the growth rate of plant material and increasing subculture intervals. For prolonged conservation, ultralow temperature (cryopreservation) can be used in the contamination-free state of chili materials.

Some useful germplasm for continuous agricultural methods and diversity of breeding lines are lost due to the constant refinement activities, 338which are only focused on elite genotypes or germplasms and their proper conservation. This conservation method avoids the conservation of wild genotypes and wild crop-relatives that are very important for further improvement of crop cultivar. An effective and well-organized conservation system is required to support from different nations and a true continuation of this program needs an effective initiative for regular collection of plant genetic resource from wild and their good conservation management.

Mohammad Faisal Abdulrahman A. Alatar *Editors*

Synthetic Seeds

Germplasm Regeneration, Preservation and Prospects



Synthetic Seeds: An Alternative Approach for Clonal Propagation to Avoiding the Heterozygosity Problem of Natural Botanical Seeds



Biswajit Ghosh and Sk Moquammel Haque

Abstract The seed is a functional element of sexual reproduction of higher plant. In nature, the humble beginning of the independent life of higher plants starts along with seed germination. Seeds are the "mysterious genetic capsules" which store the genetic information and carry forward to next progeny. The zygotic embryo present inside the botanical seed serves as propagule to produce offspring, and these embryos are always heterozygous because of the recombination during meiotic crossing over in the course of gamete formation as well as for mix-up of the genome of two different parents through cross-pollination. In seed-propagated crops, the agricultural yield is highly unstable due to heterozygosity among seed-derived plants. The answer of this problem is synthetic seeds—the functional mimic of botanical seeds.

Synthetic seed is one of the most promising tools of plant biotechnology, which could be tailor-made for horti- and agricultural improvement at present as well as upcoming days. As all the propagules used for synthetic seed preparation are produced through in vitro clonal propagation, which means they did not encounter two fundamental events of sexual reproduction, the meiotic recombination (during crossing over) and gametic fusion of two different parental genome (crosspollination), both of these events can create new types of heterozygosity in zygotic seeds. Therefore synthetic seed-derived offspring are always true to type to their source plant. Although, unlike zygotic seed, new types of heterozygosity are never generated in synthetic seeds, the heterozygosity already existed in the mother plant is always transmitted in all synthetic seed-derived offspring.

However, the heterozygosity problem will be totally avoidable, and production of homozygous synthetic seeds is also possible only by using double haploid source plant, because double haploid plants are always truly homozygous. Otherwise synthetic seed technology can only aid to restrict the formation of new types of heterozygosity in offspring, which are abundant in botanical seeds.

M. Faisal, A. A. Alatar (eds.), Synthetic Seeds, https://doi.org/10.1007/978-3-030-24631-0_4

B. Ghosh (EI) - S. M. Haque

Plant Biotechnology Laboratory, Post Graduate Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata, India e-mail: hiswajit@rkmvccrahara.org

[©] Springer Nature Switzerland AG 2019

Reference Series in Phytochemistry Series Editors: J.-M. Mérillon · K.G. Ramawat SPRINGER REFERENCE

Sumita Jha Editor

Endophytes and Secondary Metabolites





Endophytism in Zingiberaceae: Elucidation of Beneficial Impact

Avijit Chakraborty, Subrata Kundu, Swapna Mukherjee, and Biswajit Ghosh

Contents

| 1 | Introduction | 188 | |
|---|--|-----|--|
| 2 | Decoding the Molecular Interaction in Endophytism | 189 | |
| 3 | 3 Impact of Endophytic Microorganisms on Plants | | |
| 4 | 4 Diversity of Endophytes Associated with the Family Zingiberaceae | | |
| 5 Advantageous Imprint Within the Zingiberaceae Family due to Endophytism | | | |
| | 5.1 Plant Growth Promotion by Endophytes | 192 | |
| | 5.2 Synthesis of Bioactive Compounds | 199 | |
| | 5.3 Antimicrobial Activity of Endophytes | 202 | |
| | 5.4 Biocontrol Activity of Endophytes | 202 | |
| 6 | Conclusion | 206 | |
| Re | eferences | 207 | |

Abstract

Endophytism is a unique relationship between plant and endosymbiotic microorganism wherein the microbes colonize within plant tissues without producing any disease etiology. Various groups of endophytes isolated from different medicinal plants are extremely significant in this respect for their ability to synthesize novel bioactive compounds as well as for the modulation of productivity. Endophytes also play various crucial roles in growth, biotic and abiotic stress tolerance, and adaptation. With the implementation of "state-of-the-art" technologies in molecular biology, the specific identification of associated microorganism as well as their relationship with corresponding host plants has been explicitly deciphered in

A. Chakraborty · S. Kundu · B. Ghosh (🖂)

Plant Biotechnology Laboratory, Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Kolkata, India

e-mail: avijit.microbio@gmail.com; subratakundu83@gmail.com; ghosh_b2000@yahoo.co.in

S. Mukherjee

Department of Microbiology, Dinabandhu Andrews College, Kolkata, India e-mail: swamuk15@gmail.com

© Springer Nature Switzerland AG 2019

S. Jha (ed.), *Endophytes and Secondary Metabolites*, Reference Series in Phytochemistry, https://doi.org/10.1007/978-3-319-90484-9_31

RESEARCH TRENDS IN BIORESOURCE MANAGEMENT AND TECHNOLOGY

-EDITORS-Ratikanta Maiti Humberto Gonzalez Rodríguez Biswajit Ghosh Narayan Chandra Sarkar Debashis Mandal Rajpal Meena Ashok K. Thakur A V Ramanjaneyulu



CHAPTER 28 MEDICALLY BIOACTIVE NATURAL MOLECULES FROM PLANT BIORESOURCES

Biswajit Ghosh¹, Ratikanta Maiti², Narayan Chandra Sarkar³, Subrata Kundu¹ and Tuhin Chatterjee¹

¹Plant Biotechnology Division, P.G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata-700118, India
²Facultad de Ciencias Forestales, Universidad Autónoma de Nuevo León, NL 67700 Linares, Mexico.

³Department. of Agronomy, Visva-Bharati University, Sriniketan, West Bengal, India, PIN 731236

Contents

28.1. Introduction

28.2. A long Journey of Drug Discovery from Plant Natural Products

28.3. Natural Product: Bioactive Molecules for Health

28. 4. Organizations for Plant based Natural products

28.5 Natural Product are mostly Secondary Metabolites in nature

28.6. Extraction and Characterization of both quality and quantity of Bioactive Natural products from plants.

28.7. Medicinal Plant bioresources for Natural Products References

Abstract

Plant natural products represent a large family of versatile chemical scaffolds with comprehensive range of biological activities that have remarkably used as anthropological medicine from ancient times. These bioactive molecules serve as vital resources of promising drugs and plays pivotal roles for development of synthetic drugs. Their medicinal importance has rigorously being studied based on experimental



Transgenesis and Secondary Metabolism



and Secondary Metabolism Transgenesis and Secondary Metabolism pp 1-22 Cite as

Metabolic Engineering for Improving Production of Taxol

Subrata Kundu, Sumita Jha & Biswajit Ghosh 🖂

Living reference work entry | First Online: 26 December 2016 578 Accesses

Part of the Reference Series in Phytochemistry book series (RSP)

Abstract

Taxol (generic name paclitaxel), a complex diterpenoid, is an efficient antineoplastic drug extracted from the plant. It has been approved for the management of several cancers including lungs, breast, and ovary cancers. The bark of several Taxus species is the natural source of taxol, but its lower accumulation (0.01–0.04% dry weight) elevated the price of extraction. Its complex structure prohibits the complete chemical synthesis of the compounds in economical approach at the industrial level. Therefore, a plethora of approaches has been implemented by several researchers for alternative and economical production of taxol. The advent of recombinant DNA technologies has resulted in the commencement of metabolic engineering as an effective alternative for the production of pharmaceutically important plant natural products at industrial levels. Plants have emergence as a perfect system for metabolic engineering due to its relatively cheap price and easiness in growing. Plant cell factories provide an alternative source for the scale-up of the production of high added value secondary metabolites including the anticancer drug taxol that is biosynthesized in Taxus spp. in very tiny quantity. The demand for taxol and its derivatives has increased enormously owing to its unique antineoplastic activity, lack of the taxane ring in nature and complexity of chemical synthesis. Therefore, countless efforts have been executed in worldwide for the biotechnological production of taxol. In this chapter, we have discussed different features of metabolic engineering, including genetic manipulation of plants as well as microbes to increase production of taxol and its precursors.

WOODHEAD PUBLISHING SERIES IN FOOD SCIENCE, TECHNOLOGY AND NUTRITION



BIOPESTICIDES Advances in Bio-Inoculants

VOLUME 2

Edited by AMITAVA RAKSHIT, VIJAY SINGH MEENA, P. C. ABHILASH, B. K. SARMA, H. B. SINGH, LEONARDO FRACETO, MANOJ PARIHAR, AND ANAND KUMAR SINGH





Advances in Bio-inoculant Science

2022, Pages 285-299



Chapter 20 - Development and regulation of microbial pesticides in the post-genomic era

Anirban Bhar *, ^b, Akansha Jain *, Sampa Das *

Show more 🗸

+ Add to Mendeley 🦂 Share 9 Cite

https://doi.org/10.1016/B978-0-12-823355-9.00018-3

Get rights and content

Abstract

Microbial pesticides consist of active beneficial microorganisms or any natural products of microbial provenance that have a promising role in pest management. The development of a microbial pesticide needs isolation and screening of effective biocontrol strains and data for trials under field and greenhouse. Commercial application of a microbial pesticide requires large-scale production, formulation with suitable additives to increase the shelf-life of the product, and proper storage. Thrust in the research of microbe-based pesticides can be seen with the large number of patents, but only a very small proportion of them reach markets. The reason behind the hurdle in marketing is the stringent regulatory framework due to biosafety or environmental concerns increasing overall costs, causing a trail in its commercialization. Post-genomic technologies like CRISPR/Cas9 have reformed genome editing technologies and have increased the possibilities of developing the new edited biopesticides. The new microbial pesticide products will require additional regulatory challenges to define low-risk contenders so as to facilitate easy commercialization and fling in the market.

Concepts and Strategies in Plant Sciences Series Editor: Chittaranjan Kole

Bidyut Kumar Sarmah Basanta Kumar Borah *Editors*

Genome Engineering for Crop Improvement



Chapter 9 Improving Biotic and Abiotic Stress Tolerance in Plants: A CRISPR-Cas Approach



Akansha Jain, Anirban Bhar, and Sampa Das

Abstract Genome editing technologies have advanced speedily in the past few years and have become one of the most paramount tools in the management of abiotic and biotic stress-related damages of the plant species at the genetic level. The clustered regularly interspaced short palindrome repeats (CRISPR)/CRISPR-associated protein 9 (Cas9) RNA-guided DNA endonuclease has the potential to edit genomes in living cells and is much easier to carry out and has outdone other gene editing tools. In this chapter, we summarize how CRISPR enables genome editing and the recent advances made in CRISPR-based technologies, especially in crop protection. We also discuss the regulatory viewpoint regarding the fate of CRISPR/Cas9 in developing biotic and abiotic resistance in crop plants and future challenges.

Keywords Abiotic stress · Biotic stress · CRISPR-cas technology · Genome editing · Targeted mutagenesis

A. Jain · A. Bhar · S. Das (⊠)

Division of Plant Biology, Bose Institute Centenary Campus, CIT Scheme, VII-M, P 1/12, Kankurgachi, Kolkata 700054, West Bengal, India e-mail: sampadpb@gmail.com; sampa@jcbose.ac.in

A. Jain e-mail: akansha007@rediffmail.com

A. Bhar e-mail: anirbanbhar06@gmail.com

A. Bhar Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, West Bengal, Kolkata 700118, India

© Springer Nature Switzerland AG 2021
B. K. Sarmah and B. K. Borah (eds.), Genome Engineering for Crop Improvement, Concepts and Strategies in Plant Sciences, https://doi.org/10.1007/978-3-030-63372-1_9 217

[#]Akansha Jain and Anirban Bhar contributed equally to the work.

Aryadeep Roychoudhury Editor

Rice Research for Quality Improvement: Genomics and Genetic Engineering

Volume 1: Breeding Techniques and Abiotic Stress Tolerance



Rice Tolerance to Multiple Abiotic Stress: Genomics and Genetic Engineering

Anirban Bhar

Chapter First Online: 01 November 2020 346 Accesses

Abstract

Changing environment has a huge impact on bio-resources and global agriculture. Abiotic stress factors are dramatically increasing along with these uncontrolled environmental changes. Rice (Oryza sativa) is the most important crop providing food toward more than half of the world populations, and India is one of the major rice growing country. This important crop plant experiences massive yield loss due to abiotic out-lashes, e.g., salinity, drought, heat stress, cold shock, UV damage, and mineral toxicity. The sessile nature of plants make them easy targets of several environmental odds, but long-term evolutionary interaction of plants with environment in turn shapes reprogramming of its defense signaling networks tightly. The subtle changes in the environment can be sensed by the plant very efficiently and are portrayed by their genetic orchestrations. Due to enormous development in modern genomics, technologies, and biotechnological applications, the minute changes in gene expression and modification of metabolic functions can now be precisely recorded. Besides, complex modulations in metabolic network through biotechnology are implicated to overcome the situations in a positive way. Studies focusing on specific abiotic stress and its protection have long been implicated in different plants including rice. Unfortunately, growing yield loss in rice due to multiple abiotic stress factors supersedes increasing demand of this crop. Recently, a versatile approach has been flourished to meet the yield-demand ratio against multiple abiotic stresses. The present chapter describes various important abiotic stresses in rice plants, their complex defense signaling mechanism, and recent developments to combat these multiple stress factors comprehensively.

Mechanism of Plant Hormone Signaling under Stress

0

 \oplus

Edited by Girdhar K. Pandey Department of Plant Molecular Biology, University of Delhi South Campus, New Delhi, India

Volume II

 \oplus

WILEY Blackwell
Redox Regulatory Networks in Response to Biotic Stress in Plants: A New Insight Through Chickpea-*Fusarium* Interplay

Anirban Bhar^{1,2}, Sumanti Gupta^{1,3}, Moniya Chatterjee¹, and Sampa Das¹

¹ Division of Plant Biology, Bose Institute, West Bengal, India

² Post Graduate Department of Botany, Ramakrishna Mission Vivekananda Centenary College, West Bengal, India
³ Department of Botany, Rabindra Mahavidyalaya, Champadanga, West Bengal, India

2.1 Introduction

In its 4.5 billion years of dramatic life, the Earth has experienced innumerable environmental as well as biological transfigurations; among them, the appearance of life and development of oxygenated environment on Earth were two major events. Although life originated 3.7 billion years ago, it took another 1 billion years to develop oxygen (O_2) in its atmosphere. Oxygenation started 2.4 billion years ago and mostly by the active participation of submerged aquatic cyanobacteria, the event was famously called the "great oxygenation event" (GOE) (Flannery and Walter, 2012). Generation of reactive oxygen species (ROS) was the inevitable event of an oxygenated environment. ROS includes superoxide radical (O_2^{-}), hydrogen peroxide (H_2O_2), hydroxyl radical (HO^{-}), hydroperoxyl radical (HOO⁻), and so on produced either in cell organelles as by product of some energy utilizing metabolic processes, that is, photosynthesis, respiration, photorespiration, and so on, or in the cytosol by the action of NADPH oxidase due to some specific stress factors (Tripathy and Oelmüller, 2012). The plants have evolved several scavenging "machines" to detoxify these harmful toxic oxygen intermediates. The ROS are effectively scavenged enzymatically and non-enzymatically within the plant cell to maintain healthy redox homoeostasis. Different biotic and abiotic factors can perturb the balance between production and scavenging of ROS leading to the oxidative burst. Previously, it was thought that any kind of oxidative reactive molecules are highly toxic and fatal to the plant itself. Dr. Noriyuki Doke, plant pathologist at the Nagoya University, Japan, first demonstrated the occurrence of ROS in cell cytoplasm of potato tubers during incompatible interaction with *Phytopthora infestans* (Doke, 1983). Later on, their group also reported that this oxidative burst is NADPH oxidase dependent and conveys the signal for hypersensitive responses in potato (Yoshioka et al., 2003). Afterwards, the correlation between oxidative burst and HR was established in different plants upon diverse biotic stress inducing factors (Bestwick et al., 1997 and Yoda et al., 2003). Besides, owing to the diffusible capability of ROS, it can also act as a signaling molecule in long distance plant signaling (Pitzschke et al., 2006). Recently, it has also been documented that ROS can also augment different signaling pathways directly

Mechanism of Plant Hormone Signaling under Stress, First Edition, Volume 2. Edited by Girdhar Pandey. © 2017 John Wiley & Sons, Inc. Published 2017 by John Wiley & Sons, Inc.

Innovations in Fermentation and Phytopharmaceutical Technologies

Edited by Hrudayanath Thatoi Sonali Mohapatra Swagat Kumar Das





Innovations in Fermentation and Phytopharmaceutical Technologies 2022, Pages 3-12



Chapter 1 - Photo bioreactors for production of biodiesel from algae: A short review

Bikash Chandra Behera *, Harisankar Dey ^b, Riya Jalan ^c, Rashmi Ranjan Mishra ^c, Sonali Mohapatra ^d

Show more 🗸

🕂 Add to Mendeley 🦂 Share 📑 Cite

https://doi.org/10.1016/B978-0-12-821877-8.00008-7

Get rights and content

Abstract

Due to higher production capability of carbohydrates, lipids, and proteins, microalgae are considered an alternative energy resource for biofuel production. Photo <u>bioreactors</u> that use light as an energy source for algal biomass can be used for the maximum production of metabolites. Hence, now it is very essential to design and develop new aspects of photo bioreactors for maximum biofuel production. Apart from the aforementioned criteria, the production cost of the bioreactor, uncontaminated algal biomass, type of photo bioreactor used, ease of using the reactor, low maintenance, and space convenience measures also play vital roles in the efficiency of the reactor. Thus, this chapter aims for a perceptive understanding of the production of biodiesel from algal biomass along with brief insights into different types of bioreactors used for biofuel production from algae.

Biodiversity Conservation and Livelihood Management



Hrudayanath Thatoi Priya Ranjan Debata



Chapter 18

Freshwater Cyanobacterial Diversity of Similipal Biosphere Reserve, Odisha, India

Harisankar Dey^{1*} and Akshaya Kumar Bastia²

¹Post-Graduate Department of Botany, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Rahara, Kolkata – 700 118, West Bengal ²Post-Graduate Department of Botany, North Orissa University, Takatpur, Baripada – 757 003, Odisha *e-mail: harisankardey@gmail.com

Cyanobacteria are an extraordinarily diverse group of Gram-negative, oxygenic photosynthetic prokaryotes that originated 3.5 billion years ago and distributed in all possible biotopes of the world. The Similipal Biosphere Reserve, a unique ecosystem in the eastern part of India, occupy the northern boundary of Odisha state, lies between 21°28' to 22°08' North latitude and 86°04' to 86°37' East longitude, covering a vast area of 5578 sq. km. It is the richest watershed in the state of Odisha giving rise to many perennial freshwater bodies rich in diverse microalgae including cyanobacteria. In the present investigation, cyanobacterial samples were collected from different freshwater habitats of Similipal Biosphere Reserve including river, stream, canal and rice fields. In this study altogether 58 cyanobacterial forms belonging to 23 genera were characterized. Out of these 27 forms were heterocystous and 31 were non-heterocystous. They belonged to 2 orders namely Chroococcales and Nostocales of Cyanophyta. The most common cyanophycean members were Aphanothece, Gloeocapsa, Microcystis, Gomphosphaeria, Merismopedia, Oscillatoria, Phormidium, Lyngbya, Microcoleus, Microchaete, Anabaena, Nostoc, Aulosira, Raphidiopsis, Cylindrospermum, Calothrix, Gloeotrichia, Scytonema, Hapalosiphon, Nostochopsis, Mastigocoleus, Mastigocladopsis and Westiellopsis. Oscillatoria was the most abundant and dominant cyanobacteria followed by Phormidium, Lyngbya, Anabaena, Calothrix and Nostoc etc.

Keywords: Cyanobacteria, Diversity, Freshwater and Similipal Biosphere Reserve.

Recent Trends in Life Sciences





Editors

Prof. Jogen C. Kalita Prof. Partha P. Baruah



UGC - HRDC Gauhati University, Guwahati Recent Trends in Life Sciences ISBN: 978-93-87263-67-3

Cyanobacteria as a most important and potential source of antimicrobial secondary metabolites

Harisankar Dey*

Abstract

Cyanobacteria have been explored for their bioactive compounds with promising applications encompassing antibacterial, antivial, antifungal and anti-algal activities. Considering the present stans of widely used treatment therapies and their limitations to tackle their adverse effects, the application of bioactive compounds derived from cyanobacteria and other microalgae will prove beneficial and much more effective as compared with traditional treatment methods. The production of secondary metabolites by cyanobacteria has an interesting scientific and commercial potential important group of prokaryotes that needs through investigation for bioactive metabolites particularly those that are less studied and unexplored

Key words: Cyanobacteria, antimicrobial, secondary metabolites

Introduction:

Cyanobacteria are extraordinarily diverse group of Gram-nege oxygenic photosynthetic prokaryotes that originated 3.5 billion year and distributed in all possible biotopes of the world. Due to their occur *P.G. Der

*P.G. Department of Botany, Ramakrishna Mission Vivekananda College (Autonomous, College with Potential forExcellence, NAAC Rahara, Kolkata-700118, West Bengal, India, E-mail:-harisankardey and the standard sta

Biotechnology and Nature

Dulal De Sovan Roy Gopal Chandra Bera

3

3'

De. Dulal, S. Roy, G. C. Bera (2018) (Editors), Biotechnology and Nature, Kabitika, Pages 260. ISBN 978-93-87602-66-3

Antimicrobial screening of naturally occurring freshwater filamentous green algae *Spirogyra* sp.

Harisankar Dey

Abstract

Green algae have been recognized during the last several years as sources of novel cytotoxic, anti-viral, antialgal, growth stimulatory, antibacterial and antifungal metabolites as well as specific enzyme inhibitors. Spirogyra is a filamentous green algae commonly found in freshwater bodies. The aim of the present work is to study the antimicrobial screening of the cell extracts of naturally occurring freshwater green algae Spirogyra sp. against clinically significant microorganisms. In this study five test pathogens have been considered, these are two Gram-positive bacteria namely Bacillus subtilis and Staphylococcus aureus, one Gram-negative bacterium Escherichia coli and pathogenic fungi Candida albicans and Candida krusei. Crude metabolites have been extracted using four solvents namely Chloroform, Methanol, Butanol and Petroleum ether. The antimicrobial activities of crude extracts have been evaluated using agar cup diffusion method. Among the solvents highest antimicrobial activity is detected in Methanol extracts followed by Chloroform, Butanol and Petroleum ether extracts in case of pathogenic bacteria. But in case of pathogenic fungi highest activities have been detected in Methanol extracts followed by Butanol, Petroleum ether and Chloroform extracts. The methanolic crude extracts have showed highest zone of inhibition against Candida krusei (27.87 mm) followed by Escherichia coli (26.90 mm) and Staphylococcus aereus (26.13 mm) respectively. The lesser activities have been detected in petroleum ether extracts against Escherichia coli (13.03 mm), Staphylococcus aereus (13.06 mm) and Bacillus subtilis (12.90 mm). The present findings of antimicrobial activity of filamentous green algae

Harisankar Dey: P. G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College, (Autonomous), Rahara, Kolkata-700118, West Bengal, India.

E-mail: harisankardey@gmail.com

11111111 76

Chittaranjan Kole Editor

Genomic Designing for Biotic Stress Resistant Pulse Crops



Chapter 8 Genomic Designing Towards Biotic Stress Resistance in Mungbean and Urdbean



Anirban Kundu, Sayak Ganguli, and Amita Pal

Abstract Mungbean (Vigna radiata) and urdbean (V. mungo) are considered two important crops amongst the Asiatic Vigna species, which are primarily farmed for food, fodder and manure, and have emerged as a suitable alternative to other grain legumes. Despite their agronomic relevance, these two species have a limited crop production, yielding just one-third to one-fourth of their full potential. The key factor behind low yield can be attributed to various biotic stresses (pathogenic infection and insect infestation) that occur at all phases of plant growth as well as post-harvest period. The major contributors in this regard are the Yellow mosaic virus, Macrophomina blight, powdery mildew, anthracnose, Cercospora leaf spot, bacterial leaf spot, root-knot nematodes, and post-harvest pests, such as bruchids. Development of new cultivars through conventional breeding could be an alternative, but the narrow genetic base of these two crops has hindered the progress. Additionally the time-consuming and labor-intensive nature of the traditional breeding techniques has aggravated the problem further. To accelerate the breeding process scientists have turned towards genomic tools, particularly OTL mapping and genomics-assisted breeding which provide potential ways for development of elite cultivar for biotic stress resistance. Despite sincere efforts, both mungbean and urdbean are slow runner in genomics research, although mungbean was one of the pioneer legumes targeted for genome analysis at the dawn of the plant genomics era. Completion of the mungbean genome sequence in 2014 and the recent de novo sequencing of the urdbean genome in 2020 has empowered the researchers to develop genomic resources and identification and mapping of potential gene(s) associated with biotic stress resistance. The present chapter therefore covers the various biotic constrains in the production of mungbean and urdbean and cumulates the previous, current and future endeavors on

A. Kundu

S. Ganguli

A. Pal (🖾) Division of Plant Biology, Bose Institute, Kolkata, West Bengal, India e-mail: amita@jcbose.ac.in

P.G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Rahara, West Bengal, India

Department of Biotechnology, St. Xavier's College (Autonomous), Kolkata, West Bengal, India

[©] The Author(s), under exclusive license to Springer Nature Switzerland AG 2022 C. Kole (ed.), *Genomic Designing for Biotic Stress Resistant Pulse Crops*, https://doi.org/10.1007/978-3-030-91043-3_8

Protective Chemical Agents in the Amelioration of Plant Abiotic Stress

Biochemical and Molecular Perspectives

Edited by

Aryadeep Roychoudhury Department of Biotechnology St. Xavier's College (Autonomous), Kolkata Kolkata, India

Durgesh Kumar Tripathi Amity Institute of Organic Agriculture Amity University Uttar Pradesh Noida, Uttar Pradesh, India

WILEY Blackwell

Sugars and Sugar Polyols in Overcoming Environmental Stresses

Saswati Bhattacharya¹ and Anirban Kundu²

¹ Department of Botany, Dr. A.P.J. Abdul Kalam Government College, New Town, Rajarhat, West Bengal, India ² P.G. Department of Botany, Ramakrishna Mission Vivekananda Centenary College, Rahara, West Bengal, India

4.1 Introduction

4

Plants require an array of abiotic factors such as sunlight, temperature, moisture, water, mineral salts, nutrients, as well as O₂ and CO₂ in order to attain optimal growth. Each of these abiotic factors has a precise effect on plant growth and development, which depends on its magnitude and concentration. Any deviation in the intensity of these optimal abiotic factors in their chemical or physical environment may lead to a condition known as abiotic stress (Bray et al. 2000; Paul and Roychoudhury 2019). Under natural environments, plants are very often exposed to these abiotic stresses that adversely affect plant growth, development, and reproduction (Rosa et al. 2009; Roychoudhury et al. 2009). Drought, salinity, heat, and freezing temperature are important examples of such environmental adversities that restrict the plants from displaying their full genetic potential and account for extensive crop loss (Cramer et al. 2011; Keunen et al. 2013; Roychoudhury et al. 2008).

In plants, abiotic stress involves three primary phases comprising stress sensing, signaling, and exhaustion. Early phases of stress involve sensing or perception of the adverse abiotic stimuli through various sensors and induce a signaling cascade that relays the stress signal to the interior of the cell (Roychoudhury and Banerjee 2017). This eventually leads to an alteration in gene expression, thereby changing the host physiology and metabolism referred to as exhaustion (Rosa et al. 2009; Duque et al. 2013). Additionally, a fourth phase known as regeneration may come into existence that involves partial or total normalization of the physiological aspects of the plants upon removal of the stress factors. Continuous agitations of these stress factors may result in reduced photosynthesis, impaired water transport, osmotic imbalance, disturbed ion homeostasis, membrane instability, and oxidative stress through excessive generation of reactive oxygen species (ROS) that collectively hinder growth and development of plants (Rosa et al. 2009; Van den Ende and El-Esawe 2014; Roychoudhury et al. 2016).

To counter the impact of these hostile environmental conditions, plants have evolved complex molecular and physiological stratagems that aid in their survival under these

Protective Chemical Agents in the Amelioration of Plant Abiotic Stress: Biochemical and Molecular Perspectives, First Edition. Edited by Aryadeep Roychoudhury and Durgesh Kumar Tripathi. © 2020 John Wiley & Sons Ltd. Published 2020 by John Wiley & Sons Ltd.

An Insight into GREEN CHEMISTRY

Hell.

2/07

Chandrakanta Bandyopadhyay



ABOUT THE BOOK

Green Chemistry has now become an integral part of every chemistry curriculum all over India to make the coming generations aware about the sustainable developments. Use of renewable feedstock as starting material, use of alternative energy sources, use of benign solvent as reaction medium, performing reactions under ambient conditions, minimization of by-products are some of the prime criteria of green chemistry. This book is an endeavor to enlighten the readers with the inner sense of green chemistry. Once the inner sense ignites the readers mind, the systematic development may become easier in the field of green chemistry.

CONTENTS

- Introduction
- Alternative energy sources used in Chemical reactions: Microwave (Introduction, Generation, Interaction with materials, Theory, and Examples): Ultrasound (Sonochemistry): (Introduction, Generation, Theory, and Examples); Mechanical energy (Mechanochemistry): (History, Theory, Different effects, Reactors, Examples and Industrial importance).
- Solvents: Water (Types of reaction, Properties of water, Theory of organic reactions in aqueous medium and Examples): Aqueous miceliar readium (Surfactani-classification, Mechanism of reactions, Examples); Supercritical CO₂ (scCO₂) (Introduction, Properties, Utility, Drwaback, Examples, Micelle technology in scCO₂); Gas-Expanded Liquids (GXLs) (Introduction, Types, Properties, Utility, Drawback, Examples); Ionic Liquid (IL) (Introduction, Criteria of IL, Preparation, Effect of IL on Organic Reaction, Examples); Fluorous biphasic solvent; Polyethylene glycol (PEG).
- Green Synthesis of some compounds: Adipic acid, Catechol, Disodium iminodiactate (DSIDA), Ibuprofen
- Greener approaches in Industrial application: Green Oxidant, Marine antifoulant, Rightfit Pigments, Poly Lactic acid, Healthier fats and oils, Gradie to Gradle carpeting, Biofuels.
- Practical experiments related to Green Company.
- Revision Questions with short answers.

ABOUT THE AUTHOR



Chandrakanta Bandyopadhyay received his B. Sc., M. Sc. and Ph. D. degrees in Chemistry from the University of Calcutta in 1978, 1980 and 1987, respectively. He worked under the supervision of Prof. C. K. Ghosh for his doctoral degree. He joined the Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Kolkata as a junior Lecturer in the year 1984. At present he is working as the Head of that department. He did his postdoctoral

research in the Department of Chemistry, Academia Sinica, Nankang, Taipei in 1991 with Prof. Ruben J. R. Hwu. His independent research interest lies on the chemistry of chromones, bichromones and bischromones, and multicomponent reactions based on chromone skeleton in micellar media. He has so far more than fifty publications with principal authorship in this field and has supervised five PhD students. He has been honored with (i) Prof. Navneeth Rao Best Teacher Award in 2013 by A. V. Rama Rao Research Foundation, Hyderabad and (ii) Coastal Chemical Research Society Award (Category C) in 2015.



BOOKS & ALLIED (P) Ltd.

No. 1-E(1) 'SHUBHAM PLAZA' (1st Floor) 83/1, Beliaghata Main Road, Kolkata 700010 *Tel*: (033)23740062, 8274085530 *e-mail*: booksandallied1960@gmail.com, booksmktng@gmail.com





An Insight in GREEN CHEMISTRY

Chandrakanta Bandyopadhyay

ABOUT THE BOOK

Green Chemistry has now become the integral part of every chemistry curriculum all over India to aware the coming generations about the sustainable developments. Use of renewable feedstock as starting material, use of alternative energy sources, use of benign solvent as reaction medium, performing reactions under ambient conditions, minimization of by-product are some of the prime criteria of green chemistry. This book is an endeavor to enlighten the readers with the inner sense of green chemistry. Once the inner sense ignites the readers mind, the systematic development may become easier in the field of green chemistry.

CONTENTS

- Introduction
- Alternative every sources used in Champarresections: Microwave (Introduction, Generation, Interaction with materials, Theory, and Examples): Ultrasound (Sonochemistry): (Introduction, Generation, Theory, and Examples); Mechanical energy (Mechanochemistry): (History, Theory, Different effects, Reactors, Examples and Industrial importance).
- Solvents: Water (Types of reaction, Properties of water, Theory of organic reactions in aqueous medium and Examples); Aqueous micellar medium (Surfactant-classification, Mechanism of reactions, Examples); Supercritical CO₂ (scCO₂) (Introduction, Properties, Utility, Drwaback, Examples, Micelle technology in scCO₂); Gas-Expanded Liquids (GXLs) (Introduction, Types, Properties, Utility, Drawback, Examples); Ionic Liquid (IL) (Introduction, Criteria of IL, Proparation, Effect of IL on Organic Reaction, Examples); Fluorous biphasic solvent; Polyethylene glyc.
- Green Synthesis of some compounds: Adip Gatechol, Disodium iminodiactate (DSIDA), Ibuprofen
- Greener approaches in Industrial application: Green Oxidant, Marine antifoulant, Rightfit Pigments, Poly Lactic acid, Healthier fats and oils, Cradle to Cradle carpeting, Biofuels.
- Practical experiments related to Green Chemistry.
- Revision Questions with short answers.

ABOUT THE AUTHOR

Chandrakanta Bandyopadhyay received his B. Sc., M. Sc. and Ph. D. degrees in Chemistry from the University of Calcutta in 1978, 1980 and 1987, respectively. He worked under the supervision of Prof. C. K. Ghosh for his doctoral degree. He joined the Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Kolkata as a junior Lecturer in the year 1984. At present he is working as the Head of that department. He did his postdoctoral research in the Department of Chemistry, Academia Sinica, Nankang, Taipei in 1991 with Prof. Ruben J. R. Hwu. His independent research interest lies on the chemistry of chromones, bichromones and bischromones, and multicomponent reactions based on chromone skeleton in micellar media. He has so far more than fifty publications with principal authorship in this field and has supervised five PhD students. He has been honored with (i) Prof. Navneeth Rao Best Teacher Award in 2013 by A. V. Rama Rao Research Foundation, Hyderabad and (ii) Coastal Chemical Research Society Award (Category C) in 2015.



BOOKS AND ALLIED (P) Ltd.

No. 1-E(1) 'SHUBHAM PLAZA' (1st Floor) 83/1, Beliaghata Main Road, Kolkata 700010 *Tel*: (033)23740062, 8274085530 e-mail: booksandallied1960@gmail.com, booksmktng@gmail.com



Covering CBCS Syllabus

Basic Concepts on Solid Phase Synthesis and Combinatorial Chemistry





Chandrakanta Bandyopadhyay

ABOUT THE BOOK

In the newly introduced CBCS curriculum 'Solid phase synthesis', 'Reagents on solid support' and 'Combinatorial chemistry' are introduced into the B.Sc Honours and M.Sc curriculum of almost all universities. Combinatorial chemistry is a new branch of chemistry and is associated with drug discoveries in pharmaceutical industries. Earlier the drug discovery process was very slow, expensive and laborious because screening was performed with each individual pure sample. After the discovery of combinatorial chemistry, this screening process can now be carried out with mixture of samples without proper purification and success rate of finding lead compound becomes much higher than in earlier processes. The development of combinatorial chemistry is largely made on the solid phase synthesis of compound library. Syntheses of compound library and their de-convolution become easy when a compound is linked to a solid support. Solution phase synthesis of combinatorial library is also possible but suffers from some disadvantages during synthesis and de-convolution.

ABOUT THE AUTHOR



Chandrakanta Bandyopadhyay received his B.Sc, M.Sc. and Ph.D. degrees in Chemistry from the University of Calcutta in 1978, 1980 and 1987, respectively. He worked under the supervision of Late Prof. C. K. Ghosh for his doctoral degree. He joined the Department of Chemistry, Rama Krishna Mission Vivekananda Centenary College, Rahara, Kolkata as a junior lecturer in the Year 1984. At present he is working as the Head of that department. He did his postdoctoral research in the Department of Chemistry Academia Sinica, Nankang, Taipei, Taiwan in 1991 with Prof. Ruben J. R. Hwu. His independent

research interest lies in the chemistry of chre multicomponent reactions based on chromone altogether 67 research papers in peer reviewed of with principal authorship. He has supervised five. University of Calcutta. He has authored a book entite and insight into Green Chemistry" in May, 2019; second edition of this book has been published in 2021 with Books & Allied (P) Ltd.

bichromones and bischromones; micellar media. He has published d international journals of which 52 ments for their Ph.D. degree from the

He has been awarded with

- (i) Prof. Navneeth Rao Best Teacher Award in the year (2013) by A. V. Rama Rao Research Foundation, Hyderabad.
- (ii) Costal Chemical Research Society Award (Category C) in 2015.
- (iii) Certificate of Excellence in Teaching by UNICEF in 2021.



BOOKS & ALLIED (P) Ltd. No. 1E(1), 'SHUBHAM PLAZA'

83/1, Dr. S. C. Banerjee Road, Beliaghata, Kolkata 700010 Tel : (033)23740062, e-mail : booksandallied1960@gmail.com website : www.booksandallied.com



NATURAL PRODUCTS' CHEMISTRY

Editor Niranjan Das

Assistant Professor (Chemistry) Netaji Subhas Mahavidyalaya Udaipur, Gomati, Tripura (India)



Natural Products' Chemistry Editor: Dr. Niranjan Das (2017) Write & Print Publications, N.D.

Chapter 4

Antimicrobial and Antileishmanial Activity of Isoflavonoids Isolated from Seeds of *Millettia ferruginea*: An Endemic Legume Tree in Ethiopia

-MANASH KUMAR CHOUDHURY', YOSEPH SHIFERAW', KUMAR RANABIR SUR', DIGANTA DEY¹⁵, SUKALYANI DEBNATH⁵, SUBHALAKSHMI GHOSH⁵, RATNAMALA RAY¹, BANASRI HAZRA⁵

Introduction

Millettia ferruginea (Hochst.) Baker plants, with two distinct subspecies namely ferruginea and darassana belonging to Fabaceae (Leguminosae) family, are widely distributed within the agro-climatic zones of 1000-2500 meter above the sea level in Ethiopia (Andualem and Gessesse, 2014). This leguminous tree grows up to 25-meter high and often found in association with essential crops, like barley, sorghum and maize, demonstrating a beneficial effect owing to its nitrogen-fixing property. It also serves as shade tree in coffee plantation, and feeds the honey-bees on its flowers, while the leaves and shoots are mostly taken as fodder for the ruminants. Therefore, this endemic plant, known as 'Berbera' or 'Brebra' in local Amharic language, plays important role for the regional agro-forestry in Ethiopia (Hailu *et al.*,

^{*} Department of Chemistry, Dilla University, Dilla, P.O. Box 419, Ethiopia.

Department of Chemistry, R.K. Mission Vivekananda Centenary College, P.O - Rahara
 - 700 118, West Bengal, India.

Department of Pharmaceutical Technology, Jadavpur University, Jadavpur, Kolkata -700 032, India.

S Department of Microbiology, Ashok Laboratory Clinical Testing Centre Private Limited, Kolkata - 700068, India.





Fundamentals of Physical Science

Sisir Ranjan Majumdar Subhabrata Banerjee





Fundamentals of Physical Science

New Book Syndicate Kolkata 2 0962 Written according to the new syllabus of West Bengal Board of Secondary Education for class IX of all schools in West Bengal

FUNDAMENTALS OF PHYSICAL SCIENCE

Physical Science & Environment with Test Papers



Sisir Ranjan Majumdar, M.Sc., B.Ed.

Retired Selection Grade Lecturer in Physics, Panskura Banamali College, Midnapore.

Subhabrata Banerjee, M.Sc., Ph.D.

Asst. Professor, Postgraduate Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Rahara; Formerly Post Doctorate Fellow, Dept. of Chemical and Biomolecular Engineering, National University of Singapore.

Joydeep Dasgupta, B.E.E.

New Syllabus 2017

NEW BOOK SYNDICATE

www.booksyndicate.in

SCHOOLS SCHOOLS

Ten Teachers

SCHOOL SCHOOL

New Book Syndicate Kolkata 2 0657 Written for the students of Class VI of all schools of West Bengal according to the latest syllabus & curriculum.

NUT THE

SCHOOL SCIENCE

PHYSICS & CHEMISTRY & BIOLOGY

WITH PROJECT & SAMPLE PAPERS for SUMMATIVE EXAMINATION



TEN TEACHERS

Editorial Support

Prof. Arup Kumar Mitra, Ph.D. Prof. Debajyoti Chattopadhyay, Ph.D. Prof. Subhabrata Banerjee, Ph.D. Ms. Susmita Choudhury, M.A., B.Ed. Mr. Joydeep Dasgupta, B.E.E.

Revised, Enlarged and Updated 2nd Edition 2021

NEW BOOK SYNDICATE www.booksyndicate.in



শুভব্রত ব্যানাজ্জী





Book Syndicate (P) Ltd. Kolkata 1 3234

ISBN 978-81-933941-3-7

ত্রিপুরাসহ পশ্চিমবঙ্গের সমস্ত বিশ্ববিদ্যালয়ের নব্প্রবর্তিত B.Sc. (General) পাঠক্রম (CBCS) উপযোগী

প্রশোত্তরে **অজৈব রসায়ন** B. Sc. General Course

ড. শুভব্রত ব্যানার্জ্জী, এম. এস-সি., পি-এইচ. ডি.

অ্যাসোসিয়েট প্রফেসর, রসায়ন বিভাগ, রামকৃষ্ণ মিশন বিবেকানন্দ সেন্টিনারী কলেজ, রহড়া; Former Post Doctoral Fellow, ন্যাশনাল ইউনিভার্সিটি অফ সিল্গাপুর, সিল্গাপুর।

> New Syllabus 2017

ৰুৰু সিন্ডিকেট প্ৰাইভেট লিমিটেড

www.booksyndicate.in

PALIT'S Elementary Physical Chemistry



Palit Banerjee



Santik Godit

Prof. Santi Ranjan Palit was born in Kolkata on March 24, 1942. His father, Naranarayan Palit, had his ancestral home in the district of Barishal, now in Bangladesh. It was the strong influence and insistence of his mother Srimati Kusum Kumari that Prof. Palit could pursue his higher education despite several odds. He stood first class first in B.Sc. with Honours in Chemistry in 1931 and repeated the same feat in the M.Sc. Examination in the

year 1933. After struggling for two long years without any job, he could finally receive a research fellowship in the Department of Chemistry of the University of Calcutta. In the following year he joined Vidyasagar College, Kolkata as a faculty member and within a short time became very popular among the students and colleagues. It is during this time that he authored the book "Elements of Physical Chemistry" (1938), which became very popular among the students.

In July 1938, Prof. Palit joined Lac Research Institute in Ranchi as a Research Assistant. For this job he was interviewed at Shimla by the famous scientist Sir S.S. Bhatnagar. Impressed by depth of knowledge of Prof. Palit, he encouraged the young researcher to undertake independent research studies. Prof. Palit's work on cosolvency earned him the prestigious Premchand Roychand Scholarship and the D.Sc. degree from the University of Calcutta.

After the sudden demise of his father, Prof. Palit returned to Kolkata and in 1943, he joined Stanford University, U.S.A. at the invitation of famous scientist Prof. McBain. He also worked with Prof. Herman Mark at Polytechnic Institute of Brooklyn, New York on the emerging field of polymer science.

On his return to India, barely a couple of months before India was finally freed from the British rule, he was offered the post of head of the Department of Physical Chemistry at the prestigious Indian Association for the Cultivation of Science (IACS) by Prof. Meghnad Saha, the then president of IACS. Motivated by the nationalist spirit Prof. Saha outlined a massive expansion plan for the institute in terms of research activities. On his part, Prof. Palit contributed significantly, chalking out a comprehensive and integrated plan of research for the department and for himself.

Throughout his entire career, he contributed significantly in the frontier areas of Physical Chemistry and Polymer Science. In his lifetime, he could publish more than 350 research papers and earned recognition from India and abroad. He was nominated as the Fellow of National Academy of Science, Fellow of Indian National Science Academy and Fellow of Royal Institute of Chemistry (London).

Prof. Palit was engaged in active research work literally till the last day of his life (September 13, 1981). He will be remembered fondly as a dedicated and devoted researcher, a successful writer and as a popular teacher by the scientific community.

Book Syndicate (P) Ltd. Kolkata 1 3261 ISBN 978-81-89019-62-4

Written according to the syllabi for B.Sc.(CBCS) General course of Indian Universities

PALIT'S Elementary Physical Chemistry

B.Sc. GENERAL

By SANTI RANJAN PALIT

1.2-

M.Sc. (Gold Medalist), P.R.S., D.Sc. (Cal.); C. Chem., F.R.S.C. (Lond.); F. Ind. Acad. Sc., F.N.A. Professor Emeritus, Indian Association for the Cultivation of Science, Kolkata; Lately, Visiting Professor, University of Science & Technology, Kumasi, Ghana (W. Africa); University of Florida, U.S.A., and Fritz Hober Institute der Max Planck Gesellschaft, Berlin; Formerly, Research Associate, Stanford University, California and Polytechnic Institute, Brooklyn, New York, U.S.A.; Formerly of Lac Research Institute, Ranchi and Vidyasagar College, Kolkata.

Edited & Updated by SUBHABRATA BANERJEE

M.Sc., Ph.D. Associate Professor, Department of Chemistry (with Post Graduate Section) Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata; Formerly Post Doctoral Fellow, Department of Chemical & Biomolecular Engineering, National University of Singapore.

> THIRTY-FIRST EDITION 2018

BOOK SYNDICATE PRIVATE LIMITED

www.booksyndicate.in

SCIENCE

Ten Teachers


SCHOOL SCIENCE

New Book Syndicate Kolkata 2 0657 Written for the students of Class VI of all schools of West Bengal according to the latest syllabus & curriculum.

SCHOOL SCIENCE PHYSICS & CHEMISTRY & BIOLOGY WITH PROJECT

TEN TEACHERS

Editorial Support Prof. Arup Kumar Mitra, Ph.D. Prof. Debajyoti Chattopadhyay, Ph.D. Prof. Subhabrata Banerjee, Ph.D. Ms. Susmita Choudhury, M.A., B.Ed. Mr. Joydeep Dasgupta, B.E.E.

New Syllabus

NEW BOOK SYNDICATE

www.booksyndicate.in

SCHOOL SCIENCE

Debajyoti Chattopadhyay Subhabrata Banerjee





New Book Syndicate Kolkata 2 0757 Written for the students of Class VII of all schools of West Bengal according to the latest syllabus & curriculum.

SCHOOL SCIENCE

PHYSICS & CHEMISTRY & BIOLOGY

Class 7

PROJECT • MODEL QUESTIONS

Prof. DEBAJYOTI CHATTOPADHYAY

M.Sc., Ph.D., F.Z.S.I.

Associate Professor and Head (Retd.), Department of Zoology, Ramakrishna Mission Vivekananda Centenary College, Rahara; Author, Life Science and Biology books for classes VI to XII in English and Bengali; 'Snatak Pranibidya'(B.Sc.-Gen.), 'Applied Zoology'(B.Sc.-Hons.).

Prof. SUBHABRATA BANERJEE

M.Sc., Ph.D.

Assistant Professor, Postgraduate Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Rahara; Author, 'School Science' (VIII) and 'Elements of Physical Science' (X).

Under the Editorship of **Joydeep Dasgupta**, B.E.E.

New Syllabus 2021

Bengal BOOK SYNDICATE Pvt. Ltd. www.booksyndicate.in

Debajyoti Chattopadhyay Subhabrata Banerjee

SCA

0

SCHOOL SCIENCE

New Book Syndicate Kolkata 2 0857

(IIIIII)

SCHOOL SCIENCE

PHYSICS & CHEMISTRY & BIOLOGY

Class 8

Including PROJECTS & MODEL QUESTIONS

Prof. DEBAJYOTI CHATTOPADHYAY

M.Sc., Ph.D., F.Z.S.I. Associate Professor and Head (Retd.), Department of Zoology, Ramakrishna Mission Vivekananda Centenary College, Rahara; Author, Life Science and Biology books for classes VI to XII in English and Bengali; 'Snatak Pranibidya'(B.Sc.-Gen.), 'Applied Zoology'(B.Sc.-Hons.).

Prof. SUBHABRATA BANERJEE

M.Sc., Ph.D.

Assistant Professor, Postgraduate Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Rahara; Author, 'School Science' (VI, VII, VIII) and 'Elements of Physical Science' (IX, X).

Under the Editorship of Joydeep Dasgupta, B.E.E.

New Syllabus 2021

NEW BOOK SYNDICATE www.booksyndicate.in

দীপ্তেন্দুভূষণ দত্ত শুভৱত ব্যানাৰ্জী

স্নাতক বসাহান

Book Syndicate (P) Ltd. Kolkata 1 3208 কলিকাতা বিশ্ববিদ্যালয়ের B. Sc. (General) নবপ্রবর্তিত পাঠক্রম অনুযায়ী লিখিত

অধ্যাপক শুভৱত ব্যানাৰ্জী

অ্যাসোসিয়েট প্রফেসর, রসায়ন বিভাগ (স্নাতকোত্তর বিভাগ-সহ) রামকৃষ্ণ মিশন বিবেকানন্দ শতবার্ষিকী মহাবিদ্যালয়, রহড়া

অধ্যাপক দীপ্তেন্দুভূষণ দত্ত

অ্যাসোসিয়েট প্রক্ষেসর (অবসরপ্রাপ্ত), *রসায়ন বিভাগ,* মহারাজা মণীন্দ্র চন্দ্র কলেজ, কলকাতা

> প্রথম প্রকাশ : 2022 CBCS

বুক সিন্ডিকেট প্রাইভেট লিমিটেড www.booksyndicate.in

NOBLE METAL-METAL OXIDE HYBRID NANOPARTICLES

Edited by Satyabrata Mohapatra, Tuan Anh Nguyen and Phuong Nguyen-Tri

Noble Metal–Metal Oxide Hybrid Nanoparticles: Fundamentals and Applications explores the next generation of nanomaterials, which are constructed from at least two different nanomaterials, in order to overcome the limits of single components, to improve properties, to achieve new properties not presented in their counterparts, and/or to achieve multiple functionalities for single nanoparticle. In the first part of the book, the chapters focus on the rational design, controlled synthesis, advanced characterizations, and in-depth understanding of structure– property relationships. The second part emphasizes the promising applications of these hybrid nanoparticles in real world. The combined experimental/theoretical approach is highly demanded to rapidly advance this advanced nanomaterial that promises to revolutionize various aspects of our life and society from health, to clean energy, and to the environment.

End-User Key Features

- Provides the fundamentals of hybrid nanoparticles, including synthesis, characterization, and properties.
- Explains how the hybrid nanoparticles can exhibit the superior features, as compared to the single individual nanoparticles.
- Introduces last emerging applications of the hybrid nanoparticles, including nanocatalyst, theranostics, sensors, antibacterials, energy conversion, and storage.

Related Titles

- *Epitaxial Growth of Complex Metal Oxides* 1e Gertjan Koster, M Huijben and GuusRijnders - 9781782422457
- Ultrasmall Lanthanide Oxide Nanoparticles for Biomedical Imaging and Therapy - 1e - Gang Ho Lee and Jeong-Tae Kim - 9780081000663
- Applications of Graphene and Graphene-Oxide based Nanomaterials -1e - Sekhar Ray - 9780323375214

elsevier.com/books-and-journals

NOBLE

METAL-METAL

OXIDE HYBRID NANOPARTICLES

NOBLE METAL-METAL OXIDE HYBRID NANOPARTICLES

Fundamentals and Applications

Mohapatra • Nguy Nguyen-Tri

MATERIALS SCIENCE

ISBN 978-0-12-814134-2

Edited by Satyabrata Mohapatra Tuan Anh Nguyen Phuong Nguyen-Tri

Micro & Nano Techno, gies Series

To protect the rights of the author(s) and publisher we inform you that this PDF is an uncorrected proof for internal business use only by the author(s), editor(s), reviewer(s), Elsevier and typesetter MPS. It is not allowed to publish this proof online or in print. This proof copy is the copyright property of the publisher and is confidential until formal publication.

CHAPTER

c0002

Theoretical Aspects of Synthesis for Controlled Morphological Nanostructures

Sougata Sarkar¹ and Tarasankar Pal²

¹Department of Chemistry, Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata, West Bengal, India ²Department of Chemistry, Indian Institute of Technology, Kharagpur, West Bengal, India

s0010

2.1 NUCLEATION AND GROWTH OF NANOPARTICLES: THEORETICAL PERSPECTIVES

- p0010 Different existing methods of fabrication towards the growth of nanoparticles, nanocrystals, and quantum dots are worth mentioning, where each method is more ideal for the generation of one single category of nanoparticle having a different size and shape. Little changes in the experimental parameters can considerably affect the properties of the nanomaterials. And hence, the growth mechanisms of them are often difficult to understand in detail and therefore offer a challenge to the scientific community to find out the same. This understanding of the mechanism leading to the growth of the particles in the nanoregime is important for both scientific and for technological considerations. For many years, there has been a common acceptance that the nucleation and growth of nanoparticles can be analyzed by LaMer burst nucleation and a diffusion limited Ostwald ripening process.
- p0015 So here we will highlight the theoretical aspects of nucleation and growth of nanoparticles following the anticipated theoretical frameworks as described below.

2

An Approach toward Character Recognition of Bangla Handwritten Isolated Characters

 $(\mathbf{\Phi})$

Payel Rakshit, Chayan Halder and Kaushik Roy

CONTENTS

۲

| 2.1 | Intro | duction | 15 |
|------|---------|--|----|
| 2.2 | Prope | osed Framework | 16 |
| | 2.2.1 | Database | 17 |
| | 2.2.2 | Feature Extraction | 18 |
| | 2.2.3 | Attribute Selection and Classification | 18 |
| 2.3 | Resul | ts and Discussion | 20 |
| | 2.3.1 | Comparative Study | 21 |
| 2.4 | Conc | lusion | 26 |
| Refe | erences | | |
| | | | |

2.1 Introduction

Recognition of characters from their images is one of the most essential tasks in the field of computer vision. Optical character recognition (OCR) has lately become a very interesting field of research, especially for Indic scripts, due to its potential in Asian countries like India. The task, however, is quite difficult when images of handwritten characters are considered [1, 2]. Recently, various works on character recognition from handwritten characters have become available [1-13], while some very established standard character recognition systems from printed characters are already commercially available [14, 15]. Numerous techniques on several scripts [3] for offline isolated character recognition have already appeared in the literature. Bhowmik et al. [3] proposed two-stage hierarchical learning architectures based on a support vector machine (SVM), whereas Bhattacharya et al. [5] proposed an efficient two-stage approach for Bangla handwritten character recognition and achieved very good recognition accuracy with a multi-layer perceptron (MLP) classifier. Maitra et al. [6] also developed an approach for the handwritten character recognition of multiple scripts based on a convolution neural network (CNN). At the same time, Surinta et al. [7] contributed ۲

READ—A Bangla Phoneme Recognition System

Himadri Mukherjee, Chayan Halder, Santanu Phadikar and Kaushik Roy

Abstract Speech Recognition is a challenging task especially for a multilingual 1 country like India as the speakers are habituated in using mixed language and 2 accent. Bangla is a very popular language in East Asia and a fully functional Automated Speech Recognition System (ASR) for it is yet to be developed. Every language embodies a set of sounds called phoneme set, which is the building block for 5 the words of that language. READ (Record Extract Approximate Distinguish) is a 6 Bangla phoneme recognition system, proposed toward the development of a Bangla 7 ASR. To start with, Mel Scale Cepstral Coefficient (MFCC) features have been used for testing on a database of 1400 Bangla vowel phonemes and an accuracy of 98.35 % has been obtained. 10

AQ1 AQ2

12 **1** Introduction

11

¹³ To use the digital resources more and more in a convenient way, the user interface

Keywords READ · ASR · Phoneme · MFCC · Approximation · MLP

of the devices needs to be brought within the grasp of the rustics. The user interface

should be designed in such a way so that the users feel that they are interacting with

their peers and not a device. One way of achieving this is making the devices verbally

C. Halder e-mail: chayan.halderz@gmail.com K. Roy

e-mail: kaushik.mrg@gmail.com

S. Phadikar Department of Computer Science & Engineering, Maulana Abul Kalam Azad University of Technology, Kolkata, India e-mail: sphadikar@yahoo.com

© Springer Nature Singapore Pte Ltd. 2017 S.C. Satapathy et al. (eds.), *Proceedings of the 5th International Conference on Frontiers in Intelligent Computing: Theory and Applications*, Advances in Intelligent Systems and Computing 515, DOI 10.1007/978-981-10-3153-3_59 1

421448_1_En_59_Chapter 🖉 TYPESET 🗌 DISK 🗌 LE 🖉 CP Disp.:4/11/2016 Pages: 10 Layout: T1-Standard

H. Mukherjee (∞) · C. Halder · K. Roy

Department of Computer Science, West Bengal State University, Kolkata, India e-mail: himadrim027@gmail.com

Line, Word, and Character Segmentation from Bangla Handwritten Text—A Precursor Toward Bangla HOCR

Payel Rakshit, Chayan Halder, Subhankar Ghosh and Kaushik Roy

Abstract The basic functionalities of optical character recognition (OCR) are to recognize and extract text to digitally editable text from document images. Apart from this, an OCR has other potentials in document image processing such as in automatic document sorter, writer identification/verification. In current situation, various commercially available OCR systems can be found mostly for Roman script. Development of an unconstrained offline handwritten character recognition system is one of the most challenging tasks for the research community. Things get more complicated when we consider Indic scripts like Bangla which contains more than 280 modified and compound characters along with isolated characters. For recognition of handwritten document, the most convenient way is to segment the text into characters parts. So line, word and character level segmentation plays a vital role in the development of such a system. In this paper, a scheme for tri-level segmentation (line, word, and character) is presented. Encouraging segmentation results are achieved on a set of 50 handwritten text documents.

Keywords OCR \cdot Bangla handwritten character recognition \cdot Line segmentation Word segmentation \cdot Character segmentation

C. Halder e-mail: chayan.halderz@gmail.com

S. Ghosh e-mail: sgcs2005@gmail.com

K. Roy e-mail: kaushik.mrg@gmail.com

© Springer Nature Singapore Pte Ltd. 2018 R. Chaki et al. (eds.), *Advanced Computing and Systems for Security*, Advances in Intelligent Systems and Computing 666, https://doi.org/10.1007/978-981-10-8180-4_7 109

P. Rakshit (🖂) · C. Halder · S. Ghosh · K. Roy

Department of Computer Science, West Bengal State University, Barasat, Kolkata 700126, West Bengal, India e-mail: prmylife20@gmail.com

Word-Level Multi-Script Indic Document Image Dataset and Baseline Results on Script Identification

S. K. Obaidullah, Department of Computer Science and Engineering, Kolkata, India

K. C. Santosh, Department of Computer Science, The University of South Dakota, Vermillion, SD, USA

Chayan Halder, West Bengal State University, Kolkata, India

Nibaran Das, Jadavpur University, Kolkata, India

Kaushik Roy, West Bengal State University, Kolkata, India

ABSTRACT

Document analysis research starves from the availability of public datasets. Without publicly available dataset, one cannot make fair comparison with the state-of-the-art methods. To bridge this gap, in this paper, the authors propose a word-level document image dataset of 13 different Indic languages from 11 official scripts. It is composed of 39K words that are equally distributed i.e., 3K words per language. For a baseline results, five different classifiers: multilayer perceptron (MLP), fuzzy unordered rule induction algorithm (FURIA), simple logistic (SL), library for linear classifier (LibLINEAR) and bayesian network (BayesNet) classifiers are used with three state-of-the-art features: spatial energy (SE), wavelet energy (WE) and the Radon transform (RT), including their possible combinations. The authors observed that MLP provides better results when all features are used, and achieved the bi-script accuracy of 99.24% (keeping Roman common), 98.38% (keeping Devanagari common) and tri-script accuracy of 98.19% (keeping both Devanagari and Roman common).

KEYWORDS

Multi-Script Documents, Official Indic Script Database, Script Identification

1. INTRODUCTION

The work of multi-script document processing has an importance for a country like India, where 23 different official languages (including English) are present and 11 different scripts are used to write them. We handle various multi-script documents in our day to day life and automatic processing of those documents is a pressing need in this digital era. In general, OCRs are script specific, and processing documents having more than one script is not easy. Therefore, one of the common/suggested solutions is to develop a script identification system (SIS), so that we can take it as a precursor to the specific OCR. To adress this issue, in this paper, we present a database that is composed of 13 different languages from 11 different scripts (having fairly large amount words in it) for automatic

DOI: 10.4018/IJCVIP.2017040106

Copyright © 2017, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

script identification in multi-script documents. Figure 1 shows a general block diagram for multiscript document processing system.

Since last decade, researchers have addressed Indic script identification problem. But very few works are available till date. Among them, one work has been reported (Pati et al. 2008), which consider 11 different scripts in their study. They have used a database from 11 different languages, where two languages: Kashmiri and Dogri originating from Northan part of India were not considered. To represent the scripts, two texture based features namely Gabor filter and directional cosine transform (DCT) based frequency domain techniques were used. Based on these features, their reported performances are 98% for bi-Script and tri-Script, and 89% for eleven-scripts by using three different classifiers: nearest neighbor, linear discriminative and support vector machine (SVM). Since then, this can be considered as a benchmark work on printed script identification (PSI) at word level.

Considering other popular works on Indic and non-Indic scripts, a textual feature based technique has been proposed (Hochberg et al. 1997) and tested on identify six different scripts: Arabic, Armenian, Devanagari, Chinese, Cyrillic, and Burmese. This is one of the earlier works addressing the script identification problem. In this work, only one Indic script was considered along with five non-Indic scripts.

An attempt for line level script identification (Pal et al. 2002) was proposed and tested on five different scripts: Bangla, Devanagari, Chinese, Arabic and Roman.

A technique (Jahawar et al. 2003) using headline and contextual information based features was proposed to identify Devanagari and Telugu scripts. In addition with that, PCA was used to reduce the feature vector size and the classification was done using SVM.

A Gabor energy based technique with k-nearest neighbor (k-NN) classifier (Joshi et al. 2006) for paragraph level script identification was proposed and tested on ten different Indic scripts. Comparing with the earlier works, the number of scripts considered in this work was good enough covering most of the official Indic scripts.

A technique (Dhanya et al. 2002) using using Gabor filter based directional feature and SVM classifier was proposed to separate Tamil and Roman scripts.

A method for script identification by combining trainable classifiers has been proposed (Chaudhury et al. 2000) and tested on six different scripts: Devanagari, Telugu, Roman, Malayalam, Bangla and Urdu.

In the script identification review paper (Ghosh et al. 2010; Singh et al. 2015), authors pointed out the unavailability issue of benchmark works by considering all official Indic scripts. Following this review, we are, indeed, motivated to publish a benchmark database and results considering all 13 official Indic scripts.

The remainder of the paper is organized as follows. In Section 2, we discuss about the languages considered in this work. In Section 3, we explain our database. We then describe our method in section 4. It includes preprocessing, feature extraction, and script identification. In section 5, we provide experimental test results and analysis. We conclude the paper in section 6.

2. SCRIPTS AND LANGUAGES OF INDIA

A script is defined as a set of notations to represent a single language or a class of languages. When a particular script is used for a single language then script identification and language identification has the same meaning. Examples of such scripts are Dogri, Oriya etc. On the other side many languages are available with common script for all of them. One popular example of such script is Devanagari script which is used by languages like Bodo, Konkani, Marathi, Maithili, Nepali, Sanskrit, Sindhi, and Hindi etc. Roman script is used by English and Santali language in India. So in these cases a priori script identification is must for language identification.

Script Identification system vary widely in the way they acquire their input data (text image), the mode of text being acquired (whether it is a printed or handwritten text). As we have already mentioned, in general, script identification systems are divided according to raw data (image) acquisition into two main systems namely Off-line and On-line script identification systems. Again they are divided into Handwritten and Printed category depending upon the text being acquired.

A brief description about official Indian languages is presented in the following paragraph onwards.

2.1. Bangla

Originated from the Indo-European language family, is the state language of West Bengal and Tripura. People living in Bihar, Dhanbad, Manbhum, Singhbhum, Santal Parganas of Jharkhand, Garo Hills of Meghalaya, Goalpara District of Assam, Nagaland and Mizoram also use this language. It is spoken by 181 million population of India.

2.2. Hindi

One of the most popular languages in India uses this script. Under Indo-European language family, Hindi is predominantly used by about 182 million people residing in the northern parts of India namely in Uttar Pradesh, Himachal Pradesh, Uttaranchal, Delhi, Rajasthan, Punjab, Madhya Pradesh and northern Bihar.

2.3. Dogri

Dogri language is supposed to belong to the Indo-European family of languages. The language is used by people living in area between Chenab and Ravi rivers in Jammu and Kashmir, Chandigarh and West Bengal. About 3.8 million people use this language.

2.4. Gujarati

Gujarati, originated from the Indo-European language family, Gujarati is the State language of Gujarat. People living in Rajasthan, Madhya Pradesh, Maharashtra and Karnataka also use Gujarati. The language is spoken by 46.5 million population of India.

2.5. Gurumukhi

The origin of *Punjabi* language can be traced to the Indo-European language group. It is state language of Punjab. The language is spoken by 1.05 million population of India.

2.6. Kannada

Kannada, the origin of the language can be traced in the Dravidian language family. It is the State language of Karnataka. People living in other states like Tamil Nadu, Andhra Pradesh and Maharashtra also use this language. Kannada is spoken by 3.63 million Indian populations.

2.7. Kashmiri

Kashmiri, language is originated from the Indo-European language group. The language is spoken by people living in Jammu and Kashmir, Kashmir Valley, Punjab, Delhi and Uttar Pradesh. About 5.6 million people use this language as a medium of communication.

2.8. Malayalam

Malayalam language is said to belong to the Dravidian language family. It is the State language of Kerala. Malayalam is also used by inhabitants of the Laccadive Islands and neighboring states of Kerala. The language is spoken by 35.9 million population of India.

2.9. Oriya

Oriya, originated from the Indo-European language family. It is state language of Orissa. About 31.7 million population living in Assam, Singhbhum and Ranchi districts of Jharkhand, Raipur, Raigarh and Bastar districts of Chhattisgarh, Midnapore district of West Bengal and Vishakhapatnam District of Andhra Pradesh.

2.10. Roman

It is used to write *English* which is an International language. It, along with most European languages, is a descendant of the ancient Proto-Indo-European language family. About 328 million people in our country use this language as a communication medium.

2.11. Tamil

*Tamil, o*riginated from the Dravidian group of languages. It is the state language of Tamil Nadu and it is also spoken in the neighboring states. 65.7 million Indian population use Tamil as a medium of communication.

2.12. Telugu

Telugu, classified under the Dravidian language family, it is the State language of Andhra Pradesh. The language is also used by people living in the neighboring states. About 69.8 million of Indian population uses this language.

2.13. Urdu

Urdu, the language is said to have originated from the Indo-European language family. Urdu is the State language of Jammu and Kashmir. About 60.6 million of Indian population residing in Jammu and Kashmir and other Muslims use this language.

3. DATABASE

The major contribution of the present work is a word-level document image dataset from thirteen languages. As shown in Table 1 our database of thirteen different official Indic languages: 1) Bangla

| Language | Sample 1 | Sample 2 |
|---------------|-------------|-------------|
| 1. Bangla | কলকাতা | বিদ্যুৎ |
| 2. Devanagari | जनश्रुतियाँ | पाकिस्तान |
| 3. Dogri | मुक्खमंत्री | अधिकारें |
| 4. Gujarati | વિસ્તારમાં | મહિલાઓ |
| 5. Gurumukhi | ਸਮੀਖਿਆ | ਕਰਵਾੳੲ |
| 6. Kannada | ಮೊನ್ನೆಯಷ್ಟೇ | ವಹಿಸದೇ |
| 7. Kashmiri | اماپۇز | مسلسل |
| 8. Malayalam | തീവ്രവാദി | പോലീസ് |
| 9. Oriya | କରାଯାଇଛ | ଅଧିକାରୀଙ୍କୁ |
| 10. Roman | allegation | example |
| 11. Tamil | அளவில் | தொகுப்பு |
| 12. Telugu | శుక్రవారం | ఇచ్చినట్లు |
| 13. Urdu | عدالت | اقدامات |

| Table 1. Sam | ple word images | of 13 different | t official Indic lan | iquages, i.e. | . 11 different | scripts |
|--------------|-----------------|-----------------|----------------------|---------------|----------------|---------|
| | | | | | | |

(BEN), 2) Devanagari (DEV), 3) Dogri (DOG), 4) Gujarati (GUJ), 5) Gurumukhi (GUR), 6) Kannada (KAN), 7) Kashmiri (KAS), 8) Malayalam (MAL), 9) Oriya (ORY), 10) Roman (ROM), 11) Tamil (TAM), 12) Telugu (TEL), 13) Urdu (URD) with 3K words per languages. Altogether, we have collected 39K words. We have collected the samples from different newspaper, articles and books. For example, Bangla words were collected from scanned copy of different Tagore's books, novels, poems and newspaper. As a consequence, the collected samples vary writing style, thickness of the characters and resolution. Document image scanning was carried out using HP flatbed scanner, resolution 300 dpi and stored at 8-bit gray level jpeg format. The word dimension is found in the range of 150x50 pixels. Note that the word images are extracted by an automated process, as explained in (Hangarge et al. 2013).

The database is created for public use but, limited to research purpose. A part of the database is available on-line, and will be provided upon the request.

4. SCRIPT IDENTIFICATION

Our study is not an exception; we start with pre-processing, and then extract features for script identification purpose. In our study, we study three different features: 1) spatial energy (SE), 2) wavelet energy (WE) and 3) the Radon transform (RT), including their possible combinations, by using five different classifiers: 1) multilayer perceptron (MLP) (Obaidullah et al. 2014), 2) fuzzy unordered rule induction algorithm (FURIA) (Huhn et al. 2009), 3) simple logistic (SL) (Sumner et al. 2005) 4) LibLINEAR (Fan et al. 2008) and 5) BayesNet (Obaidullah et al. 2014). Again, our idea is not only to check what features but also to check what classifiers can consistently provide optimal performance.

4.1. Pre-Processing

The word images are binarized by using the following steps. 1) In grayscale word image, region-ofinterests (ROIs) are generated using a local window-based algorithm. Run length smoothing algorithm is applied to overcome the presence of stray/hollow regions generated due to window size. Connected component labelling is applied and the ROIs are mapped to the original grayscale images. 2) A global thresholding technique is then applied on ROIs because of the small sizes of the blocks. Figure 2 shows a general block diagram of the pre-processing stages.

4.2. Features

As said before, we propose to study three different features: spatial energy (SE), wavelet energy (WE) and the Radon transform (RT).

4.2.1. Spatial Energy (SE)

SE distribution varies in accordance with the change in textural information, and therefore, it is important in our study. SE distribution was observed by computing entropy on the grayscale images. It can be represented by:

$$Entropy = -\sum p(i, j) \log(p(i, j))$$

where p(i,j) is the probability of occurrence of the pixel intensity at location (i,j). In general, entropy is complement of energy. Therefore, for any non-uniform or aperiodic gray level distribution, there exists high entropy (Shanon 1949).

Another measure is the standard deviation of binary images of different scripts. Standard deviation is a measure of the variability of the image pixels. It can be represented by:

$$\sigma_{x} = \sqrt{\frac{1}{n} \left\{ \sum_{i=1}^{n} x_{i}^{2} - \frac{1}{n} \left(\sum_{i=1}^{n} x_{i} \right)^{2} \right\}}$$

where, $x_1, x_2, ..., x_n$ be n observations of a random variable X, which is representation of an arbitrary image pixel.

4.2.2. Wavelet Energy (SE)

For present work, wavelet packets has been generated using DWT or discrete wavelet transform (Mallet 1989) which uses sub-band coding on images with respect to spatial and frequency components and allows analysis the images from coarse to fine level. Here Daubechies wavelets dbN where N = 1, 2, 3 are chosen to generate sub-band images with approximation coefficients cA, cH, cV and

cD. Their advantage includes computational ease with minimum resource and time requirements. These orthogonal wavelets are characterized by maximum number of vanishing moments for some given support (Mallet 1989). Here a signal (for present work it is a word image) is decomposed into different frequencies with different resolutions for further analysis. In general the family of Daubechies wavelet is denoted as dbN, where the family is denoted by the term db and the number of vanishing moments is represented by N.

To study the applicability of wavelet analysis in our work, we studied that an image can be represented by the combinations of different coefficients i.e constant, linear, quadratic etc. Daubechies db1 represent the constant coefficient of the image component, db2 represent the linear and db3 can represent quadratic coefficients. So here, wavelet decomposition at level 1 has been made using db1, db2 and db3 which are capable enough to capture the constant, linear and quadratic coefficients of an image component. Four coefficients namely approximation coefficients (CA), horizontal coefficients (chi), vertical coefficients (cave), and diagonal coefficients (cod) has been generated.

To measure the WE or wavelet energy feature we have computed wavelet entropy on these approximation coefficients for each of the sub-band images.

Suppose ws is the word level image signal and $(ws_i)_i$ the coefficients of ws in an orthonormal basis. Then the normalized shanon entropy is defined as:

$$\begin{split} SE\left(ws_{i}\right) &= ws_{i}^{2} \; \log\left(ws_{i}^{2}\right) \\ SE\left(ws_{i}\right) &= -\sum ws_{i}^{2} \log\left(ws_{i}^{2}\right) \end{split}$$

It produces a feature vector of dimension fifteen.

4.2.3. The Radon Transform (RT)

Motivated by the presence of the strokes at different orientations in the word images, we propose to use the RT. The RT consists of a collection of projections of a pattern at different angles (Deans 1983), as illustrated in Figure 3. In other words, the radon transform of a pattern f(x, y) and for a given set of angles can be thought of as the projection of all non-zero points. This resulting projection is the sum of the non-zero points for the pattern in each direction, thus forming a matrix. The matrix

Figure 3. Illustration of the Radon transform theory (Santosh, K.C., Lamiroy, B., Wendling, B.: DTW for matching radon features: a pattern recognition and retrieval method. In: 13th International Conference on Advances Concepts for Intelligent Vision Systems, pp. 249–260 (2011)).

elements are related to the integral of f over a line $L(\rho, \theta)$ defined by $\rho = x \cos \theta + y \sin \theta$ and can formally be expressed as:

$$R(
ho, heta) = \iint_{-\infty}^{\infty} f(x,y) \delta(x\cos\theta + y\sin\theta -
ho) dxdy$$

where $\delta(.)$ is the Dirac delta function, $\delta(x) = 1$, if x = 0 and 0 otherwise. Also, $\theta \in [0, \pi)$ and $\rho \in]$ - ∞ , ∞ [. For the RT, *Li* is in normal form (ρ_{ρ}, θ_{j}).

Such a description is useful for scripts such as Bangla and Devanagari, where there exists horizontal line, known by the name `matra' or `shirorekha'. These clear lines can be exploited by computing 0^{0} projection. Similarly, scripts like Tamil and Roman have many vertical lines which can be represented by 90⁰. However, to exploit meaningful information, we do not require all possible orientations, and therefore, we study the RT at an interval of 15⁰.

To compute RT based feature vector we applied the Radon transform on each of the binary word images. Additionally RT spectrum of each of the sub band images is also obtained from Daubechies multi-resolution analysis using db1, db2 and db3 at level 1. Then statistical textural features are computed from the generated Radon spectrum. This step results a sixty five dimensional RT feature vector. First RT is computed on original images and twelve sub band images (generated using db1, db2 and db3), generating a total of thirteen RT images. Then five statistical features are computed on each of these RT images generating a total sixty five dimensional feature vector.

4.3. Script Classification

In our study, three different classifiers are used to train and to identify the words. They are MLP, FURIA and RF, which are briefly explained in the following.

4.3.1. Multilayer Perceptron (MLP)

It consists of multiple layers with number of neurons in each layer represented as a directed graph (Obaidullah et al. 2014). MLP uses back propagation algorithm (Roy et al. 2004) to train the network. In our experiment, we choose the configuration of the NN as 84-hl-13 (i.e., 84 number of attributes while taking SE+WE+RT and 13 output classes). We empirically designed the number of neurons in the hidden layer, hl.

4.3.2. Fuzzy Unordered Rule Induction Algorithm (FURIA)

It is a fuzzy-rule-based classifier which learns from fuzzy rules and unordered rule sets (Huhn et al. 2009). It is an extension of the well-known rule learner RIPPER algorithm (Cohen at al. 1995) which is a state-of-the-art rule learner technique. Its preserves its advantages, such as simple and comprehensible rule set for the learning. Along with that, RIPPER also includes a number of positive modifications and extensions. In particular, FURIA learns fuzzy rules instead of conventional rules and unordered rule sets instead of lists of rules. Moreover, to deal with uncovered examples, it makes use of an efficient rule stretching method.

4.3.3. Simple Logistic (SL)

SL is a classifier which builds linear logistic regression model (Sumner et al. 2005). As a base learner LogitBoost algorithm is used along with a simple regression function as follows to train the samples:

$$F\left(x\right) = \frac{1}{1 + e^{-\left(\beta_0 + \beta_1 x\right)}}$$

4.3.4. LibLINEAR

LibLINEAR is a sused to train a very larger set of data with a linear classification model (Fan et al. 2008). We have used L2 loss support vector machine as the SVM type parameter. For present experiment both the bias and cost parameter is set to 1.0.

4.3.5. BayesNet

The popular Bayesian classifier use Bayesian network learning algorithms like K2 and B to train the samples (Obaidullah et al. 2014).

5. EXPERIMENTS

5.1. Evaluation Metrics

To measure the performance of the system, we use the following metric:

 $Identification_{_{Rate}} = \frac{\# Correctly _Classified _Words}{\# Total _Words} \times 100\%$

where specifically, we have computed the features (cf. Section 3.2), their possible combinations, and classifiers (cf. Section 3.3) separately.

5.2. Setup

In our study, from 13 different languages from 11 different scripts, we have considered two different test categories: 1) bi-script and 2) tri-script. In general, there are ${}^{13}C_2$ and ${}^{13}C_3$ possible combinations of bi-script and tri-script categories. But, considering the nature of the multi-script documents, these straightforward combinations may not hold true in the real-world (e.g. postal documents and application forms). We have also observed that, Devanagari and Roman exist in most of the documents. This means that any bi-script or tri-script document in general contains either or both Devanagari and/or Roman in addition to their local script. Considering such a context, we have formed two different script sub-categories for bi-script case 1 and case 2. Bi-script case 1 contains twelve script combinations with Devanagari common. Bi-script case 2 contains Roman as common script, for all remaining 12 scripts. For tri-script category, we have a total number of 11 combinations where both Devanagari and Roman are kept as common with other local scripts.

Also, note that, we have divided the database into training and test sets as 2:1 ratio.

5.3. Results and Analysis

5.3.1. Feature Selection

Again, our experimental test framework can be summarized as follows. As said before, in this work, our idea is not only to check what features but also to check what classifiers can consistently provide optimal performance. Therefore, we have seven different tests in accordance with the use of individual features and their possible combinations: SE, WE, RT, SE+WE, SE+RT, WE+RT and SE+WE+RT. We found that the combination of SE, WE and RT produces the highest accuracy, i.e. 98.38% using MLP classifier. So, rest of the experiments is conducted with SE+WE+RT feature and five different classifiers to find the best classifier.

5.3.2. Comparing the Performance of Different Classifiers

In Table 2, average performance scores for different feature combinations are provided. The results are provided for bi-script case 1. One of the scores in this table is computed by making 12 numbers

| Feature Type (Dimension) | Accuracy (%) |
|--------------------------|--------------|
| SE (4) | 81.93 |
| WE (15) | 91.10 |
| RT (65) | 96.93 |
| SE+WE (19) | 94.83 |
| SE+RT (69) | 97.86 |
| WE+RT (80) | 97.80 |
| SE+WE+RT (84) | 98.38 |

Table 2. Bi-script case 1 (Devanagari common): Average performance scores (in %) for different feature combinations tested using MLP classifier

of runs as shown in Table 3. Altogether, we have 12 (bi-script combinations) x 3 (classifiers) = 36 runs, for just a single feature type. In Table 2, the best performance (i.e., 98.38%) is obtained when all features are combined, so in rest of the experiments this feature combination is used. In a similar fashion, bi-script case 2 has been tested, where Roman is common. Results are provided in Tables 4 and 5 for bi-script case 2 (see Tables 2 and 3). In the latter case (i.e., Table 4), the highest possible accuracy is 99.24%. Like before, best result is obtained when all features are combined (even for triscript combinations). In Table 6, average performance scores are provided for triscript combinations, where the highest possible identification rate is 98.19%. In this test, we have submitted 11(tri-script combinations) x 3 (classifiers) = 33 runs, for just a single feature type. Again, for a comparison

Table 3. Bi-script case 1 (Devanagari common): Average performance scores (in %) for 12 different combinations when all features (SE, WE, RT) are combined

| Bi | Bi-Script Recognition Accuracy (%) Keeping Devnagari as Common with one of the Twelve Scripts | | | | | | | | | | | | |
|-----------------|---|------|------|------|------|------|------|------|------|------|------|------|-------|
| Classifier | BEN | DOG | GUJ | GUR | KAN | KAS | MAL | ORY | ROM | TAM | TEL | URD | μ |
| MLP | 94.7 | 99.7 | 99.4 | 90.9 | 99.2 | 99.9 | 99.7 | 99.9 | 99.3 | 98.4 | 99.9 | 99.6 | 98.38 |
| FURIA | 95 | 99 | 98.7 | 89.5 | 97.9 | 99.3 | 98.8 | 99.5 | 97.6 | 95.9 | 98.8 | 99 | 97.42 |
| Simple Logistic | 87.7 | 99.7 | 98.6 | 79 | 98.4 | 98.9 | 99.1 | 99.7 | 98.8 | 93.9 | 99.1 | 99.1 | 96.00 |
| LIBLINEAR | 88.8 | 99.7 | 98.4 | 79.9 | 98.6 | 98.9 | 98.3 | 99.4 | 98.5 | 94.3 | 99.2 | 98.6 | 96.05 |
| BayesNet | 82.8 | 86.8 | 90.8 | 78.9 | 87.9 | 94.5 | 85.4 | 97.5 | 88.1 | 80 | 94.8 | 95.9 | 88.62 |

Table 4. Bi-script case 2 (Roman common): Average performance scores (in %) for different feature combinations tested using MLP classifier

| Feature Type (Dimension) | Accuracy (%) |
|--------------------------|--------------|
| SE (4) | 80.94 |
| WE (15) | 92.56 |
| RT (65) | 98.01 |
| SE+WE (19) | 95.06 |
| SE+RT (69) | 98.96 |
| WE+RT (80) | 99.07 |
| SE+WE+RT (84) | 99.24 |

| 1 | Bi-Script Recognition Accuracy (%) Keeping Roman as Common with one of the Twelve Scripts | | | | | | | | | | | | |
|-----------------|---|------|------|------|------|------|------|------|------|------|------|------|-------|
| Classifier | BEN | DEV | DOG | GUJ | GUR | KAN | KAS | MAL | ORY | TAM | TEL | URD | μ |
| MLP | 99 | 99.3 | 99.3 | 98.2 | 99.3 | 99.3 | 99.5 | 99.1 | 99.7 | 99.3 | 99.5 | 99.4 | 99.24 |
| FURIA | 96.6 | 97.6 | 97.8 | 94.9 | 99.2 | 99 | 99.2 | 97.4 | 98.9 | 97.4 | 98.6 | 98.3 | 97.91 |
| Simple Logistic | 97.4 | 98.8 | 98.2 | 93.6 | 99.1 | 98 | 97.6 | 94.1 | 98.5 | 97.6 | 98.1 | 97.7 | 97.39 |
| LIBLINEAR | 95.9 | 98.5 | 98 | 92.9 | 98.8 | 97.4 | 97.3 | 85.3 | 98.4 | 97.2 | 98.1 | 97.8 | 96.30 |
| BayesNet | 92.5 | 88.1 | 86.9 | 88 | 93.3 | 87.6 | 92.8 | 82.6 | 94.4 | 90.3 | 92.8 | 94.1 | 90.28 |

Table 5. Bi-script case 2 (Roman common): Average performance scores (in %) for 12 different combinations when all features (SE, WE, RT) are combined

Table 6. Tri-script (Devanagari and Roman common): Average performance scores (in %) for 11 different combinations when all features (SE, WE, RT) are combined

| Tri-Script Recognition Accuracy (%) Keeping Devnagari and Roman as Common with one of the Eleven Scripts | | | | | | | | | | | | |
|--|------|------|------|------|------|------|------|------|------|------|------|-------|
| Classifier | BEN | DOG | GUJ | GUR | KAN | KAS | MAL | ORY | TAM | TEL | URD | μ |
| MLP | 96.2 | 99.2 | 97.8 | 94 | 98.9 | 99.6 | 98.7 | 99.5 | 97.9 | 99.3 | 99 | 98.19 |
| FURIA | 93.4 | 96.9 | 95.6 | 89 | 96.7 | 97 | 96 | 97.6 | 94.4 | 97.7 | 96.7 | 95.55 |
| Simple Logistic | 90.7 | 98 | 94 | 84.7 | 96.5 | 96.7 | 95.5 | 98 | 94 | 97.9 | 96 | 94.73 |
| LIBLINEAR | 90.1 | 97.3 | 93.4 | 84.2 | 95.4 | 95.5 | 90.1 | 97.2 | 92.8 | 97.1 | 95 | 93.46 |
| BayesNet | 79.8 | 82 | 81.9 | 76.9 | 81.6 | 86.3 | 78.8 | 89.8 | 76.5 | 87.2 | 87.6 | 82.58 |

(between the classifiers) purpose, their average scores are provided in Table 7, where we found MLP> FURIA> SL>LibLINEAR>BayesNet. In this comparison table, one can also note that higher the script combination, lower the performance of classifiers {which is obvious because it increases number of classes to be classified.

5.4. Previous Relevant Work

Prior to this study, Pati et al. (Pati et al. 2008) proposed word-level script identification by using 11 Indic languages, where Gabor and DCT based features are taken. They have compared their performances using three different classifiers namely neural network (NN), linear discriminant analysis (LDA) and support vector machine (SVM). Their performance scores are approximately 98% from both bi-script and tri-script combinations.

In contrast, our work is composed of all 13 official languages under 11 different scripts, with 39k dataset. Three types of features are used: spatial energy, wavelet energy and radon transform. Performances of five different classifiers namely MLP, FURIA, SL, LibLINEAR and BayesNet have

Table 7. Tri-script (Devanagari and Roman common): Average performance scores (in %) for 11 different combinations when all features (SE, WE, RT) are combined

| Eastern Trans (Dimansion) | | Clas | sifier | | Bayesnet | |
|---------------------------|-------|-------|-----------------|-----------|----------|--|
| reature Type (Dimension) | MLP | FURIA | Simple Logistic | LIBLINEAK | | |
| Bi-script case 1 (12) | 98.38 | 97.42 | 96.00 | 96.05 | 88.62 | |
| Bi-script case 2 (12) | 99.24 | 97.91 | 97.39 | 96.30 | 90.28 | |
| Tri-script (11) | 98.19 | 95.55 | 94.73 | 93.46 | 82.58 | |

been compared, and MLP is found to be best performer. In our comprehensive tests, we have script identification rate of 98.38% (keeping Devanagari common) and 99.24% (keeping Roman common) for bi-script combination, and identification rate of 98.19% for tri-script combination. For better understanding a comparative chart is shown by Table 7.

The graphical representation of the performance comparison of different classifiers is illustrated in Figure 4.

6. CONCLUSION

Script identification is a well-studied document analysis problem since several years. But we do not have fairly large dataset, which cover the larger domain of Indic languages and scripts, and therefore one cannot make a fair comparison of state-of-the-art methods. To bridge this gap, in this paper, we have presented a word-level document image dataset of 13 different Indic languages from 11 official scripts. It is composed of 39K words that are equally distributed i.e., 3K words per language. For a baseline results, five different classifiers: multilayer perceptron (MLP), fuzzy unordered rule induction algorithm (FURIA), simple logistic (SL), library for linear classifier (LibLINEAR) and bayesian network (BayesNet) classifiers are used with three state-of-the-art features: spatial energy (SE), wavelet energy (WE) and the Radon transform (RT), including their possible combinations. We observed that MLP provides better results when all features are used, and achieved the bi-script accuracy of 99.24% (keeping Roman common), 98.38% (keeping Devanagari common) and tri-script accuracy of 98.19% (keeping both Devanagari and Roman common).

Our immediate step includes increasing the number of languages and data samples per languages so that, we may evaluate all possible combinations. Some misclassification issues i.e., from Kashmiri-Urdu, Devanagari-Gurumukhi combinations are need to be addressed. Evaluating the effect of classifier integration and the issue of font sensitivity for various Indic scripts on script identification performance is also in our plan. We also plan to work on optimization issues using advance machine learning algorithm like extreme learning machine, deep neural network and soft computing paradigms (Liu et al. 2016; Li et al. 2017; Fang et al. 2016) to boost up the overall performance of script identification.

REFERENCES

Breiman, L. (2001). Random Forests. Machine Learning, 45(1), 5-32. doi:10.1023/A:1010933404324

Chaudhury, S., Harit, G., Madnani, S., & Shet, R. B. (2000). Identification of scripts of Indian languages by Combining trainable classifiers. In *Proceedings of Indian Conference on Computer Vision Graphics and Image Processing*.

Cohen, W. (1995). Fast Effective Rule Induction. In *Proceedings of the Twelfth International Conference on Machine Learning* (pp. 115-123).

Deans, S. R. (1983). Applications of the Radon Transform. New York: Wiley Interscience Publications.

Dhanya, D., Ramakrishna, A. G., & Pati, P. B. (2002). Script Identification in Printed Bilingual Documents. *Sadhana*, 27(1), 73–82. doi:10.1007/BF02703313

Fan, R., Chang, K., Hsieh, C., Wang, X., & Lin, C. (2008). LIBLINEAR - A Library for Large Linear Classification. *Journal of Machine Learning Research*, *9*, 1871–1874.

Fang, Y., Liu, Z. H., & Min, F. (2016). Multi-objective cost-sensitive attribute reduction on data with error ranges. *Int. J. Mach. Learn. Cybern.*, 7(5), 783–793. doi:10.1007/s13042-014-0296-3

Ghosh, D., Dube, T., & Shivprasad, S. P. (2010). Script Recognition-A Review. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *32*(12), 2142–2161. doi:10.1109/TPAMI.2010.30 PMID:20975114

Hangarge, M., Santosh, K. C., & Pardeshi, R. (1983). Directional discrete cosine transform for handwritten script identification. In *Proceedings of the International Conference on Document Analysis and Recognition* (pp. 344-348).

Hochberg, J., Kelly, P., Thomas, T., & Kerns, L. (1997). Automatic Script Identi_cation from Document Images using Cluster-based Templates. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *19*(2), 176–181. doi:10.1109/34.574802

Huhn, J., & Hullermeier, E. (2009). FURIA: An algorithm for unordered fuzzy rule induction. *Data Mining and Knowledge Discovery*, *19*(3), 293–319. doi:10.1007/s10618-009-0131-8

Jawahar, C. V., Kumar, M. N. S. S. K. P., & Kiran, S. S. R. (2003). A Bilingual OCR for Hindi-Telugu Documents and Its Applications. In *Proceedings of International Conference on Document Analysis & Recognition* (pp. 408-412). doi:10.1109/ICDAR.2003.1227699

Joshi, G. D., Garg, S., & Sivaswamy, J. (2006). Script identification from Indian documents. In *Proceedings* of International Association of Pattern Recognition Workshop on Document Analysis Systems (pp. 255-267). doi:10.1007/11669487_23

Li, J., Mei, X., Prokhorov, D., & Tao, D. (2017). Deep Neural Network for Structural Prediction and Lane Detection in Traffic Scene. *IEEE Trans. Neural Networks Learn. Syst.*, 28(3), 690–703. doi:10.1109/TNNLS.2016.2522428 PMID:26890928

Liu, P., Huang, Y., Meng, L., Gong, S., & Zhang, G. (2016). Two-stage extreme learning machine for highdimensional data. *Int. J. Mach. Learn. Cybern.*, 7(5), 765–772. doi:10.1007/s13042-014-0292-7

Mallat, S. G. (1989). A theory for multiresolution signal decomposition: The wavelet representation. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *11*(7), 674693. doi:10.1109/34.192463

Obaidullah, S. M., Mondal, A., Das, N., & Roy, K. (2014). Script Identification from Printed Indian Document Images and Performance Evaluation Using Different Classifiers. Applied Computational Intelligence Soft Computing, 2014.

Pal, U., & Chaudhuri, B. B. (2002). Identification of Different Script Lines from Multi-script Documents. *Image and Vision Computing*, 20(13/14), 945–954. doi:10.1016/S0262-8856(02)00101-4

Pardeshi, R., Chaudhuri, B. B., Hangarge, M., & Santosh, K. C. (2014). Automatic Handwritten Indian Scripts Identification. In *Proceedings of International Conference on Frontiers in Handwriting Recognition* (pp. 375-380).

Pati, P. B., & Ramakrishnan, A. G. (2008). Word-level multi-script identification. *Pattern Recognition Letters*, 29(9), 1218–1229. doi:10.1016/j.patrec.2008.01.027

Roy, K., Pal, U., & Banerjee, A. (2004). A system for word-wise handwritten script identification for Indian postal automation. In *Proceedings of the 1st IEEE INDICON India Annual Conference* (pp. 266–271). doi:10.1109/INDICO.2004.1497753

Shannon, C. E., & Weaver, W. (1949). The Mathematical Theory of Communication. Univ of Illinois Press.

Sumner, M., Frank, E., & Hall, M. (2005) Speeding up Logistic Model Tree Induction. In *Proceedings of European Conference on Principles and Practice of Knowledge Discovery in Databases* (pp. 675-683).

S. K. Obaidullah has completed B.E in Computer Sc. & Engineering from Vidyasagar University, M. Tech in Computer Sc. & Application from University of Calcutta and Ph.D(Engg.) from Jadavpur University in the year 2004, 2009, 2016 (thesis submitted) respectively. He has more than eleven years of professional experience including two years in industry and nine years in academia out of which five years of research. Presently he is working as an Assistant Professor in the Dept. of Computer Science & Engineering, Aliah University, Kolkata. He has published more than 30 research papers in reputed peer reviewed journal and national/international conferences. His research interests are Document Image Processing, Pattern Recognition, Computer Vision.

K. C. Santosh is an Assistant Professor at the University of South Dakota (USD) for the department of computer science. Before joining the USD, from 2013 to 2015, Dr. KC worked as a research fellow at the U.S. National Library of Medicine (NLM), National Institutes of Health (NIH). He worked as a postdoctoral research scientist at the LORIA research centre, Universite de Lorraine in direct collaboration with industrial partner ITESOFT, France, for 2 years. He also worked as a research scientist at the INRIA Nancy Grand Est research centre for 3 years, until 2011. Dr. KC has demonstrated expertise in pattern recognition, image processing, computer vision and machine learning with various applications in handwriting recognition, graphics recognition, document information content exploitation, medical image analysis and biometrics. Dr. KC published more than 80 research articles, including a book section in encyclopedia of electrical and electronics engineering. Dr. KC is an assoc. editor of Int. J. of Machine Learning & Cybernetics (JMLC), Springer and J. of Pattern Recognition Research (JPRR), serves on the editorial board member of SpringerPlus, Int. J. Computer Vision and Image Proc. (IJCVIP), Frontiers in ICT: Computer Image Analysis, Cultural Heritage Digitization: Frontiers in Digital Humanities, and served as a review panel for Natural Science and Engineering Research Councils (NSERC) of Canada and National Science Foundation (NSF).

Chayan Halder has done his Bachelors in Computer Science from BRS College Barrackpore, Kolkata under University of Calcutta in 2008 and completed his Masters in Computer Science from West Bengal State University, Barasat in 2010. He has worked as a Project linked person in Indian Statistical Institute (ISI) Kolkata, during 2011. Currently, he is pursuing his PhD from West Bengal State University as Senior INSPIRE Fellow of Department of Science and Technology Delhi, since Nov. 2011. His current area of research includes Document image processing, Handwriting Analysis etc. He has more than 30 publications in various international and national Journals and Conferences.

Nibaran Das has completed B.E in Computer Sc. & Engineering from Kalyani University,M.E and PhD(Engg.) in Computer Sc. & Engg. from Jadavpur University in the year 2003, 2005 and 2012 respectively. He is currently working as an Assistant Professor at the Department of Computer Science and Engineering, Jadavpur University, Kolkata, India. He has published more that 60 research papers/book chapters in reputed conferences and journals. His research interest includes image processing, pattern recognition, machine learning and natural language processing.

Kaushik Roy is currently working as Professor and Head, Dept. of Computer Science, West Bengal State University, Barasat, India. He has published more that 100 research papers/book chapters in reputed International & National Journals and Conferences. His research interest includes Pattern Recognition, Document Image Processing, Medical Image Analysis, Online Handwriting Recognition, Speech Processing, Natural Language Processing etc.

Chapter 1

Offline Writer Verification Based on Bangla Handwritten Characters Using Enhanced Textual Feature

Jaya Paul, Anasua Sarkar, Chayan Halder, and Kaushik Roy

| 1.1 | Introd | uction | 2 |
|------|----------|---|----|
| 1.2 | Literat | ture Survey | 2 |
| | 1.2.1 | Offline and pseudo-dynamic approaches | 2 |
| | 1.2.2 | Approaches of writer-dependent and writer-independent | |
| | | methods | 3 |
| | 1.2.3 | Writer identification (many to one) | 3 |
| | 1.2.4 | Writer verification (one-to-one matching) | 3 |
| | 1.2.5 | Biometric property | 4 |
| | 1.2.6 | Handwriting as biometric | 4 |
| | 1.2.7 | Types of writers | 5 |
| | 1.2.8 | Genuine writer or original writer | 5 |
| | 1.2.9 | Forged writer | 5 |
| | 1.2.10 | Database | 5 |
| 1.3 | Introd | uction to Bangla | 6 |
| | 1.3.1 | Bangla script | 6 |
| 1.4 | Metho | d | 7 |
| 1.5 | Data (| Collection and PreProcessing | 8 |
| 1.6 | Featur | e Extraction Techniques | 9 |
| | 1.6.1 | Feature extraction based on dual-tree complex wavelet | |
| | | transformation | 9 |
| | 1.6.2 | Feature extraction based on GLCM | 10 |
| | 1.6.3 | Edge direction information | 11 |
| 1.7 | Dissim | ilarity Measure | 11 |
| 1.8 | Classif | ication Techniques | 11 |
| | 1.8.1 | Multi-layer perceptrons networks | 11 |
| | 1.8.2 | Simple logistic | 12 |
| | 1.8.3 | Radial basis function networks | 12 |
| 1.9 | Experi | mental Results | 13 |
| | 1.9.1 | Performance evaluation criteria | 13 |
| | 1.9.2 | Dissimilarity vector calculation | 14 |
| 1.10 | Verifica | ation Results | 14 |
| 1.11 | Conclu | isions | 17 |
| | Refere | nces | 18 |

1.1 Introduction

Writer verification has been magnetizing the attraction of the researchers as a most important role play for writer authentication. The last few years, many algorithms and systems with high authentication rates have been introduced. Various approaches for handwritten character authentication problem have been developed [1–4]. Some approaches are worked in Bangla characters [5]. In one of the relevant early works, the likelihood ratio is used in forensic document identification [6]. The statistical model [7,8] is used for writer verification and also includes a mathematical formula for calculating the strength of evidence of same/different writer. The approaches are classified into two categories, namely online systems and offline systems. The handwritten shape and stock information are available in online verification system [9], but this information is unavailable for the offline method. The offline system is more complex than the online system. There has not been much work on the verification of handwritten Bangla characters [9,10]. Therefore, there is a pressing need for such a system. The present paper deals with writer verification based on handwritten Bangla characters.

1.2 Literature Survey

In the literature, different works can be found on writer verification. Text-independent and text-dependent data sets are available in the writer verification system. In the textdependent method, the text contents are same for known and unknown writers. The textdependent system for writer verification offers higher discriminative power using small amount of data, as compared to text-independent methods [11]. The text-independent system finds similarity between writing patterns to verify the writers. Forgery possibility is reduced for text-independent and needs a large volume of data. But the text-dependent method increases the forgery case due to copy of same text. But it is very useful in signature verification where most of the time the genuine writer uses the system and not suitable for frequent rejection. In the text-independent method forgery is reduced, but it needs more data samples. In this case it is possible that the genuine writer can also be rejected. The writer verification uses in different purposes, like historical document analysis [12], graphology, mobile devices [13], DNA and fingerprints are also used in terms of verification [14].

1.2.1 Offline and pseudo-dynamic approaches

Earlier works [15] and [16] have proposed many methods for writer verification. Handwriting shape information has been widely used in offline writer verification mode. Primary methods that are used for character shape information of handwritting are referred to as offline approaches [15,16]. Gray level co-occurrence matrix (GLCM)[17] and dual-tree complex wavelet transforms (DT-CWT) features are frequently used in Bangla character and writer verification [18–20]. In [21], the researchers propose a method that estimates dynamic information from static handwriting. All these methods are calling pseudo-dynamic approaches and are resistant to forged handwriting. The methods are categorized into used motor control theory [22] and temporal order of stroke production. Ferrer et al. [23] propose methods that explain intensity variation and stroke information. Earlier forensic science studies [24,25] report the usefulness estimate of dynamic information from static handwriting.

To enhance the performance of the writer verification system, we have proposed a new approach to extract texture information from the handwriting sample [18,20]. The survey [19,20] show texture descriptors, texture based features and dissimilarity. Local binary patterns and phase quantization have been used in [19] writer identification. In [20] the scientists achieve the performance of 96.1%. Some examples of this scheme can be found in Marti et al. [26], Srihari et al. [27], Bulacu et al. [28], Bensefia et al. [29], Siddiqi and Vincent [30].

1.2.2 Approaches of writer-dependent and writer-independent methods

Writer-dependent builds on one specific model per writer. The drawback of this method is that a new model needs to be built for a new writer [15,16]. Another important issue in this method is that usually a substantial amount of data is need to construct a well-founded model. However, this type of approach used for signature verification.

The writer-independent method is based on the FDE (forensic document examination) approach, which considers the intraclass (writer) and interclass (writer) similarities of handwritten characters. This model classifies the handwriting into two authenticity classes. The two classes are genuine and forgery. This approach is used in various work [31]. The probability distributions (PDF) of interclass (writer) and intraclass (writer) are collected from training samples in the writer-independent approach. Comparing these probability density function values, the original author of that document is decided by dissimilarity. Based on the concept of dissimilarity, the writer-independent method used a distance metric [32]. Muramatsu and Matsumoto [33] propose a model which used user specific dissimilarity vectors that combine original dissimilarity and used mean vector for each writer. It is considered as a distance of different writers and individual characteristics in handwriting.

Most of the identification and verification works on western script (like Roman script). Srihari et al. [34], Bulacu et al. [28], Bensefia et al. [29], Siddiqi and Vincent [30], etc. Doermann and Jain propose an identification system which used the multi-script writers on the English, Arabic and Greek languages [35].

1.2.3 Writer identification (many to one)

Writer identification systems must recognize a writer among N number of writers in a large dataset. The process of identifying a person involves performing comparisons among multiple handwritings. These systems aim to confirm identity and build on writer information. A variety of features have been proposed, like structural or statistical and local or global. All these features are served to distinguish the individual writer from other writers. Said et al. [3] used Gabor filters and co-occurrence matrices to identify the writer and consider each writer's handwriting as a different texture. Macro and micro features are extracted [34] from the document and establish the individuality of handwriting. The research pursued in [36] proposes an identification system [26] which extracts structural features from each line of handwritten documents.

1.2.4 Writer verification (one-to-one matching)

A writer verification system decides whether a handwritten document belongs to the same writer or different writers. It is the validity checking procedure for the claimed identity. Naturally, the writer verification issue is a true/false problem. Signature verification is one of the ways which is used with many different methods of classification as reported in the survey, namely distance measures [1,37], dissimilarity [38], hidden Markov models [39], Bayesian classifiers [40], and grapheme clustering [29].

The manual process of document examination is a tedious job and is also very timeconsuming. Srihari et al. [41] introduce a handwriting examination system, which is known as CEDAR-FOX. This system can be used in writer verification as well as in signature verification.

1.2.5 Biometric property

4

Nowadays the biometric property is used in different areas in our daily life. This property is a human identification system by determining the authenticity of particular behavioral features [42]. A small portion of the biometric properties of a human are used in different applications. A general biometric system is shown in Figure 1.1.

A number of biometric properties have been used in several areas [43]. For the requirements of the system, a specific biometric property is used. Some applications of biometric properties are found in the face recognition system [44], with two phases—face detection and tracking. Some other methods are—facial matching, fingerprint recognition [45], hand geometric recognition [46], personal recognition [47], retina recognition [48], voice recognition [49], sclera recognition [50], and keystroke dynamics [51]. In Figure 1.2, we show different examples of the biometric characteristics.

1.2.6 Handwriting as biometric

Handwriting biometric is the authentication process of identifying the author of a given handwritten text, offline or online. Automated handwritten documents and signatures (online, offline) are considered the most socially and legally accepted property for authentication. Writer verification and writer identification are methods for writer authentication based on the system. Signature identification [52] and verification are also authentication methods based on the system. Signature verification [53] and identification can be either dynamic or static. In the offline mode, digital images of handwritten documents are available. In the online mode, documents are acquired by means of pen-sensitive computer displays or graphic tablets. A handwritten document is a biometric property generated by a composite method arising in the writer's brain [54]. Handwriting-based authentication is commonly used in forensic document examination [25]. The main aim of the forensic document examination is to provide enough evidence about questionable documents, using various scientific methods.

FIGURE 1.1: General biometric model.

FIGURE 1.2: Examples of biometric characteristics: (a) voice, (b) fingerprint, (c) hand geometry, (d) sclera, (e) face, (f) iris, (g) keystroke, (h) handwriting.

1.2.7 Types of writers

On the literature survey, the field of writer verification generally considers two different types of writers. First is the genuine writers or original writer; second is the forged writer.

1.2.8 Genuine writer or original writer

When a handwritten document is produced by an authentic writer under normal conditions, the writer is called the genuine writer or original writer. The interwriter stability and variability of the original writer are affected by many factors, such as age, mental state, habit, and practical conditions [53].

1.2.9 Forged writer

There are usually two different types of forgeries available. The first one is the unskilled forgery, which is written by a person who does not know the pattern of the original or may be without much practice. The second type is a skilled forgery where a copy of the document is represented as an original or written by the genuine writer. Various skill levels of forgeries can be found in Nguyen et al. [55].

1.2.10 Database

A handwriting database has great importance in our study of writer verification area. All the research works into the writer verification field as they have been conducted for several years, there have some different languages of standard offline databases are created. Bulacu et al. [38] created a system on writer verification and identification on Roman databases like the IAM database [56], Unipen database [57], and Firemaker set [58]. They propose to combine allographic and textural features for text-independent writer identification with Arabic script. But due to the lack of availability of a Bangla script database, the development of a Bengali writer verification system has been negatively affected. Only Halder and Roy [10] used Bangla characters (covering all alphabets, vowel modifiers, vowel modifiers) and Bangla numerals in [58] for writer identification in their research works.

1.3 Introduction to Bangla

1.3.1 Bangla script

Bangla is the seventh most popular language in the world and the second most popular language in India [59]. Almost 200 million people in the eastern part of the Indian subcontinent speak this language [59]. Bangla alphabets are used in texts of Bangla, Manipuri, and Assamese languages. Bangla script has more than 250 characters (consonants, vowels, and compound characters). A lot of research has already been done in this direction for several scripts [1,3]. The works have been applied successfully to various commercial applications, such as question document examination, bank check verification, etc. [7,60].

The biometric-based authentication system is used for two purposes: identification and verification.

Bangla has 11 vowels and 40 consonants and these are called the basic Bangla characters. It has lots of numbers, compound shapes, and complex letters. Figure 1.3 shows an example of Bangla alphabets. In Figure 1.3, we show the Bangla character shapes which are more complex than the Roman scripts. There exists a horizontal line (called a matra) which is

| ক ক্ষ | শ প্র | গ চা | ঘ ধ্ৰ | 8 G | ъ₽ | |
|--------|-------|------------|----------------|------|--------|--------------------------|
| E Z | জ উ | ঝ দ্রা | 48 B | 52 | 50 | - |
| ভ ট | J J | ं क् | ্ জ | থ স | দ দি | (a) Bangla consonants |
| ¥ A | न त | প প | <u>s</u> e 76 | ৰ ব্ | ত ত | - |
| ম স্কা | য ম | র সু | ^च त | ৰ সু | त्र की | - |
| ষ শ্ব | স্প্র | হ চু | s é | ु पू | ਭ ਮੂ | - |
| ٩ţ | e 6 | 0 8 0 8 | * v | | | |
| | | | 1 | | | |

| 3 | জা | A | আ গুনা | 12 51 | क है | 2 2 | E T | |
|---|-----|----|--------|-------|------|-----|-----|-------------------|
| | খ্য | 24 | e a | E E | 18 B | 8 B | | (b) Bangia voweis |

FIGURE 1.3: Examples of (a) Bangla consonants and (b) Bangla vowels.
sometimes absent for certain characters. In Bangla script, a vowel following a consonant takes a modified shape. This modified shape is placed at the left, right, and bottom of the consonant, or both at left and right. These modified shapes are called the modified characters.

The handwritten character verification system which is proposed in this article consists of four major phases: preprocessing phase, feature extraction techniques, dissimilarity measurement in the process calculating Kullback–Leibler (KL) divergence distances on the questioned document examinations between same-writer and different-writer samples, and finally, the classification phase.

In order to construct a more precise verification system, the following four methods are combined in this work:

- 1. DT-CWT feature extraction.
- 2. GLCM feature extraction.
- 3. KL divergence distance measure on writers.
- 4. Different benchmark classification methods.

1.4 Method

In this section, the overall idea of the proposed method has been described. For the present work, we have contemplated a sample database of 150 writers, consisting of different Bangla Isolated characters: consonants, vowels, numericals, and vowel modifiers are collected. The different- and same-writer variations can be seen in the distance value (dissimilarity measure) among handwriting from different writers. The experts analyze and verify the writers on the basis of these distance values. We can see the difference in Figure 1.4. In this work, we have used combined textural features of DT-CWT and GLCM to obtain that difference for writer verification. To verify unknown writers comparing a database of known writers, first textural features are calculated, then the dissimilarity feature vector is calculated and finally using them, the verification result is obtained.

Figure 1.5 depicts the proposed diagram of the writer verification process. At first, the collected data are preprocessed and the textural feature extraction methods of



FIGURE 1.4: Sample of four different isolated Bangla characters from three different writers.



FIGURE 1.5: Diagram of the proposed writer verification system.

DT-CWT and GLCM are applied separately and then as a combined feature extraction method on the chosen dataset. The classifiers are then applied on the computed distances to calculate the dissimilarity measures between the questioned and the reference handwriting.

1.5 Data Collection and PreProcessing

Here we designed a simple data collection form [58] consisting of all Bangla numerals and alphabets. The total number of writer is 150 in the current work. Each writer has five sets of the same copy. For the present work, data collection has been done by different writers in [61]. Most of the writers of the database are right-handed. Out of 150 writers, now we have to consider full five sets of data from 123 writers (used for current purpose work). Here we show an example of our sample collection document form in Figure 1.6. The details about the data collection and the preprocessing method on the data can be found in [9].

| জ অ | আ ওদ। | 12 2 | * Fr | £ 2 | æ G |
|--------|-------|------------|-----------|------|----------|
| ঋ শ্বন | P P | R E | a 3 | 8 B | |
| ক ক | শ প্র | न ध | च ६४ | 8.6 | <u>5</u> |
| ×٤ | ज रह | ঝ 2ন | A8 (93 | 59 | 2.4 |
| E E | য য | ণ ন | 5 J | ণ স | ল দ |
| 4 X | न त | প প | # 20 | ৰম | 3 8 |
| भ द्भ | य भ | त्र 🟹 | व्य हर्मे | ৰ ম | শকা |
| ৰ শ্ব | त्र भ | र इ. इ. | क दे | ΔĒ | स्र भू |
| ° \$ | 20 | s 0 0 | ° • | 11 | FF |
| 19 | - 7 | - a | • 2 | 22 | 5 3 |
| री देन | ~ | ° 0 | 22 | 22 | 00 |
| 8 0 | e a | 5 5 | 99 | 5 12 | 6 4 |

FIGURE 1.6: Sample data collection of isolated Bangla handwritten characters.

1.6 Feature Extraction Techniques

1.6.1 Feature extraction based on dual-tree complex wavelet transformation

The proposed methodology is to use a modified DT-CWT [62–64] where multiscale analysis and direction-oriented feature extractions are possible.

We use the decomposition level six for the wavelet transform. In this work, first we normalize 128×128 dimensional image data and then the feature vectors have been computed over it. After using a Gaussian filter, we get 128-dimension image features. Subsequently, we get 64×64 -dimensional feature vectors, which have been computed using the DT-CWT algorithm.

Complex-valued wavelet is defined in Equation 1.1:

$$\Psi_c(t) = \Psi_r eal(t) + \Psi_i mg(t) \tag{1.1}$$

Here $\Psi_c(t)$ is the complex wavelet filter, $\Psi_r eal(t)$ is the real part, and $\Psi_i mg(t)$ is the imaginary part of the wavelet. DT-CWT functions h(p,q) have the following equation:

$$h(p,q) = d(p,q)e^{(j(w_p p + w_q q))}$$
(1.2)

where h(p,q) is the DT-CWT functions, d(p,q) is a Gaussian function centered at (0,0) and the center frequency is (w_p, w_q) of the corresponding subband. The complex coefficients of the k-th subband of the l-th level are as follows:

$$x_k^l = y_k^l + j z_k^l \tag{1.3}$$

In Equation 1.4 we calculate the magnitude of each subband:

$$x_k^l = \sqrt{((y_k^l)^2 + (z_k^l)^2)} \tag{1.4}$$



FIGURE 1.7: The schematic diagram of n level dual tree complex wavelet transforms (DT-CWT).

The magnitude is inconsiderate because d(p,q) is slowly varying. At each level, complex coefficients angles are $\pm 15^{\circ}$, $\pm 45^{\circ}$, $\pm 75^{\circ}$. These two properties are very useful for writer verification.

Figure 1.7 shows a DT-CWT feature extraction diagram for the verification system. DT-CWT can be use as a dual-tree formation [65]. The up sampling and down sampling before filtering and after filtering are needed to support the shift invariance. Here we use six levels of the dual-tree complex wavelet. We collected outputs of subband images into complex wavelet coefficients. Getting more information is referred to in [66].

1.6.2 Feature extraction based on GLCM

The GLCM is a texture analysis of statistical method and different combination of grayscale pixel value occur either horizontally, vertically, or diagonally of an image. It is a common textual analysis of images, we get it from Haralick et al. [67].

In Equation 1.5 the co-occurrence matrix G of an image P with size $M \times M$ is defined:

$$G(p,q) = \Sigma^M_(a=1)\Sigma^M_(b=1) \begin{cases} 1, if P(a,b) = s \text{ and } P(a+\Delta_a, b+\Delta_b) = q\\ 0, otherwise. \end{cases}$$
(1.5)

Here, in Equation 1.5, the offset $(\Delta a, \Delta b)$ parameterization makes the co-occurrence matrix sensitive to rotation. The offset $(\Delta a, \Delta b)$ is specifying the distance between the pixel-ofinterest and its adjacent pixel. Choosing an offset vector, the rotation of the image is not equal to 180°, will result in a different co-occurrence matrix for the same image. To achieve a degree of rotational invariance (i.e., 0°, 45°, 90°, 135°) using a set of offsets sweeping through 180 degrees at the same distance parameter Δ by forming the co-occurrence matrix. In this approach, GLCM is calculated with Energy, Contrast, Correlation, and Homogeneity in four directions, considering the pairs like G[s,q] and G[s,p]. Following this approach, we obtain 22 feature vectors using the modified GLCM feature extraction method over our chosen dataset. Here, we use a maximum of 22 dimension features. Twenty-two dimensional feature vectors have been computed using GLCM method in MATLAB[®], which is different from the work of Haralick [67]. Then the first-order statistics of standard deviation and mean are computed over the features.

1.6.3 Edge direction information

In handwriting verification, edge information is very important to enlarge the dimension of writing features. Here we use first-order statistics which capture the information in 172 dimensions. First-order statistics of feature depend on the pixel value of the histogram. In current work, two first-order statistics are calculated:

$$(Mean)\mu = \frac{1}{M} \Sigma^M_{(i=1)} E_i \tag{1.6}$$

$$(Standard \, deviation)S = \sqrt{\frac{1}{(M-1)} \Sigma^{M}_{(i=1)} |E_i - \mu|^2}$$
 (1.7)

Here, vector I_i is made up of M scalar observations. Therefore, finally 172 feature vectors are obtained.

1.7 Dissimilarity Measure

DT-CWT generates 64X64 dimensional vectors of the first-order statistics. In the next phase, we use the distance metric based on the dissimilarity representation in [68] using KL_{dist} (Kullback–Leibler divergence) method. To define the Kullback–Leibler divergence distance, let A and B be two discrete probability distributions. Then KL of B from A [69] is defined as follows:

$$KL_{dist}(A||B) = \Sigma_i A(i) \log \frac{A(i)}{B(i)}$$
(1.8)

In this method, Gaussian distribution is applied on each writer set to find out the KL_{dist} of same-writer sets. Different writer KL_{dist} distances are calculated between one writer from each set with different writers from all sets.

1.8 Classification Techniques

1.8.1 Multi-layer perceptrons networks

We can define an MLP by joining some neurons with functional neurons and gives one numerical output. The first hidden layer of the neurons network consists of functional neurons, whereas subsequent layers are created with numerical neurons. For example, a single hidden layer functional output of MLP enumerates the following function:

$$H(g) = \sum_{i=0}^{n} a_i T(b_i + \int w_i g d\mu)$$
(1.9)

where w_i is the function of the weight space.

Figure 1.8 shows the architectural graph of MLP with two hidden layers and one output. Here the network shown is of a fully connected type.





FIGURE 1.9: Architecture of traditional radial basis function network.

1.8.2 Simple logistic

Logistic Model Trees (LMTs) are the combination of two complementary classification schemes, namely, tree induction and linear logistic regression. It has been shown that LMTs perform ruthlessly with other cutting edge classifiers [70]. The drawback of LMTs is the time consuming method. The fixed number of iterations are repeatedly called in the LogitBoost algorithm [71]. In this work, we use SimpleLogistic as a classifier.

In the LogitBoost approach [71] on all data, we use the number of iterations that gives the lowest squared error on the test set from the average values over the cross-validations. We will refer to this method as SimpleLogistic [70].

1.8.3 Radial basis function networks

Radial basis function (RBF) networks are the supervised learning algorithms. In theory they could be recruited in any kind of model (linear or nonlinear) and any class of network (single layer or multilayer). However, since Broomhead and Lowes' work in 1988 [72], the RBF networks have traditionally been incorporated with radial functions in a single layer network as shown in Figure 1.9. The aim of RBF is to approximate the target function through linear combinations of radial kernels, such as Gaussian. Thus the output of an RBF network learning algorithm typically consists of a set of centers and weights for these functions.

1.9 Experimental Results

Standard datasets of Bangla handwriting are not available. So, we have to use Bangla handwriting samples from [58]. To enrich the result of our proposed system, we have used Bangla handwriting samples containing 71 Bangla characters, including vowel modifiers and numerals. Figure 1.3 shows the sample of the collected handwriting. From our datasets, 123 writers are selected and each writer has five sets. Each document consists of 71 characters. Each writer has 355 Bangla isolated characters. So, 123 writers have 43,665 characters.

Here we use one of the most popular tools, Weka [73] for executing machine learning algorithms for data mining tasks. For the purposes of our research work purpose, we have used the SimpleLogistic, RBF network (RBF) and multilayer perceptron (MLP) classifiers. We have used these classifiers as those have given some supportive results for our work than other classifiers of Weka. We have used five-fold scheme above to mention three different classifiers of Weka tool for verification of the writer.

1.9.1 Performance evaluation criteria

The geo-mean [33] metric used to evaluate our classifiers results in highly complexed datasets. Therefore, the geo-mean [33] metric is acquired to evaluate the performance of our experiments over this chosen dataset. It is defined as follows:

$$Sensitivity = \frac{tp}{tp + fn} \tag{1.10}$$

$$Specificity = \frac{tn}{tn + fp} \tag{1.11}$$

$$Geo-mean = \sqrt{sensitivity \times specificity} \tag{1.12}$$

Here in Equations 1.11 and 1.12, tp, fn, tn, and fp are "true positive," "false negative," "true negative," and "false positive," respectively from receiver-operator characteristics (ROC). Finally, the g-mean-based error rate (%) [73] is calculated as follows:

$$g\text{-mean}(error rate) = (1 - (geo\text{-mean}))X100.$$
(1.13)

Error rates of verification are defined in [74] [Error rates in fault diagnostics or biometric verification/identification] as follows:

$$False \ acceptance \ rate \ (FAR) = fp \tag{1.14}$$

$$False \ rejection \ rate \ (FRR) = fn \tag{1.15}$$

where false acceptance rate (FAR) denotes the genuine writer rate rejected by the system. False rejection rate (FRR) denotes different writer rates incorrectly accepted by the system.

1.9.2 Dissimilarity vector calculation

The interclass dissimilarity vector length between samples from the same writer is 1,230 (= ${}^{5references}C_2 \ge 123$ writers).

About 3,050 (123 writers $\times {}^{5}C_{1} \times 5$ references) dissimilarity vectors are calculated between samples from different writers as interclass dataset.

1.10 Verification Results

Figures 1.10 and 1.11 show the ultimate verification result when the verification approach is done by different classifiers, both on GLCM features alone and again on GLCM combined with DT-CWT features vectors, to verify a writer. The x axis in Figures 1.10 and 1.11 show the different classifiers and the y axis shows the percentages of the geomean error rate. Here we obtain higher accuracy results in Table 1.1 in comparison with single GLCM features, after combining these two texture features. But when we use only GLCM features on our isolated Bangla handwritten characters as shown in Figure 1.10, the accuracy becomes very low. However, in Figure 1.11 the accuracy for the proposed combined GLCM and DT-CWT features is high. Hence, it demonstrates that single-feature GLCM is enriched when it is combined with the DT-CWT method for feature extraction. With the proposed automated verification system, the innovative result of the isolated Bangla



FIGURE 1.10: Comparative performances of the different geo-mean error rates on GLCM features using different classifiers.



FIGURE 1.11: Comparative performances of the different geo-mean error rates on modified DT-CWT features using different classifiers.

| Classifier name | Geo-mean error rate of modified dual tree complex wavelet transform | Geo-mean error rate of GLCM |
|------------------------------|---|--|
| MLP SimpleLogistic RBF | $1.0880 \\ 1.6304 \\ 1.4965$ | $\begin{array}{c} 12.5646 \\ 18.77 \\ 55.3039 \end{array}$ |
| True positive rate (TPR) | | |
| | False positive rate (FPR) | |
| True positive rate (TPR) | (d) | |
| | False positive rate (FPR) | 1 |
| | | |

TABLE 1.1:Geo-mean-error rate of modified dual tree complexwavelet transform and GLCM of different classifiers

FIGURE 1.12: (a), (b), and (c) are different ROC curves using combined features with different classifiers.

False positive rate (FPR) (c)

characters reaches to 98.0695% value in accuracy, which is the highest percentage of verification obtained so far.

We have analyzed the ROC characteristics of the performances of the chosen classifiers over our isolated Bangla characters dataset. Figures 1.12 and 1.13 show the ROC curves



FIGURE 1.13: (a), (b), and (c) are different ROC curves using GLCM features with different classifiers.

obtained for the solutions of SimpleLogistic, RBF, and MLP classifiers in our experiments. The Precision, Recall, F-Measure, and ROC area values obtained for the classifiers using GLCM features have been shown in Table 1.2 for both same-writer and different-writer classes.

A higher value for ROC area denotes better classification results. For same-writer and different-writer classes, SimpleLogistic, RBF, and MLP classifiers obtain 0.858, 0.794 and 0.884 values respectively. Therefore, MLP classifier shows the highest efficiency in detecting same writer and different-writer classes in our chosen dataset.

Similarly, using combined GLCM and DT-CWT features, the parameters obtained from ROC characteristics have are in Table 1.3. The ROC area obtained using this proposed combined feature set by SimpleLogistic, RBF, and MLP classifiers are, respectively, 0.985, 0.998, and 0.996. Therefore, the RBF classifier shows the best performance among chosen classifiers with combined features.

| Classifier | Pre | ecision | Pre | ecision | F-m | easure | RO | C area |
|----------------|--------|-----------|-----------------|-----------|-----------------|-----------|--------|-----------|
| name | Same | Different | \mathbf{Same} | Different | \mathbf{Same} | Different | Same | Different |
| | writer | writer | writer | writer | writer | writer | writer | writer |
| SimpleLogistic | 0.576 | 0.933 | 0.829 | 0.796 | 0.829 | 0.859 | 0.858 | 0.858 |
| with GLCM | | | | | | | | |
| RBF with GLCM | 0.450 | 0.777 | 0.220 | 0.910 | 0.295 | 0.838 | 0.794 | 0.794 |
| MLP with GLCM | 0.607 | 0.986 | 0.967 | 0.790 | 0.746 | 0.877 | 0.884 | 0.884 |

TABLE 1.2: Class-wise evaluation parameters on solutions obtained from different classifiers using GLCM features

TABLE 1.3: Class-wise evaluation parameters on solutions obtained from different classifiers using combined GLCM and DT-CWT

| Classifier | Pre | ecision | Pre | ecision | F-m | leasure | RO | C area |
|--|--------|-----------|--------|-----------|--------|-----------|--------|-----------|
| name | Same | Different | Same | Different | Same | Different | Same | Different |
| | writer | writer | writer | writer | writer | writer | writer | writer |
| SimpleLogistic with GLCM | 0.953 | 0.994 | 0.984 | 0.984 | 0.968 | 0.989 | 0.985 | 0.985 |
| RBF with combined GLCM and DT-CWT | 0.984 | 0.992 | 0.976 | 0.995 | 0.980 | 0.993 | 0.998 | 0.998 |
| MLP with combined GLCM and DT-CWT | 0.961 | 0.997 | 0.992 | 0.986 | 0.976 | 0.992 | 0.996 | 0.996 |

Moreover, all classifiers show significant superior performances on our chosen dataset after using the combination of DT-CWT features with GLCM features. This signifies the efficiency of our proposed combined feature extraction method for the writer verification problem.

1.11 Conclusions

The automatic writer verification method is a very challenging task in the domain of finance and forensic analysis. In this chapter, to enhance the verification accuracy over isolated Bengali characters samples, we have proposed a hybrid model which is a combination of well-known GLCM and new DT-CWT-based feature extraction methods to compute dissimilarity between same-writer and different-writer classes. For comparitive study, a similar kind of work was done by some different algorithms using Bengal character dataset [75]. Furthermore, we have utilized Kullback-Leibler divergence measure as the dissimilarity norm over the extracted features. The advantages of our present method are as follows:

- 1. In our writer-dependent approaches we calculated dissimilarity vector, the writer specific Kullback–Leibler divergence dissimilarity measure is used to improved verification accuracy.
- 2. The individual GLCM based and combined GLCM–DT-CWT based features are extracted from samples obtained by multiband image scanners and those features are used to provide superior writer verification results.

- 3. Our experimental results show that the combined feature extraction method raises the accuracy from 73.67% to 98.9%, using the RBF network classifier.
- 4. Furthermore, when comparing using three different classifiers, the g-mean error rate has been reduced to 1.6-1.0% using our proposed combining methods.

Therefore, in our experimental results, our proposed combined feature extraction method has shown significant improvement over well-known GLCM based features for the automated writer verification problem on isolated Bengali characters. As for the future research works, the authors will utilize this improved feature extraction method for forgery detection.

References

- S. H. Cha and S. Srihari. Multiple feature integration for writer verification. In Proceedings of 7th International Workshop on Frontiers in Handwriting Recognition, Amsterdam, Netherlands, September 11–13, 2000, pp. 333–342, 2000.
- R. N. Morris. Forensic Handwriting Identification. San Diego, CA: Academic Press, 2000.
- H. E. S. Said, T. N. Tan, and K. D. Baker. Personal identification based on handwriting. In Fourteenth International Conference on Pattern Recognition, pp. 149–160, 2000.
- S. Srihari, S. H. Cha, H. Arora, and S. Lee. Individuality of handwriting: A validity study. In *Proceedings of 6th International Conference on Document Analysis and Recognition*'01, pp. 106–109. IEEE, 2001.
- A. Dutta and S. Chaudhury. Bengali alpha-numeric character recognition using curvature features. *Pattern Recognition*, 26(12): 1757–1770, 1993.
- Y. Tang and S. N. Srihari. Likelihood ratio estimation in forensic identification using similarity and rarity. *Pattern Recognition*, 47(3): 945–958, 2014.
- S. Srihari, M. Beal, K. Bandi, V. Shah, and P. Krishnamurthy. A statistical model for writer verification. In *Proceedings of International Conference on Document Analysis* and Recognition, pp. 1105–1109, 2005.
- H. Srinivasan, S. Kabra, C. Huang, and S. Srihariand. On computing strength of evidence for writer verification. In *Ninth International Conference on Document Analysis* and Recognition (ICDAR 2007), vol 2, pp. 844–848. IEEE, 2007.
- L. Wan, B. Wan, and Z.-C. Lin. On-line signature verification with two-stage statistical models. In *Proceedings of Eighth International Conference on Document Analysis and Recognition*, pp. 282–286. IEEE, 2005.
- C. Halder and K. Roy. Individuality of isolated Bangla numerals. Journal of Network and Innovative Computing, 1: 33–42, 2013.
- I. Tomai, B. Zhang, and S. N. Srihari. Discriminatory power of handwritten words for writer recognition. In *Proceedings of the 17th International Conference on Pattern Recognition*, pp. 638–641. IEEE, 2004.

- A. Fornes, J. Llados, G. Sanchez, and H. Bunke. Writer identification in old handwritten music scores. In *Eighth IAPR International Workshop on Document Analysis Systems* (DAS '08), pp. 638–641. IEEE, 2008.
- R. Chaudhry and S. K. Pant. Identification of authorship using lateral palm print a new concept. *Journal of Forensic Science*, 141(1): 49–57, 2004.
- L. Schomaker. Advances in writer identification and verification. In Ninth International Conference on Document Analysis and Recognition (ICDAR 2007), pp. 1268– 1273, IEEE, 2007.
- R. Plamondon and S. N. Srihari. On-line and off-line hand writing recognition: A comprehensive survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 22(1): 63–84. IEEE, 2000.
- D. Impedovo and G. Pirlo. Automatic signature verification: The state of the art. *IEEE Transactions on Systems, Man, and Cybernetics Part C: Applications and Reviews*, 38(5): 609–635, 2008.
- H. Chayan, Sk. Md. Obaidullah, J. Paul, and K. Roy. Writer verification on bangla handwritten characters. In *Advanced Computing and Systems for Security*, pp. 53–68 New Delhi, India: Springer, 2016.
- M. S. Shirdhonkar and M. Kokare. Off-line handwritten signature identification using rotated complex wavelet filters. *IJCSI International Journal of Computer Science Issues*, 8(1): 478-482, 2011.
- D. Bertolini, L. S. Oliveira, E. Justino, and R. Sabourin. Texture-based descriptors for writer identification and verification. *Expert Systems with Applications*, 40: 2069–2080, 2013.
- R. K. Hanusiak, L. S. Oliveira, E. Justino, and R. Sabourin. Writer verification using texture-based features. *International Journal on Document Analysis and Recognition* (*IJDAR*), 15: 213–226, 2012.
- V. Nguyen and M. Blumenstein. Techniques for static handwriting trajectory recovery: A survey. In DAS '10 Proceedings of the 9th IAPR International Workshop on Document Analysis Systems, pp. 463–470, 2010.
- R. Plamondon and C. M. Privitera. The segmentation of cursive handwriting: An approach based on off-line recovery of the motor-temporal information. *IEEE Transactions on Image Processing*, 8: 80–91, 1999.
- M. A. Ferrer, J. Francisco Vargas, A. Morales, and A. Ordonez. Robustness of offline signature verification based on gray level features. *IEEE Transactions on Information Forensics and Security*, 7: 966–977, 2012.
- D. Ellen. Scientific Examination of Documents: Methods and Techniques, 3rd ed. Boca Raton, FL: CRC Press, 2005.
- 25. L. Jane. Forensic Document Examination: Fundamentals and Current Trends, 1st ed. Norwell: Academic Press, 2014.
- U.-V. Marti, R. Messerli, and H. Bunke. Writer identification using text line based features. In Proceedings of Sixth International Conference on Document Analysis and Recognition, pp. 463–470. IEEE, 2001.

- H. Arora, S. Lee, S. N. Srihari, and S. H. Cha. Individuality of handwriting. *Journal of Forensic Science*, 47: 1–17, 2002.
- M. Bulacu, L. Schomaker, and L. Vuurpijl. Writer identification using edge-based directional features. In *Proceedings of Seventh International Conference on Document Analysis and Recognition*, pp. 937. IEEE, 2003.
- A. Bensefia, T. Paquet, and L. Heutte. A writer identification and verification system. Pattern Recognition Letters, 26: 2080–2092, 2005.
- I. Siddiqi and N. Vincent. Text independent writer recognition using redundant writing patterns with contour-based orientation and curvature features. *Pattern Recognition*, 43: 3853–3865, 2010.
- D. Pavelec, E. Justino, L. V. Batista, and L. S. Oliveira. Author identification using writer-dependent and writer-independent strategies. In *Proceedings of the 2008 ACM* Symposium on Applied Computing, pp. 414–418, 2008.
- E. Pkalska and R. P. Duin. Dissimilarity representations allow for building good classifiers. *Pattern Recognition Letters*, 23: 943–956, 2002.
- T. Matsumoto and D. Muramatsu. Online signature verification algorithm with a userspecific global-parameter fusion model. In *IEEE International Conference on Systems*, Man and Cybernetics (SMC 2009), pp. 486–491. IEEE, 2009.
- S. N. Srihari, S. H. Cha, H. Arora, and S. Lee. Individuality of handwriting. *Journal of Forensic Science*, 47: 856–872, 2002.
- R. Jain and D. Doermann. Writer identification using an alphabet of contour gradient descriptors. In 12th International Conference on Document Analysis and Recognition (ICDAR), pp. 550–554. IEEE, 2013.
- B. Zhang, S. N. Srihari, and S. Lee. Individuality of handwritten characters. In Proceedings of Seventh International Conference on Document Analysis and Recognition, pp. 1086–1090. IEEE, 2003.
- S.-H Cha and S. N. Srihari. On measuring the distance between histograms. *Pattern Recognition*, 35: 1355–1370, 2002.
- M. Bulacu and L. Schomaker. Text-independent writer identification and verification using textural and allographic features. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 29(4): 701–717, 2007.
- 39. A. Schlapbach. Writer Identification and Verification. Clifton, VA: IOS Press, 2007.
- I. Siddiqi and N. Vincent. A set of chain code based features for writer recognition. In 10th International Conference on Document Analysis and Recognition (ICDAR '09), pp. 981–985. IEEE, 2009.
- S. N. Srihari and G. Leedham. A survey of computer methods in forensic document examination. In *Proceedings of 11th Conference International on Graphonomics Society* (IGS 2003), pp. 278–281, 2003.
- D. Maltoni, R. M. Bolle, D. Zhang, and J. P. Campbell. Guest editorial special issue on biometric systems. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews*, 35: 273–275, 2005.

- 43. J. L. Wayman, A. Jain, D. Maltoni, and D. Maio (Eds.). *Biometric Systems Technology*, Design and Performance Evaluation. London, UK: Springer, 2005.
- 44. D. V. Klein. Foiling the cracker: A survey of, and improvements to, password security. In Proceedings of the 2nd USENIX Security Workshop, pp. 5–14, 1990.
- D. Maltoni, D. Maio, A. Jain, and S. Prabhakar. Handbook of Fingerprint Recognition. London, UK: Springer Science and Business Media, 2009.
- R. Sanchez-Reillo, C. Sanchez-Avila, and A. Gonzalez-Marcos. Biometric identification through hand geometry measurements. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 35: 1168–1171, 2000.
- J. Daugman. The importance of being random: Statistical principles of iris recognition. Pattern Recognition, 36: 279–291, 2003.
- A. Jain, R. Bolle, and S. Pankanti (Eds.). Biometrics: Personal Identification in Networked Society. New York, NY: Springer Science and Business Media, 2006.
- J. P. Campbell. Speaker recognition: A tutorial. In *Proceedings of the IEEE*, 85(9): 1437–1462, 1997.
- Z. Zhou, E. Y. Du, N. Luke Thomas, and E. J. Delp. Multi-angle sclera recognition system. In Computational Intelligence in Biometrics and Identity Management (CIBIM), IEEE, 2011.
- F. Monrose and A. Rubin. The importance of being random: Statistical principles of iris recognition. In Proceedings of the 4th ACM Conference on Computer and Communications Security, pp. 48–56, 1997.
- W. Stone Henry and A. C. Sanderson. A prototype arm signature identification system. In Proceedings of IEEE International Conference on Robotics and Automation, vol 4, pp. 107–131, IEEE, 1987.
- R. Plamondon and G. Lorette. Automatic signature verification and writer identification 17 the state of the art. *Pattern Recognition*, 22: 107–131, 1989.
- R. Plamondon. A kinematic theory of rapid human movements: Part III. kinetic outcomes. *Biological Cybernetics*, 78: 133–145, 1998.
- 55. V. Nguyen, M. Blumenstein, V. Muthukkumarasamy, and G. Leedham. Off-line signature verification using enhanced modified direction features in conjunction with neural classifiers and support vector machines. In *Ninth International Conference on Document Analysis and Recognition (ICDAR 2007)*, vol. 2, pp. 734–738, IEEE, 2007.
- U. V. Marti and H. Bunke. The iam-database: An English sentence database for off-line handwriting recognition. *International Journal on Document Analysis and Recognition*, 5: 39–46, 2002.
- 57. G. L. Schomaker, R. Plamondon, R. Liberman, and S. Janet. Unipen project of online data exchange and recognizer benchmarks. In *Proceedings of the 12th IAPR International Conference on Pattern Recognition, Computer Vision and Image Processing*, vol. 2, pp. 29–33. IEEE, 1994.
- C. Halder and K. Roy. Individuality of isolated Bangla characters. In Proceedings of ICDCCom, pp. 1–6. IEEE, 2014.

- 59. G. F. Simons Lewis, M. Paul and C. D. Fennig. *Ethnologue: Languages of the World*. Texas: SIL International, 2016.
- N. Gorski, V. Anisimov, E. Augustin, O. Baret, and S. Maximov. Industrial bank check processing: The A2iA Check-readerTM. International Journal on Document Analysis and Recognition, 3: 196–206, 2001.
- C. Halder, J. Paul, and K. Roy. Individuality of Bangla numerals. In 2012 12th International Conference on Intelligent Systems Design and Applications (ISDA). IEEE, 2012.
- A. Eleyan, H. Ozkaramanli, and H. Demirel. Dual-tree and single-tree complex wavelet transform based face recognition. In *IEEE 17th Conference on Signal Processing and Communications Applications (SIU 2009)*, vol. 3, pp. 610–621. IEEE, 2009.
- G.-Y. Zhang, S.-Y. Peng, and H-M. Li. Combination of dual-tree complex wavelet and svm for face recognition. In 2008 International Conference on Machine Learning and Cybernetics, vol. 5. IEEE, 2008.
- Y. Peng, X. Xie, W. Xu, and Q. Dai. Face recognition using anisotropic dual-tree complex wavelet packets. In 19th International Conference on Pattern Recognition (ICPR 2008). IEEE, 2008.
- P. Zhang, T. Bui, and C. Suen. Wavelet feature extraction for the recognition and verification of handwritten numerals. Wavelet Analysis and Active Media Technology, 3: 3–9, 2005.
- N. Kingsbury. Image processing with complex wavelets. Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences, 357(1760): 2543–2560, 1999.
- R. M. Haralick, K. Shanmugan, and I. Dinstein. Textural features for image classification. *IEEE Transactions on Systems, Man, and Cybernetics*, 3: 610–621, 1973.
- S. Kullback and R. A. Leibler. On information and sufficiency. The Annals of Mathematical Statistics, 22: 79–86, 1951.
- M. Kubat and S. Matwin. Combination of dual-tree complex wavelet and SVM for face recognition. In Proceedings of the Fourteenth International Conference on Machine Learning, vol. 97. Citeseerx, 1997.
- N. Landwehr, M. Hall, and E. Frank. Logistic model trees. *Machine Learning*, 59: 161–205, 2005.
- J. Friedman, T. Hasti, and R. Tibshirani. Additive logistic regression: A statistical view of boosting. *The Annals of Statistics*, 28: 337–407, 2000.
- D. S. Broomhead and D. Lowe. Multivariable functional interpolation and adaptative networks. *Complex Systems*, 11: 321–355, 1988.
- M. Hall et al. The WEKA data mining software: An update. ACM SIGKDD Explorations Newsletter, 11: 10–18, 2009.
- 74. S. Pankanti, N. K. Ratha, A. W. Senior, R. M. Bolle, and J. H. Connell. *Guide to Biometrics*. New York, NY: Springer, 2004.
- J. Paul, C. Halder, Sk. Md Obaidullah, and K. Roy. Writer verification on Bangla handwritten characters. In *Advanced Computing and Systems for Security*, pp. 53–68. New Delhi, India: Springer, 2015.



Swami Vivekananda and Youth

Ramakrishna Mission Vivekananda Centenary College, Rahara

My faith is in the younger generation, the modern generation, out of them will come my workers. They will work out the whole problem, like lions. I have formulated the idea and have given my life to it.

Will you respond to the cell of your nation? Each one of you has a glorious future if you dare believe me. Have a tremendous faith in yourselves, like the faith I had when I was a child, and which I am working out now. Have that faith each one of you, in yourself - that eternal power is lodged in every soul - and you will revive the whole of India. Ay, we will then go to every country under the sun, and our ideas will before long be a component of the many forces that are working to make up every nation in the world. We must enter into the life of every race in build and abroad; shall have to work to bring this about. Now for that, I want young men. "It is the young, the strong, and healthy, of sharp intellect that will reach the Lord", say the Vedas. This is the time to decide your future while you possess the energy of youth, not when you are worn out and jaded, but in the freshness and vigour of youth. Work this is the time; for the ireshest, the untouched, and unsmelled flowers alone are to be leid at the feet of the Lord, and such He receives. Rouse yourselves, therefore, or life is short. There are greater works to be done than aspiring to become lawyers and picking quarrels and such things. A far greater work is this sacrifice of yourselves for the benefit of your race, for the welfare of burnarity.

Arise, awake, for the time is propitious. Already everything is opening out before us. Be bold and fear not. It is only in our scriptures that this adjective is given unto the Lord Abbit. Abbit. We have to become Abbih, fearless, and our task will be done. Arise, ewake, for your country needs this tremendous sacrifice. It is the young men that will do it. "The young, the energetic, the strong, the well-built, the intellectual" for them is the task.

- Swami Vivekananda



RKMVC College Rahara, Kolkata

Ramakrishna Mission Vivekananda Centenary College Rahara Kolkata - 700118 Phone No. : 033-25682049 rkmvccollege@rkmvccrahara.org



Publisher's Note

Swami Vivekananda, expresses his dream in the following words, in one of his letters to Alasinga Perumal, on 20th August, 1893: *A hundred thousand men and women, fired with the zeal of holiness, fortified with eternal faith in the Lord, and nerved to lion's courage by their sympathy for the poor and the fallen and the downtrodden, will go over the length and breadth of the land, preaching the gospel of salvation, the gospel of help, the gospel of social raising - up -- the gospel of equality.* Inspired by this vision, Ramakrishna Mission Vivekananda Centenary College, Rahara is bringing out 'Swami Vivekananda and Youth' a book for the youth to know, admire and

Major part of the book consists of lectures delivered by eminent thinkers on Swami Vivekananda at an International Seminar on 'Youth & Swami Vivekananda' organized in the College on 13th January, 2015. This bouquet includes deliberations by Revered Swami Jyotirupananda, Minister-in-Charge, Vedanta Centre, Moscow, Russia, Revered Swami Suparnananda, Secretary, Ramakrishna Mission Institute of Culture, Golpark, Kolkata, Swami Sumanasananda, The then Secretary, Ramakrishna Mission Cherrapunjee & presently at Ramakrishna Centre of South Africa, Durban & Prof. Ranjit Sen, Asiatic Society, Kolkata. We are indebted to all of them for sharing their valuable ideas with the youth. We are highly grateful to Prof. T.V. Ramakrishnan, Department of Physics, Banaras Hindu University, Varanasi & Department of Physics, Indian Institute of Science, Bangalore & Padmashree awardee, for kindly contributing an article, 'Vivekananda and Modern Science' based on his lecture delivered at Ramakrishna Mission Institute of Culture, Golpark, Kolkata. We felt Prof. T.V. Ramakrishnan's topic highly relevant for the youth, the torch bearer of Modern Science. Hope the book will definitely inspire the youth, to shape the future of the nation and the world at large in a more meaningful and fulfilling way. We are grateful to Revered Swami Jayananda, Secretary, Ramakrishna Mission Boys' Home, Rahara for his foreword. We are thankful to Shri Manas Moulic, Asst. Professor in English of our college for helping us in organizing the material for the book.

The relevance of Swami Vivekananda's message for the youth needs no introduction. But it is high time for the youth to adopt his guidelines and apply them in practice in their individual lives. With the newer challenges of moral and societal crises, Swami Vivekananda seems to heavily knock the doors of our conscience. Now, it is only for us to decide, whether we are willing to answer to his call or not.

We pray to Sri Ramakrishna, Holy Mother Sri Sarada Devi and Swami Vivekananda to inspire our lives through this book. We offer our humble effort to publish this book at their Lotus-Feet. We believe, by their holy touch, an enlivening spirit will definitely emerge from this book to benefit the youth and society at large.

Rahara

25th November, 2015

Swami Kamalasthananda



SISTER NIVEDITA AND HER CONTRIBUTIONS TO INDIA

Ramakrisona Mission Vivekananda Centenary College, Rahara If the whole of India could agree to give, say, ten minutes every evening, at the on coming of darkness to thinking a single thought, 'We are one. We are one. Nothing can prevail against us to make us think we are divided. For we are one. We are one and all anatagonisms amongst us are illusions' - the power that would be generated can hardly be measured.

The Indian people is a mightier people. It is for the nation to learn its strength, and for the individual to strive mightily therein, and nothing will be able to resist its progress. All difficulties will be broken before it like cobwebs.

.... When the whole of this nation shall be united together not in a common weakness, not in a common misfortune or grievance but in a great overflowing complex, actual, ever strong, ever living consciousness of the common nationality, the common heritage, the common struggle, the common life. Aye! The common destiny and the common hope, and so let me in all reverence and in all grateful memory and love repeat to you again those words that were spoken here in our midst so few years ago by a voice so dear, so well remembered by you all - those words that were the text of his message to his land for ever more: "Arise, awake, struggle and rest not till the goal is reached."

National unity is built on common home, the common interst and common love.

I believe that the/strength which spoke in the Vedas and Upanishads, in the making of religions and empires, in the learning of scholars, and the meditation of the saints, is born once more amongst us, and its name today is Nationality.

I believe that the present of India is deep-rooted in her past, and that before her shines a glorious future.

Let me plough my furrow across India just as deep, deep, deep into the very centre of things, as it will go. Let it be either as a hidden voice sending out noiseless things from a cell or a personality, romping and raging through the big cities – I don't care but the God of my own strong right hand grant that I do not have to waste my effervescence in western futilities. India is the starting point, and the goal, as far I am concerned. Let *her* look after the west If she wishes.

Sisten Nivedita

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE

P.O. RAHARA, KOLKATA-700118 Phone: (033)2568-2049 Email:rkmvccollege@rkmvccrahara.org Website www.rkmvccrahara.org



Price ₹ 120.00

Publishers Note

Sister Nivedita remains one of the most influential female figures of India. In 2010, the Office of the Board of West Bengal Board of Secondary Education in Salt Lake, Kolkata was named after Sister Nivedita. The Sister Nivedita Academy, an institution dedicated to her memory has been established in Chennai, Tamil Nadu. Several schools and colleges have been named after her. In 1968, the Indian Government issued a postal stamp in her memory. The Nivedita bridge near Dakshineswer, Kolkata is named in her honour. In 2015, a new Government Degree College at Hastings House, Alipur, Kolkata was named after Sister Nivedita.

On 13th November 1898 Holy Mother Sri Sarada Devi came to open Nivedita Girls' school in Bagh Bazar, Kolkata. Nivedita travelled to many places in India especially - Almora, Kashmir and Amarnath with Swamiji which helped her to understand India and the masses at large. Her love for India knew no bounds. Her magnetic personality and feeling heart and sincere love for the masses made her endearing to all classes of people. Some eminent contemporaries who came close to her were statesmen, poets, artists, scientists, historians and journalists. Ramesh Chandra Dutta, G.K. Gokhale, Bipin Chandra Pal, Jagadish Chandra Bose, Aurobindo Ghosh, Rabindranath Tagore, Jadunath Sarkar and Ramananda Chatterjee are a few in the list. Her contribution to India cannot be evaluated easily due to the cause that she had dedicated her entirety for the cause of India. Dr. Rashbehari Ghosh rightly said about her – If sister fell under the spell of India we in our turn fell under her spell, and her bewitching personality attracted thousands of our young men to her. Considering Sister Nivedita's contribution to India Tagore mentioned -- I have not noticed in any other human being the wonderful power that was hers of absolute dedication of herself. There was no defrauding of us on her part, that is, she gave herself up fully for the service of India. She did not keep anything back for her own use. She was in fact a Mother of People. When she uttered the word "Our People" the tone of absolute kinship which struck the ear was not heard from any other among us. To study her contribution to India the Ramakrishna Mission Vivekananda Centenary College, Rahara is publishing 'Sister Nivedita and Her Contributions to India' -a book to promote, analyse and understand her contribution to India in different domains.

A portion of this book consists of contributions from eminent thinkers on Sister Nivedita, who spoke at a National Seminar on 'Sister Nivedita and Her Contribution to India : A Historical Perspective' organized in the College on 9th & 10th December, 2016. We are highly grateful to Dr. Debanjan Sengupta, Doctor, Prof. (Dr.) Bishnupada Nanda, Professor & HOD, Department of Education, Jadavpur University, Prof. Nirmal Kumar Maity, Associate Professor, Bidhannagar College, Dr.Ratnabali Banerjee, Former Joint Secretary, University Grants Commission for enriching the content of the book with their pearls of wisdom.

We are thankful to Shri Manas Moulic, Asst. Professor in English of our college for helping us in giving shape to this book.

Rahara, Kolkata 10th January, 2018

Swami Kamalasthananda



SWAMI VIVEKANANDA AND HIS UNIVERSAL IDEAS

Ramakrishna Mission Vivekananda Centenary College, Rahara See that universality be not hampered in the least. Everything must be sacrificed, if necessary, for that one sentiment, universality. Whether I live or die, whether I go back to India or not, remember this specially, that universality -- perfect acceptance, not tolerance only -- we preach and perform.

Unity in variety is the plan of creation, individuality in universality.

Individuality in universality is the plan of creation. Each cell has its part in bringing about consciousness. Man is individual and at the same time universal. It is while realising our individual nature that we realise even our national and universal nature. Each is an infinite circle whose centre is everywhere and circumference nowhere.

I make two points. There are sects. Let them go on increasing in number till each is a sect by himself. None can see God exactly as another; each must believe in Him and serve Him as he sees Him. Then I want a harmonizing of the sects. Individuality is not in a fight with universality.

I want to give them dry, hard reason, softened in the sweetest syrup of love and made spicy with intense work, and cooked in the kitchen of Yoga, so that even a baby can easily digest it.

Each of us is moving towards Him along one of these radii, then it is certain that all of us must reach that centre. And at the centre, where all the radii meet, all our differences will cease; but until we reach there, differences there must be. All these radii converge to the same centre. One, according to his nature, travels along one of these lines, and another, along another; and if we all push onward along our own lines, we shall surely come to the centre.

One-sidedness is the bane of the world. The more sides you can develop the more souls you have, and you can see the universe through all souls.

-Swami Vivekananda

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE

P.O. RAHARA, KOLKATA-700118 Phone: (033)2568-2049 Email:rkmvccollege@rkmvccrahara.org Website : www.rkmvccrahara.org



Publishers Note

Swami Vivekananda, writes in one of his letters to Swami Ramakrishnananda, in 1894 from Chicago : '...see that universality be not hampered in the least. Everything must be sacrificed, if necessary, for that one sentiment, universality. Whether I live or die, whether I go back to India or not, remember this specially, that universality -- perfect acceptance, not tolerance only -- we preach and perform'. Such strong was his emphasis on universality. Charged with his inspiration the Ramakrishna Mission has tried its level best to render physical, intellectual and spiritual service to mankind irrespective of caste, creed or nationality with a vision of seeing oneself equally in all. With this legacy of universal love poured out in service at the background the Ramakrishna Mission Vivekananda Centenary College, Rahara is publishing 'Swami Vivekananda and his Universal Ideas' -a book to promote, analyse and apply the universal message of Swami Vivekananda along multifarious channels.

A portion of this book consists of contributions from eminent thinkers on Swami Vivekananda, who spoke at an International Seminar on 'Swami Vivekananda & his Universal Ideas' organized in the College on 12th January, 2016. This garland of articles include deliberations by Revered Swami Ishatmananda, President, Vivekananda Vedanta Society of Chicago, USA, Dr. J.L. Shaw, Dept. of Philosophy, Victoria University, New Zealand, Dr. Santi Nath Chattopadhyay, President & Executive Director, International Society for Inter-cultural Studies and Research, India. We are highly grateful to Revered Swami Bhajanananda, Assistant Secretary Ramakrishna Math & Ramakrishna Mission, Belur Math, Revered Swami Suvirananda, Assistant Secretary Ramakrishna Math & Ramakrishna Mission, Belur Math, Prof. Basab Chaudhuri, Vice Chancellor, West Bengal State University, Barasat, Dr. Ratnabali Banerjee, Former Joint Secretary, University Grants Commission for enriching the content of the book with their pearls of wisdom. These pearls have been strung into one string in this book. The varied backgrounds from which the contributors have hailed is itself an evidence of the universal appeal of Swami Vivekananda's ideas.

We are thankful to Shri Manas Moulic, Asst. Professor in English of our college for helping us in giving shape to this book. Today we stand amidst a peculiar situation where the towers of material prosperity are rising to the skies and yet the questions like divisiveness based on religion and nationality, power and money remain unsolved. By universality we still mean squeezing all into a single path. We are yet to realize that there can be a single goal which encourages plurality in approach. At this point Swami Vivekananda becomes relevant to redefine universality where the secular and sacred can become one, where individuality should flourish to bring home universality only if everything is subdued to sacrifice and service. This book has dealt with this issue of universality as envisioned by Swami Vivekananda looked from different corners, be it in harmonizing work and worship, be it in inter-religious exchange and admiration, be it in striking a balance amidst the opposing features of the human personality, or be it in ecological balance.

Swami Vivekananda has said 'One-sidedness is the bane of the world. The more sides you can develop the more souls you have, and you can see the universe through all souls'. Thus if we desire to be a friend of all then we have to reach the universal core from which can admire and inspire all around us of any social identity, of any mental make-up, of any school of thought. We pray to Shri Ramakrishna, Holy Mother Shri Sarada Devi and Swami Vivekananda to inspire us through this book to reach this true state of universality where we can relish the bliss of universal love and radiate universal service from ourselves.

Swami Kamalasthananda

Rahara, Kolkata 28th October, 2016 150th Birth Anniversary of Sister Nivedita



SWAMI VIVEKANANDA, INDIAN SOCIETY AND NATIONALISM

Editor SWAMI KAMALASTHANANDA

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE RAHARA There is good and bad everywhere, true — but a nation is not to be judged by its weaklings called the wicked, as they are only the weeds which lag behind, but by the good, the noble, and the pure who indicate the national life-current to be flowing clear and vigorous.

...... but our nation is totally lacking in the faculty of organisation. It is this one drawback which produces all sorts of evil. We are altogether averse to making a common cause for anything. The first requisite for organisation is obedience.....

We want to become harmonious beings, with the psychical, spiritual, intellectual, and working (active) sides of our nature equally developed. Nations and individuals typify one of these sides or types and cannot understand more than that one. They get so built up into one ideal that they cannot see any other. The ideal is really that we should become many-sided. Indeed the cause of the misery of the world is that we are so one-sided that we cannot sympathise with one another.

The tremendous engine of competition will destroy everything. If you are to live at all, you must adjust yourself to the times. If we are to live at all, we must be a scientific nation. Intellectual power is the force. You must learn the power of organisation of the Europeans. You must become educated and must educate your women.

The national ideals of India are RENUNCIATION and SERVICE. Intensify her in those channels, and the rest will take care of itself.

Then as to the methods of carrying the ideals into practical life. First, we have to understand that we must not have any impossible ideal. An ideal which is too high makes a nation weak and degraded. This happened after the Buddhistic and the Jain reforms. On the other hand, too much practicality is also wrong. If you have not even a little imagination, if you have no ideal let guide you, you are simply a brute. So we must not lower our ideal, neither are we to lose sight of practicality. We must avoid the two extremes.

Swami Vivekananda

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE

P.O. RAHARA, KOLKATA-700118 Phone: (033)2568-2049 Email:rkmvccollege@rkmvccrahara.org Website : www.rkmvccrahara.org



Price : ₹ 150.00

Publisher's note

Swami Vivekananda used to say that he is 'Condensed India'. The intense unification he felt with India and her people resulted in such a confident statement. Rabindranath Tagore wrote in a letter to Romain Rolland 'If you want to know India, study Vivekananda. In him everything is positive and nothing negative'. Similar has been the observations of many other luminaries. Thus whenever we want to know the roots of Indian Society or Nationalism and desire to gauge its present condition or future possibilities we must turn to Vivekananda as an acceptable interpreter. The Ramakrishna Mission Vivekananda Centenary College, Rahara is bringing out this book entitled 'Swami Vivekananda, Indian Society and Nationalism' to have a clear conception on this topic. It was urgent in the sense when the issue is being looked upon from various angles and is being interpreted and misinterpreted as well.

Some of the articles of the book were papers presented at a National Seminar on the topic 'Swami Vivekananda, Indian Society and Nationalism' organized in the College. Eminent scholars from different walks of life have contributed their streams of wisdom in this book to enlighten different aspects of the central theme. We are grateful to all of them for sharing their valuable ideas in the book. The Ramakrishna Mission Vivekananda Centenary College, Rahara is trying its level best to project Swami Vivekananda's man-making and character-building ideas to the youth. In its earlier attempts it has published books like 'Swami Vivekananda and Youth', 'Swami Vivekananda and His Universal Ideas', 'Sister Nivedita and her Contributions to India'. The current attempt is also a humble tribute to the great Prophet-Patriot Swami Vivekananda. The gradually declining sense of belonging to the nation is equally hampering the sense of belonging to a home or a family and as a result we are seeing various kinds of social crises. So a National pride is required and at the same time it is the stepping stone for true Universality which is also a passion for Swami Vivekananda. Moreover Vivekananda was of the opinion that harmony and exchange between India and the rest of the world is possible only when she has something unique to give. Merely begging and sitting at the feet of others for everything was not his choice. Rather he felt that in some aspects India shall be a supreme teacher while on other grounds it is ready to take up the position of a sincere student of other nations. He reminds Indians to realize this task and not just be grateful recipients of gifts from other nations. Swami Vivekananda says: 'Rights and privileges and other things can only come through friendship, and friendship can only be expected between two equals. When one of the parties is a beggar, what friendship can there be? It is all very well to speak so, but I say that without mutual co - operation we can never make ourselves strong men. So, I must call upon you to go out to England and America, not as beggars but as teachers of religion. The law of exchange must be applied to the best of our power. If we have to learn from them the ways and methods of making ourselves happy in this life, why, in return, should we not give them the methods and ways that would make them happy for all eternity? Above all, work for the good of humanity. Give up the so - called boast of your narrow orthodox life. Death is waiting for every one, and mark you this -- the most marvellous historical fact -- that all the nations of the world have to sit down patiently at the feet of India to learn the eternal truths embodied in her literature.'

Swami Vivekananda was not at all biased. He knew our national limitations the best and it was he who knew the incomparable treasures hidden within the Indian wisdom. Regarding this conscious need to learn, develop and at the same time contribute and teach the world was his plea to the nation. Regarding this essential international 'osmosis' Swami Vivekananda says, 'We want to become harmonious beings, with the psychical, spiritual, intellectual, and working (active) sides of our nature equally developed. Nations and individuals typify one of these sides or types and cannot understand more than that one. They get so built up into one ideal that they cannot see any other. The ideal is really that we should become many-sided. Indeed the cause of the misery of the world is that we are so one-sided that we cannot sympathise with one another.'

We are thankful to all who have worked for publishing this book. We are happy to publish this book on the occasion of the 125th anniversary of Swami Vivekananda's historic address at Chicago.

Swami Kamalasthananda

11^{**} September, 2019 Anniversary of Swami Vivekananda's Chicago Address





Swami Wivekananda,

Modern Science and Education

Edited By Swami Kamalasthananda

16

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE, RAHARA

The meeting with Swami Vivekananda greatly stimulated Nikola Tesla's interest in Eastern Science. The Swami later remarked during a lecture in India, "I myself have been told by some of the best scientific minds of the day, how wonderfully rational the conclusions of the Vedanta are. I know of one of them personally, who scarcely has time to eat his meal, or go out of his laboratory, but who would stand by the hour to attend my lectures on the Vedanta; for, as he expresses it, they are so scientific, they so exactly harmonize with the aspirations of the age and with the conclusions to which modern science is coming at the present time".

Mr. Tesla was charmed to hear about the Vedantic Prana and Akasha and the Kalpas, which according to him are the only theories modern science can entertain.....Mr Tesla thinks he can demonstrate that mathematically that force and matter are reducible to potential energy. I am to go see him next week to get this mathematical demonstration.

Tesla apparently failed to show the identity of energy and matter. If he had, certainly Swami Vivekananda would have recorded that occasion. The mathematical proof of the principle did come until about ten years later when Albert Einstein published his paper on relativity. What had been known in the East for the last 5,000 years was then known to the West.

~ Tesla Memorial Society of New York

RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE P.O. RAHARA, KOLKATA- 700 118 Phone: (033) 2568 2049 Email: rkmvccollege@rkmvccrahara.org Website: www.rkmvccrahara.org



Price: ₹ 300.00

Foreword

Modern Science and Education are the two pillars on which the present society and the future destinations of mankind depend. The ideas of Swami Vivekananda have a special role to remodel science and education in a newer way so as to accommodate man-making, character-building ideas into the process. Until recent times science and spirituality has been divorced from each other especially in the West. Science has been thought to be absolutely material and spirituality has been thought to be irrational. It was Swami Vivekananda who wanted to weave a civilization where science was humane and inclusive of emotional and spiritual balance of man and spirituality was daringly experimental and experiential. He wanted to remove dogmatism from both science and spirituality and open newer horizons of knowledge. Speaking of the common goal of science and spirituality Swami Vivekananda says: "Knowledge means finding this unity. I see you as men and women, and this is variety. It becomes scientific knowledge when I group you together and call you human beings. Take the science of chemistry, for instance. Chemists are seeking to resolve all known substances into their original elements, and if possible, to find the one element from which all these are derived. The time may come when they will find one element that is the source of all other elements. Reaching that, they can go no further; the science of chemistry will have become perfect. So it is with the science of religion. If we can discover this perfect unity, there cannot be any further progress." Thus by redefining science and spirituality the scopes of education change. Knowledge as a whole is to be appreciated and understood without stubborn compartmentalization. Education will become much more interdisciplinary and all inclusive. This will develop the future man in a much more holistic manner. The current book 'Swami Vivekananda, Modern Science and Education' published by Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata is an attempt to delineate the role of Swami Vivekananda in redefining the ambits of science and making it modern and inclusive of spirituality.

The book is a collection of articles contributed by various eminent thinkers and academicians who have analysed the topic from different angles. We are thankful to all of them for their thoughtful contributions. We hope that this book will inspire new understanding on science, spirituality, their mutual importance and their place in education in the light of Swami Vivekananda.

Rahara, Kolkata 1st September, 2022 Ashrama Foundation Day Swami Kamalasthananda



The Gospel of Sri Ramakrishna and its Relevance

140
15. Ibid. p. 1001
16. Ibid. p. 324
17. Ibid. p. 152
18. Ibid. p. 628
19. Ibid. p. 628
19. Ibid. p. 92
21. Ibid. p. 360
22. Ibid. p. 426
23. Ibid. pp. 90.91
24. Ibid. pp. 90.91
25. Ibid. p. 147

9

Echoes of 'Ecosophies' in the Gospel of Sri Ramakrishna

Br. Shrutichaitanya

Arne Naess, a Norwegian environmental philosopher, was watching a flea immolate itself in an acid bath under a microscope. Naess deeply empathized with the suffering flea, identified with it, and thereby felt deeply connected with the entire lifeworld.¹ This sort of experiences and ideas created an urge for formulating an ecological philosophy or '*ecosophy*' which would 'recognize the values that inhere objectively in nature independently of human wants, needs or desires.² This came to be known as the '*Deep Ecology*' in the 1970s in contrast to the prevalent '*shallow*' version of ecology based on anthropocentrism which is concerned about conservation and preservation of biodiversity only because of the use-value of non-human nature for human welfare. According to Næss, every being, whether human, animal or vegetable has an equal right to live and to blossom.³

Apart from Naess the other major contributors towards analyzing the phenomenon of Deep Ecology are George Sessions and David Rothenberg from America and Warwick Fox from Australia. Diverse streams of ideas and inspirations have commingled into the present form of Deep Ecology. Authors have pointed out the connections between Deep Ecology and ecological science (Golley, 1987), religions from around the world (Barnhill and Gottlieb, 2001), New Age spirituality (La Chapelle , 1978), direct action / ecological sabotage (Foreman, 1991), the poetry of Robinson Jeffers (Sessions 1977), the land ethic of Aldo Leopold (Devall and Sessions, 1985), the monism of Baruch Spinoza (Sessions 1977, 1979, 1985; Naess 2005), and the phenomenology of Martin Heidegger (Zimmerman 1986).⁴

Another feature of the developing models of Deep Ecology is its openness to newer versions. Naess named his own environmental philosophy as 'ecosophy T'.The 'T' stands for Naess's secluded boreal hut, Tvergastein. He gives this just as a template for other personal ecosophies to emerge.
vata Mahana

8

The Gospel of Sri Ramakrishna and Ecology – A study Swami Kamalasthananda

Nowadays the term 'ecology' is an important topic for the present day world. Newer invention of man makes more concern about environment and environmental issue in present day compare to the past with a knowledge of its different components and their relation with surrounding animate and of its different components and their relation with surrounding animate and solution world. Here comes the use of ecology. Haeckel first time in 1969 insummate world. Here comes the use of ecology. Haeckel first time in 1969 insummate world integrate ecology as the total relations of animal to both its used this term and defined ecology as the total relations of animal to both its most only the relation between the organism and environment, but assigns it in the ecosystem in a proper position so that it is an integrated component in the whole ecosystem structure. According to the modern ecologist Smith (1977) the ecology is – a multidisciplinary science which deals with organism and its place to line and focuses on the ecosystem ².

The Gospel of Sri Ramakrishna and Ecology – A study

human nace will survive (Chandi). The sustainable development which is a hot human nucleon world and the issue is so appealing in the Vedic prayer to earth issue in me of the concept of sustainable development, now being advocated at international flora, is contained in the vedic payers to the earth. It says : What of there I dig out, let that quickly grow over, / Let me not hit thy vitals, or thy heart, (Atharva veda)³ In the Islamic tradition the earth and environment are treated as most sacred thing. Islamic religion again and again gives stress upon the as most and ecosystem. The Prophet Mohammed said - Whoever plants a tree and diligently looks after it until it matures and bears fruits is rewarded Buddha through His teaching preaches ecological integration to all mankind to develop a civilization in holistic line. According to the Sikh scripture Guru Grantha Sahib the human being like all is composed five elements which are the vital matter of physical, mental and spiritual body of human being. Earth teaches us patience, love; / Air teaches us mobility and liberty; / Fire teaches us warmth and courage; / Sky teaches us equality and broad mindedness; Water teaches us purity and cleanliness (Guru Grantha Sahib). Ecology deals in one side the balance between individual freedom and social freedom for formation a well-trained society in vanguard of civilization. Ecological ethics limit social as well as individual freedom of action in the struggle for existence 4. But on other side human beings are interconnected to plants, animals, soils, atmosphere and generally whole environment. We deny this law and dictum. may invoke a historical premise, namely, that all life-forms are descended from a common source, or at least that human beings are related to other life-forms through the long historical processes of evolution. Ironically, however, the results of genomic research suggest that humans are related to the rest of life-or rooted in nature-in unexpected ways5.

127

Environmentalism is an interdisciplinary subject which deals the activities of human beings with the environment fruitfully eliminating its probable hazards. The concept of environmentalism grows in different countries in different circumstances. The root behind all movements is to protect the environment from ever growing pollution and calamities...... In Victorian Britain, an early "Back-to-Nature" movement that anticipated modern environmentalism was advocated by intellectuals such as John Ruskin, William Morris and Edward Carpenter, who were all against consumerism, pollution and other activities that were harmful to the natural world. Their ideas also inspired various protoenvironmental groups in the UK, such as the Commons Preservation Society, the

Ecological Perception in Ancient India Through Manuscript Study

– Swami Kamalasthananda

Manuscript is generally called a manually written document but not printed from in any medium. Before the arrival of printing device i.e. press or printer, all documents and books were called manuscripts as all these were produced manually. Manuscripts are not defined or rather classified by the nature of contents present in the same, which may include arts, literature, facts, fictions, esthetic creation, history, geography, mathematical calculations, maps, explanatory figures or illustrations or any type of human endeavour which has leaded man onward and forward. Manuscripts have several forms i.e. book form, scrolls or in codex format. The word 'manuscript' is derived from the medieval Latin term 'manuscriptum' that indicates hand written documents. Manuscript is a hand written composition on bark, cloth, metal, palm-leaf, paper or any other material that has significant scientific, historical or aesthetic value. Manuscripts are found in hundreds of different languages and scripts (www.indianetzone.com). The manuscripts have a long history of its existence. According to the Chambers Dictionary, 'Manuscript is a book or document written by hand before the invention of printing' (Allied Chambers (India) Limited, 2000). Modern time manuscripts refer to autographs, correspondence, and any personal type-written text required for the publication of book or monograph.

The Antiquities and Art Treasures Act, 1972 gives the legal framework for custody of manuscripts. Antiquities, defined under the Act include

any manuscript, record or other document which is of scientific, any manuser or a esthetic value and which has been in existence for historical, literary or aesthetic value and which has been in existence for not less than seventy-five years'.

Preservation of Manuscript The preservation of manuscript is a serious concern for the people of

library science, information science, literary person, social study, historical library sets from very ancient time people have a great concern for this study, etc. from very ancient civilizations also depute it. study, etc. Many ancient civilizations also deeply thought over this issue, subject. Many ancient civilizations also deeply thought over this issue. subject. Babylonia, Assyria, Sumeria, China or India; the scribes were always Babylound to preserve their writings for posterity with whatever means they worned to had. Scholars like Aristotle, Ovid and Horace were also worried about had, solution of the manuscripts from the insects'. With the technological breakthrough new scientific techniques are evolved for the preservation of the manuscripts. But the importance of the indigenous methods is still present for the preservation process. The all indigenous processes are time tested practice and are evolved in specific regions and climate condition. It has the following advantages:

• These are not hazardous for human health.

These do not have any adverse effect on the materials.

• The methods do not require much expertise, equipment and money2.

So the idea to preserve the manuscript is not the new concept in the present day. People knew that the environment factors like light, dust, moisture and the different warms are highly detrimental for all these manuscript. So people solve this problem in their own way of preventive measure. Some of these preventive measure are given below which ancient people used to conversant:

- (a) Safe upkeep of manuscripts is ensured even before writing on the leaf. Seasoning of the leaf by burying them under the mud or boiling them in water are considered to have some antiseptic effect against the damage caused by the insects.
- (b) Usually to fasten the manuscripts, holes are punched on the leaves and cords are passed through them. These are then placed in between two stiff flat wooden boards having the same type of

Manuscript and Indian Culture

Edited by Projit Kumar Palit Susmita Palit Saha





Kaveri Books

4832/24, Ansari Road, Darya Ganj New Delhi - 110002 (India) Tel.: (011) 2328 8140, 2324 5799 E-mail: info@kaveribooks.com, kaveribooks@gmail.com Website: www.kaveribooks.com



Price: ₹ 1500.00

Be a Vivekananda Prof. Manas Moulic

'Youth', the term gives more a vision before our eyes and some unique qualities and spirit than any prescribed definition of any dictionary I suppose. 'Youth', the word speaks better of freshness, vigour, mental strength and dynamism than any age group, some well built muscular figure or a handsome look.

Biologically though, the age group between 15 to 24 is said to be 'youth' as per the international standard. United Nations has described 'youth' as a period of transition from the dependence of childhood to adulthood's independence and awareness of our interdependence as members of community. Youth is a more fluid category than a fixed age-group (What do we mean by "youth"?).

However, in India, the Ministry of Youth Affairs initially had an upper age limit of 35 to be said as 'youth' but now are thinking to scale it down to 30 almost following the international standard. But does any age group or age limits determine 'youth'? Perhaps the answer is 'No'.

As per Mr. Shiv Visvanathan, a sociologist, 'youth' cannot be determined by age limit but by 'lifestyle'. 'Youth' primarily are those who fall under a very ambiguous category he said (Sawant). Swami Vivekananda had a similar feeling for the youths of India too. He described youth as one with 'an immense amount of feeling and énthusiasm in the blood'. One who are the real 'heroes who will march from one corner of the earth to the other, preaching and teaching the eternal spiritual truths of our forefathers'.

Such a high expectation Swamiji had from the youths of India. They are the 'heroes' to him who should be carrying out such great task of 'preaching and teaching the eternal spiritual truths of our forefathers' round the globe. Thus Swamiji always wanted our youths to be leaders. He wanted them to have an idea (preferably great) and have the confidence and qualities to assemble others into^a team and preach those greater concepts among the common life. He used to say that "the conviction has grown in my mind after all my travels in various lands that no great cause can succeed without an organization". And who would run them? Youths, who are leaders by heart. To Swamiji, the earth's bravest and best will have to sacrifice themselves for the good of many and for the welfare of all.

But is it so difficult a task to become such powerful selfless leaders that Swamiji wanted to see in us? The answer is obviously NO. I understand that very few are born leaders. But at the same time I also believe that with little endeavour one can become a powerful and successful leader in life.

Leadership is a skill, a quality that can be learnt with certain eagerness to learn the same and through serious practice. During my nine and half years of teaching experience in Engineering Colleges I have seen learners coming from remote villages but with indomitable will power and sincere practice they have done wonders at the interviews.

Let's do a small exercise to learn how better a leader we are and what other qualities we have to learn to become the one like Swamiji wants us to be. Take a piece of paper and draw two columns. On top of one column write LEADERSHIP QUALITIES and on the other write I AM. Under Leadership qualities list some of the leadership qualities like.

- a. Good Communication Skill
- b. Good Listener
- c. Confident
- d. Responsible
- e. Decision Maker
- f. Accountable
- g. Team spirit
- h. Assertive & Positive
- i. Accommodating
- i. Committed

Now tick beside those qualities that are really in you. In doing this exercise you should be honest enough so that you can find out your real self.

It has been found that at least 80% youths round the world do not know about who he or she really is. They are ignorant about



Sister Nivedita and her contribution to India

Sri Manas Moulic

Sister Nivedita is a unique name in Indian history. She was born in Ireland but died for the cause of India. Her previous name was Margaret Elizabeth Nobel. She met Swami Vivekananda on 1895 in London and this meeting had changed her life and mission. According to her style it is presented as --*Suppose he had not come to London that time! Life would have been like a headless dream, for I always knew that I was waiting for something. I always said that a call would come.* On 28 January 1898 she reached Kolkata responding the call of Swami Vivekananda. Before coming in Kolkata Swamiji wrote a letter to her on 29th July 1897 with the words of inspiration for the work in India and at the same time describing the condition of India.

On 13th November 1898 Holy Mother Sarada Devi came to open her school in Bagh Bazar. She travelled to many places in India specially Almora, Kashmir and Amarnath with Swamiji which helped her to understand India and the masses at large. Her love for India knew no bounds. Her magnetic personality and feeling heart and sincere love for the masses made her endearing to all classes of people. Some eminent contemporaries who came close to her were statesmen, poets, artists, scientists, historians and journalists. Ramesh Chandra Dutta, G.K. Gokhale, Bipin Chandra Pal, Jagadish Chandra Bose, Aurobindo Ghosh, Rabindra Nath Tagore, Jadunath Sarkar and Ramananda

Youth and Swami Vivekananda

Swami Kamalasthananda

Introduction:

Youth is a term which denotes a particular time period or an intermediate time between the early childhood and adulthood. But the time period varies from place to place and time to time. In some places the youth stage comes very early and in other places it comes in a comparatively later period. But the motive of the term is always same everywhere. According to the United Nations, the Youth defines the age between 15-24 for statistical purpose and analysis. Moreover several United Nations entities or organizations define the term Youth in different ways in terms of age-periods (1).

| Entity/Instrument/ Organization | Age | Reference |
|--|--|-------------------------------|
| UN Secretariat/UNESCO/ILO | Youth: 15-24 yrs | UN Instruments, Statistics |
| UNICEF/WHO/UNFPA | Adolescent: 10-19 yrs, Young People: 10-24 yrs, Youth: 15-24 yrs | UNFPA |
| UNICEF /The Convention on Rights of the Child | Child until 18 years | UNICEF |
| The African Youth Charter | Youth: 15-35 yrs | African Union. 2006 |

So the youth period is very crucial for the development of the human beings. Every nation irrespective of difference in culture always pays attention for the youth. This is due to the fact that youths are the builders of the nation, torch-bearers of civilization and pathfinders of the cultural stream. Franklin D. Roosevelt describes Youth

Ramakrishna Mission Vivekananda Centenary College, Rahara

Ecological Idea reflected in the Complete Works of Sister Nivedita

Swami Kamalasthananda

Sister Nivedita is a unique name in Indian history. She was born in Ireland but died for the cause of India. Her previous name was Margaret Elizabeth Noble. She met Swami Vivekananda on 1895 in London and this meeting had changed her life and mission. on 28 January 1898 she reached Kolkata responding the call of Swami Vivekananda. On 13th November 1898 Holy Mother Sarada Devi came to open her school in Bagh Bazar. She travelled across India to many places specially Almora, Kashmir and Amarnath with Swamiji which helped her to understand India and the masses at large. Her love for India knew no bounds. Her magnetic personality and feeling heart and sincere love for the masses made her endearing to all classes of people. Some eminent contemporaries who came close to her were statesmen, poets, artists, scientists, historians and journalists. Ramesh Chandra Dutta, G.K. Gokhale, Bipin Chandra Pal, Jagadish Chandra Bose, Aurobindo Ghosh, Rabindra Nath Tagore, Jadunath Sarkar and Ramananda Chatterjee are the few in the list. Her contribution to India cannot be listed easily due to the cause that she had spent a whole life for the cause of India.

Her writings and talks are based upon the Indian geographical, historical, and aesthetic past. She has touched the main philosophical values of Indian people, its past, present and future. She frequently used many ecological parameters of the environment for her discussion and explanation. The following observations are based upon some parameters of the nature like – Plants, River, Animal and Forest.

Plant and its utility described by Sister Nivedita:

Plants are the one of the living kingdoms on earth. It directly takes energy from sunlight and converts it into building block for the plant body. There are about 300-315 thousand species of plants, of which the great majority, some 260-290 thousand, are seed plants¹. Plant ecology is a sub-discipline of ecology which studies the distribution and abundance of plants, the effects of

Swami Vivekananda and His Universal Ideas

Swami Vivekananda and His Universal Ideas

Swami Kamalasthananda

The word universal means to be applicable to all cases, people, places, times and every respect of the universe. The oxford dictionary defines the word 'universal' as – 'Relating to or done by all people or things in the world or in a particular group; applicable to all cases'¹. Universal ideas are principles which are applicable to all case irrespective of geographical location. Universal ideas have individual as well as collective implications. To an individual any idea may not have lasting importance. It is changing with time and circumstances. Suppose any particular type of food is well accepted at any particular age but it has no universal acceptance at all ages. Regarding taste and temperament choice and need vary. It is universally found, Moreover what man perceives through five sense organs has its universal acceptance. Suppose every man perceives the colour red as red if his vision is no way impaired. Similarly all people feel hot as hot and cold as cold. So, all perceivable objects have universal standard of recognition. Collective feelings are different in different circumstances. Suppose a collective body accepts a standard in a particular time, it may also differ at other times. The aggregate is based upon common idea, understanding, belief, custom, practice and value system. So these aggregates would vary according to the changing system. This variation is a universal phenomenon. But such ideas like feeling for others, helping others and doing good to others are more or less common to each and every community because these phenomenon are the root causes for formation and sustenance of the aggregate. Universal themes are the ideas which are applicable to people in respect of interrelationship, relation with other beings and the surrounding environment. These universal themes are based upon the generalization of the different ideas. Jim Curry and John Samara had designed the following generalized universal themes in their curriculum document designed for the Texas Association for Gifted and Talented².

Swami Vivekananda on Science

Swami Kamalasthananda

The word 'Science' is derived from the Latin word scientia, meaning "knowledge". It is systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe¹. So any study which follows some standard procedure for collection of knowledge which opens for testing as well opens for further development falls under the domain of the science. Any person is thinking is also science if the process of thinking follows some standard procedure which is followed and tested by anybody and bears the similar result as that of the previous person. Similarly any work whatever is its nature, if it follows a standard procedure and gives a result which is tested by any person form any part of the globe reproduces the similar result, then this work is also science. Winds blows sea side to the main land or from main land to sea side is also science, as people find a standard method underlying this wind blowing. Day begins with rising of the sun and the day ends with setting of the same sun. This phenomenon is under the domain of science, as people find a standard principle behind this whole process. In this way planet, galaxy and whole universe follow science in is its formation and performance because people finds out a standard principle. So wherever any standard principle, it indicates science and science indicates a standard principle or procedure. Human being relates with science as well as standard principle. Human being, science and standard principle makes an intricate triad where human being plays an important role. Human being feels science as well as the standard principle and the inter-dependence of two.



6 Ramakrishna Mission Vivekananda Centenary College, Rahara -

The Body-Mind Interface : Celebrating Knowledge as a Whole in the Vivekananda Way

Swami Vedanuragananda

Science as whole: Material and Spiritual:

Swami Vivekananda had to a twin vision of making spirituality a verifiable science and to broaden the narrow ambits of science and make it inclusive of both material and spiritual sciences. His plan to bring out spirituality as a science is expressed in his lecture Reason and Religion delivered in England:

'To put it in a more concrete form: Is religion to justify itself by the discoveries of reason, through which every other science justifies itself? Are the same methods of investigation, which we apply to sciences and knowledge outside, to be applied to the science of Religion? In my opinion this must be so, and I am also of the opinion that the sooner it is done the better. If a religion is destroyed by such investigations, it was then all the time useless, unworthy superstition; and the sooner it goes the better. I am thoroughly convinced that its destruction would be the best thing that could happen. All that is dross will be taken off, no doubt, but the essential parts of religion will emerge triumphant out of this investigation. Not only will it be made scientific -as scientific, at least, as any of the conclusions of physics or chemistry -but will have greater strength, because physics or chemistry has no internal mandate to youch for its truth, which religion has.'¹

On the other hand Swami Vivekananda warns about new kind of narrowness in science which shuts its doors and windows to anything beyond their current capacity, beyond the sense-perceptions or any great truth clothed in mythology:

'In modern times, if a man quotes a Moses or a Buddha or a Christ, he is laughed at; but let him give the name of a Huxley, a Tyndall,

Swami Vivekananda, Indian Society and Nationalism

Vivekananda's Ramakrishna Model and New paradigms of 'National-Universality' for the Indian Society

Swami Vedanuragananda

Swami Vivekananda writes in a letter from Chicago to his brother disciple:

I tell you brother, let everything go on as it is, only take care that no form becomes necessary -- unity in variety -- see that universality be not hampered in the least. Everything must be sacrificed, if necessary, for that one sentiment, universality. Whether I live or die, whether I go back to India or not, remember this specially, that universality -- perfect acceptance, not tolerance only -- we preach and perform. Take care how you trample on the least rights of others. Many a huge ship has foundered in that whirlpool. Remember, perfect devotion minus its bigotry -- this is what we have got to show.¹

A newcomer in the field of the Ramakrishna-Vivekananda literature may wonder when that very Swami Vivekananda writes to Dr. Nanjunda Rao,

'India can only rise by sitting at the feet of Shri Ramakrishna.'²

Are the two statements contradictory? Here we shall try to analyse how Vivekananda's Ramakrishna is a model for universality and how it can be instrumental in the rise of the New Indian society.

Concept of National peculiarities and India:

5

Each living organism has genetic peculiarities. Each species is speciesspecific. A rat can never become a cat or a mango tree can never become a guava tree. According to Swami Vivekananda even nations are having such 'national genetics' where its entire gamut of potentials and possibilities of growth rest on central national themes peculiar to each nation. He says:

106

0

Sister Nivedita and her Contributions to India

Nivedita's Altar Shelf and Human Evolution

Swami Vedanuragananda

Sister Nivedita writes about the altar shelf in her room in the appendix of her famous book 'The Master as I saw Him':

On the altar shelf above my desk stand three objects — symbols of adoration. One of these, to the right, is a broken statue, picked up and brought to me from amongst the rubbish—heaps and brick-bats of Sarnath last year. It consists only of two feet, folded in the posture of meditation. And it stands to me for the call of Humanity upon our love and service. Are not all human loves as the Feet of the Lord? In the middle is a brass image of the Buddha, probably of Burmese workmanship, but stolen, I fear, in the Loot of Syangtse. And to the left stand the pictures of our great Gurus, Sri Ramakrishna and the Swami Vivekananda. The Swami is photographed as an Indian Sannyasin seated, but not in meditation, with shaven head and bare feet. Before him lie the staff and Kamandalu of his wandering life, and a few palms and a book represent the desire of his disciples.¹

The combination of objects of adoration on Nivedita's altar shelf is quite interesting. The three objects represent a blueprint for human evolution and we may presume it to represent Nivedita herself. Let us try to analyse the three objects present on Nivedita's altar shelf:

a) A broken statue consisting of only two feet:

Nivedita describes the first object herself and decodes its meaning, '*lt* consists only of two feet, folded in the posture of meditation. And it stands to me for the call of Humanity upon our love and service. Are not all human loves as the Feet of the Lord?' We find there are three aspects in this object:

Youth Psychology & Vivekananda's Gospel of a Man-God, Manifestation & Manliness

Br. Shrutichaitanya

If life is a room, youth is its window. This window constantly draws fresh air into the room. But it is an art to keep the windows wide open all through, so as to avoid suffocation even at a so-called old age. For some this supply of fresh air may persist even at the last moments when one is struggling for another gulp of 'Oxygen'!

From time immemorial man has known this secret and has grappled with the process of ageing to keep oneself young forever. Varied have been his approaches to lock youth which slips away from his fist everyday. So everyone knows that youth is precious. It is precious for remaining 'healthy, wealthy and wise' at a time. It is precious for attaining, acquiring and enjoying. It is precious for feeling strong and victorious.

While Western science is looking for ways to eternalize youth through genetic and physiological analysis and manipulations, the Indian spiritual scientists have long realized that it is only by knowing our eternal, ever-blissful Self, bereft of any physical changes, can one sustain and laugh at the obvious onslaughts of disease, misery, senescence and death. Among many of the celebrated verses of the Upanishads, Bhagavad Gita and other texts which sing the glory of the Self-Knowledge as the medicine for all sorts of worldly miseries, here one can point just one from the Gita:

Dehinosmin yatha dehe kaumaram yauvanam jara

Tatha dehantarah praptih dhirastatra na muhyayti.(II.13)

-Just as the fleeting stages of infancy, youth and senescence are to the embodied self, likewise even the phenomenon of transmigration of the soul from one physical body to another, through death, keeps the spiritually illumined ones unperturbed. Hence it is that spiritual illumination that is sought after, to strike a balance, an inner poise against the dual forces of pleasure and pain, of youthful gaiety and mournful senescence. Swami Vivekananda and His Universal Ideas

Swami Vivekananda, Deep Ecology & the Universal Common Balance for the fed ant & the unfed man

Br. Shrutichaitanya

The 'Real Man' & the 'Real Life' for the Unreal 'Others':

A story goes as follows:

'There was once a man who was busy building a home for himself. He wanted it to be the nicest, warmest, cosiest home in the world.

Someone came to him to ask for help because the world was on fire. But it was his home he was interested in, not the world.

When he finally built his home he found he did not have a planet to put it on."

Thus we see that our dreams and aspirations, however good and fascinating they may be will not find a place to fructify completely in the long run, if they are just for our selfish satisfaction. They will not fit into this world if they are disconnected from the world and are nowhere helping others.

On the contrary, a tiny effort dedicated to the service of others' lives long. In fact it lives for eternity as potent thought currents powerful enough to rouse others to give shape to such unselfish ideas elevating many to greater heights. Swami Vivekananda points out 'The highest men are calm, silent, and unknown. They are the men who really know the power of thought; they are sure that, even if they go into a cave and close the door and simply think five true thoughts and then pass away, these five thoughts of theirs will live through eternity. Indeed such thoughts will penetrate through the mountains, cross the oceans, and travel through the world. They will enter deep into human hearts and brains and raise up men and women who will give them practical expression in the workings of human life. ²Thus each action whether