

Advances in Intelligent Systems and Computing 340

J.K. Mandal

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Partha Pratim Sarkar

Anirban Mukhopadhyay *Editors*

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Preface

The Faculty of Engineering, Technology and Management, University of Kalyani, India is organizing the Second International Conference on INformation Systems Design and Intelligent Applications—2015 (INDIA-2015), during 8–9 January 2015 at the University of Kalyani. This is the First time the Faculty is organizing such a mega event covering all aspects of information system design and applications in Computer Science and Technology, General Science, Educational Research where scopes are not only limited to Computer Science researchers but also include researchers from Mathematics, Chemistry, Biology, Biochemistry, Engineering Statistics, Management and all other related areas where Computer Technologies may assist.

We have received papers from all corners of the world. A huge response has been received by INDIA-2015 in terms of submission of papers and we received 429 submissions across the globe. The Organizing Committee of INDIA-2015 constitutes a strong international programme committee for reviewing papers. A double-blind review process has been adopted. Each paper is reviewed by at least two and at most five reviewers. The decision system adopted by EasyChair has been employed and 210 papers have been selected through double-blind review process. The Committee has also checked for plagiarism through the professional software. Finally, 174 registered papers have been included in the two volumes of the proceedings as printed as well as online documents where 87 papers are there in each volume. INDIA-2015 received papers from ten countries outside India, namely Germany, USA, Korea, Portugal, Bangladesh, Nepal, Egypt, Australia, Iran and Vietnam.

Along with the general sessions, INDIA-2015 organizes four special sessions, namely *Multicriteria Decision Analysis and Information Technology (MCDA-IT)* (Chair: Prof. (Dr.) Bijay Baran Pal, Department of Mathematics, University of Kalyani, India), *Wireless Sensor Networks (WSNs)* (Chairs: Prof. Prasanta K. Jana, Department of Computer Science and Engineering, Indian School of Mines, Dhanbad, India and Dr. Ashok Kumar Turuk, Department of Computer Science and

Engineering, National Institute of Technology, Rourkela, India), *Machine Learning and Engineering Application (MLEA)* (Chairs: Dr. B.N. Biswal, Director (A & A), BEC, Bhubaneswar, India and Prof. Pritee Parwekar, ANITS, Visakhapatnam, India), and *Innovations in Pattern Recognition and Image Processing (PRE-IP)* (Chairs: Prof. (Dr.) S.C. Satapathy, Department of Computer Science and Engineering, ANITS, Visakhapatnam, India and Prof. Vikrant Bhateja, Department of Electronics and Communication Engineering, SRMGPC, Lucknow, India). We would like to thank the chairs and associates of the special sessions for all their initiatives to arrange the special sessions.

The proceedings of the conference is published in two volumes in **Advances in Intelligent Systems and Computing** (ISSN: 2194-5357), Springer, indexed by ISI Proceedings, DBLP, EI-Compendex, SCOPUS, Springerlink and will be available at <http://www.springer.com/series/11156>. We convey our sincere gratitude to the authority of Springer for providing the opportunity to publish the proceedings of INDIA-2015.

The first volume of the proceeding contains fields of research like Natural Language Processing, Artificial Intelligence, Virtualization, Intelligent Agent-based Computing, Web Security and Privacy, Service Orient Architecture, Data Engineering, Open Systems, Communications, Smart Wireless and Sensor Networks, Intelligent Computing in Sensor and Ad Hoc Networks, Smart Antennae, VLSI, Microelectronics, Circuit and Systems, Communication Networking and Information Security, Machine Learning, Soft Computing, Intelligent Communication Technology, Mobile Computing and Applications, Cloud Computing.

The second volume contains research topics like Software Engineering, Graphics and Image Processing, Green IT, IT for Rural Engineering, E-Commerce, E-governance, Business Computing, Business Intelligence and Performance Management, ICT for Education, IT for Inclusive Growth, UID and Transparency, Process Reengineering, Molecular Computing, Nano Computing, Chemical Computing, Intelligent Computing for GIS and Remote Sensing, Intelligent Bio-informatics, Bio Computing and Industrial Automation.

We convey our esteemed gratitude to the honourable Vice-Chancellor, Prof. (Dr.) Rattan Lal Hangloo for his extreme enthusiasm for hosting INDIA-2015 at the University of Kalyani. Also, we convey our deep sense of gratitude to the Deans, Faculty of Engineering, Technology and Management, Faculty of Science, Faculty of Arts and Commerce and Faculty of Education for their constant support and association in this big event.

We express our sincere gratitude to UGC New Delhi, India for its financial support and IEEE Kolkata Section for their technical support. We would also like to thank the programme committee members for their efforts, and the reviewers for completing a big reviewing task in a short span of time. Moreover, we would like to thank all the authors who submitted papers to INDIA-2015 and made a high-quality

technical programme possible. Finally, we acknowledge the support received from the faculty members, scholars of Faculty of Engineering, Technology and Management, officers, staffs and the authority of the University of Kalyani.

November 2014

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Contents

An In-Silico Structural Analysis of the Interactions of SoxY and SoxZ from Moderately Thermophilic Betaproteobacterium, <i>Hydrogenophilus thermoluteolus</i> in the Global Sulfur Oxidation Cycle.	1
Sujay Ray and Angshuman Bagchi	
The Effect of T192M Mutation in Stability of Alpha Dystroglycan: Study with Molecular Dynamics Simulation	11
Simanti Bhattacharya, Amit Das, Rakhi Dasgupta and Angshuman Bagchi	
Intermolecular Interaction Study of Dissimilatory Sulfite Reductase (DsrAB) from Sulfur Oxidizing Proteobacteria <i>Allchromatium vinosum</i>	19
Semanti Ghosh and Angshuman Bagchi	
Structural Bioinformatic Approach to Understand the Molecular Mechanism of the Interactions of Small Heat Shock Proteins IbpA and IbpB with Lon Protease	29
Sanchari Bhattacharjee, Rakhi Dasgupta and Angshuman Bagchi	
Computer Based Self-Pacing Instructional Design Approach in Learning with Respect to Gender as a Variable	37
Santoshi Halder, Sanju Saha and Soumita Das	
Use of Machine Learning Features to Detect Protein-Protein Interaction Sites at the Molecular Level	49
Angshuman Bagchi	

Mutual Interaction Study Between DnaK-GroEL-FtSH with Heat Shock Regulator σ32 to Explain Prokaryotic Heat Shock Regulation	55
Sourav Singha Roy, Monobesh Patra, Rakhi Dasgupta and Angshuman Bagchi	
Molecular Structure and Packing Analysis of Two Nematogenic Fluoro-Phenyl Compounds in the Crystalline Phase	63
Sripada Haldar, Pradip Kumar Mandal and Wolfgang Haase	
Fractal Image Compression with Adaptive Quadtree Partitioning and Lossless Encoding on the Parameters of Affine Transformations	73
Utpal Nandi and Jyotsna Kumar Mandal	
EMD Based Features for Discrimination of Focal and Non-focal EEG Signals	85
Manish Gehlot, Yogit Kumar, Harshita Meena, Varun Bajaj and Anil Kumar	
HHT Based Features for Discrimination of EMG Signals	95
Gaurav Sahu, Nishant Chaurasia, Prem Prakash Suwalka, Varun Bajaj and Anil Kumar	
Understanding the Interaction of Human Formin Binding Protein 4 with Formin FMN1	105
Amit Das, Simanti Bhattacharya, Angshuman Bagchi and Rakhi Dasgupta	
In-Silico Structural Analysis of SoxF Protein Through Molecular Modelling and Protein-Protein Docking from <i>Hydrogenophilus thermoluteolus</i>: An Approach to Understand the Molecular Mechanism of Thiosulfate Oxidation	115
Sujay Ray and Angshuman Bagchi	
Structural Analyses of the Mode of Binding Between AANAT Protein with 14-3-3 Protein Involved in Human Melatonin Synthesis	127
Ananya Ali, Sanchari Bhattacharjee and Angshuman Bagchi	
Development of E-Learning System in Grid Environment	133
Sajal Mitra, Ajanta Das and Sarbani Roy	

A Weighted Concept Map Approach to Generate Learning Guidance in Science Courses 143
 Anal Acharya and Devadatta Sinha

Fingerprint Recognition by Divide and Conquer Method. 153
 Samayita Bhattacharya and Kalyani Mali

Nonlocal Speckle Denoising Model Based on Non-linear Partial Differential Equations 165
 Arundhati Bagchi Misra and Hyeona Lim

Optimal Multilevel Image Threshold Selection Using a Novel Objective Function 177
 V. Rajinikanth and M.S. Couceiro

Molecular Docking Analysis of AHL Molecule on Plant Protein ARR10 187
 Anamika Basu and Anasua Sarkar

A Remote Login Password Authentication Scheme Using Row Vector with Biometric 195
 Shipra Kumari and Hari Om

A Symmetric Key Cryptosystem Using DNA Sequence with OTP Key 207
 Asish Aich, Alo Sen, Satya Ranjan Dash and Satchidananda Dehuri

Text Localization in Camera Captured Images Using Adaptive Stroke Filter 217
 Shauvik Paul, Satadal Saha, Subhadip Basu and Mita Nasipuri

Dynamic Modeling of Three Link Finger Manipulator 227
 Neeta Sahay and Sanjoy Das

Dynamic Reconfigurable Architectures—A Boon for Desires of Real Time Systems 235
 Kevin Kansagara, K V Shravya and S Sivanantham

A Real Time Gesture Recognition with Wrist Mounted Accelerometer 245
 Debjyoti Chowdhury, Soumya Jyoti Banerjee, Krishnendu Sanyal and Madhurima Chattopadhyay

Effectiveness of Proximity-Based Outlier Analysis in Detecting Profile-Injection Attacks in E-Commerce Recommender Systems	255
Parthasarathi Chakraborty and Sunil Karforma	
Novel Approach of Multiplier Design Using Ancient Vedic Mathematics	265
Angshuman Khan and Rupayan Das	
Supply Chain Model for Deteriorating Items with Imperfect Production Process Under Budget Constraint	273
Urvashi Chaudhary, S.R. Singh and Upendra Chaudhary	
Line-Level Script Identification for Six Handwritten Scripts Using Texture Based Features	285
Pawan Kumar Singh, Ram Sarkar and Mita Nasipuri	
Single Sensor Color Filter Array Interpolation Algorithms	295
C. RajaRao, Mahesh Boddu and Soumitra Kumar Mandal	
Region Based Image Retrieval Using Integrated Color, Texture and Shape Features.	309
Nishant Shrivastava and Vipin Tyagi	
Automatic Generation of Web Service Composition Templates Using WSDL Descriptions	317
S. Sowmya Kamath, Suresh Alse, Prajwal Prasad and Abhay R. Chennagiri	
Poisson Noise Removal from Mammogram Using Poisson Unbiased Risk Estimation Technique	327
Manas Saha, Mrinal Kanti Naskar and Biswa Nath Chatterji	
A Proposed Systematic User-Interface Design Framework for Synchronous and Asynchronous E-Learning Systems.	337
Syaamantak Das and Rajeev Chatterjee	
Differential Power Analysis: Attacks and Resisting Techniques	349
Hridoy Jyoti Mahanta, Abul Kalam Azad and Ajoy Kumar Khan	
Health-System Evaluation: A Multi-attribute Decision Making Approach	359
Debashree Guha and Bapi Dutta	

Analysis and Evaluation of Image Quality Metrics 369
 Tina Samajdar and Md. Iqbal Quraishi

Comparative Analysis of Color Image Encryption Using 2D Chaotic Maps. 379
 Shubhendu Kumar, Bhavna Sinha and Chittaranjan Pradhan

Automatic Model Extraction from C Code—Abstracter and Architecture 389
 Debapriyay Mukhopadhyay

Remote Sensing Image Registration Based on Particle Swarm Optimization and Mutual Information 399
 Reham Gharbia, Sara A. Ahmed and Aboul ella Hassanien

Enzyme Function Classification Based on Sequence Alignment 409
 Mahi M. Sharif, Alaa Thrwat, Islam Ibrahim Amin, Aboul Ella and Hesham A. Hefeny

A Novel Biometric Fingerprint Template Based Method for Stream Cipher Design 419
 Musheer Ahmad and Bashir Alam

A Non-linear Diffusion Based Partial Differential Equation Model for Noise Reduction in Images 429
 Subit K. Jain and Rajendra K. Ray

A Pixel Based Segmentation Scheme for Fingerprint Images 439
 Debashis Das and Susanta Mukhopadhyay

Distance Similarity as a CBR Technique for Early Detection of Breast Cancer: An Egyptian Case Study. 449
 Heba Ayeldeen, Olfat Shaker, Osman Hegazy and Aboul Ella Hassanien

Modified PCT on Variable Cipher Block Chaining Mode 457
 Manas Paul, Jyotsana Kumar Mandal and Moirangthem Marjit Singh

A Fast and Efficient Mesh Smoothing Algorithm for 3D Graphical Models Using Cubic B-Splines. 467
 Rishabh Roy, Kireeti Bodduna, Neha Kumari and Rajesh Siddavatam

Text Extraction from Scene Images Through Local Binary Pattern and Business Features Based Color Image Segmentation	475
Ranjit Ghoshal, Anandarup Roy, Bibhas Ch. Dhara and Swapan K. Parui	
Age Group Classification of Facial Images Using Rank Based Edge Texture Unit (RETU)	483
Ch Rajendra Babu, E. Sreenivasa Reddy and B. Prabhakara Rao	
Writer Identification from Handwritten Devanagari Script	497
Chayan Halder, Kishore Thakur, Santanu Phadikar and Kaushik Roy	
Quality Estimation of MT-Engine Output Using Language Models for Post-editing and Their Comparative Study	507
Kuldeep Kumar Yogi, Nishith Joshi and Chandra Kumar Jha	
Genetic Algorithm with Improved Mutation Operator for Multiple Sequence Alignment	515
Rohit Kumar Yadav and Haider Banka	
Analysis of Induced Color for Automatic Detection of ROI in Multipose AVSR System	525
Amarsinh Varpe, Prashant Borde, Sadhana Sukale, Pallavi Perdeshi and Pravin Yannawar	
Conditional Spatial Fuzzy C-means Clustering Algorithm with Application in MRI Image Segmentation.	539
Sudip Kumar Adhikari, Jamuna Kanta Sing, Dipak Kumar Basu and Mita Nasipuri	
Advancement in Guard Zone Computation Through Detection and Exclusion of the Overlapped Regions.	549
Ranjan Mehera, Arpan Chakraborty, Piyali Datta and Rajat Kumar Pal	
Design of a Mixer for Performing Efficient Mixing to Reduce Overall Assay Response Time	559
Debasis Dhal, Piyali Datta, Arpan Chakraborty and Rajat Kumar Pal	
Remotely Functional-Analysis of Mental Stress Based on GSR Sensor Physiological Data in Wireless Environment	569
Ramesh Sahoo and Srinivas Sethi	

**Dynamic Software Metrics for Object Oriented Software:
A Review** 579
Anjana Gosain and Ganga Sharma

Big Data Analytics and Its Prospects in Computational Proteomics . . . 591
Sagnik Banerjee, Subhadip Basu and Mita Nasipuri

**The Future ICT Education in India—A Pilot Study
on the Vision of Ubiquitous Learning in Higher Education** 599
Parag Chatterjee and Asoke Nath

**Study of Various Feature Extraction and Selection Techniques
for Drought Prediction in Precision Agriculture** 611
Nikhil Gaikwad, Gaurav Chavan, Hemant Palivela
and Preeja Ravishankar Babu

**Automatic Segmentation of Spoken Word Signals into Letters
Based on Amplitude Variation for Speech to Text Transcription** 621
Anik Roy and Santanu Phadikar

**Logically Organised Sensor Based Prototype Model
for Automatic Control of Process Temperature** 629
Sandip Das

**Investigations into the Goodness of Posts in Q&A
Forums—Popularity Versus Quality** 639
Deepa Anand and Sushma Ravichandran

**Color Video Compression Based on Fractal Coding
Using Quadtree Weighted Finite Automata** 649
Shailesh D. Kamble, Nileshsingh V. Thakur, Latesh G. Malik
and Preeti R. Bajaj

**BIG Data Analysis for Indian e-Governance Projects—A
Proposed Framework to Improve Real Time Reporting** 659
Manas Kumar Sanyal, Sudhangsu Das and Sajal Bhadra

**Role of Team Leaders in Employee Faith in the Performance
Appraisal Practices: An Exploratory Study on the Software
Professionals in Some Selected IT Companies in West
Bengal (India)** 669
Manas Kumar Sanyal and Soma Bose Biswas

Automatic Bus Fare Collection System in India	681
Prerit Datta, Namandeep Kaur and Naveen Garg	
Secure e-Learning Framework (SeLF)	691
Nikhilesh Barik and Sunil Karforma	
Embedding an Extra Layer of Data Compression Scheme for Efficient Management of Big-Data.	699
Sayan Pal, Indranil Das, Suvajit Majumder, Amit Kr. Gupta and Indrajit Bhattacharya	
Automatic Gesture Recognition for Health Care Using ReliefF and Fuzzy kNN	709
Sriparna Saha, Monalisa Pal, Amit Konar and Diptendu Bhattacharya	
Volume Cutting of Medical Data Using Deformable Surfaces Modeled with Level Sets	719
V.R. Bindu and K.N. Ramachandran Nair	
Improved DB-SCAN for Detecting Zonal Followers for Small Regions on Twitter	727
Nidhi Jain, Basant Agarwal and Mukesh Kumar Gupta	
Cooperative Revocation of Misbehaving Vehicles from VANET.	735
Sulata Mitra	
Identification and Recognition of Defects in Civil Structures Using Non-destructive Technique	747
Devansh Gaur, Shalini Saxena, Dhiraj Sangwan and Jagdish Lal Raheja	
Efficient Knowledge Transformation for Incremental Learning and Detection of New Concept Class in Students Classification System	757
Roshani Ade and Prashant Deshmukh	
A Software Project Risk Analysis Tool Using Software Development Goal Modeling Approach.	767
Shruti Patil and Roshani Ade	
Modeling Agility in Internet of Things (IoT) Architecture	779
Priyanka Upadhyay, Gurpreet Matharu and Naveen Garg	

Authentication in Higher Region of Convergence of Z Transform Domain (AHRocZ) 787
 Suman Mahapatra, J.K. Mandal and Madhumita Sengupta

Bilateral Filtering in Wavelet Domain for Synthesis of Flash and No-Flash Image Pairs. 797
 Abhijeet Kumar Sinha, Vikrant Bhateja, Anand Sharma and S.C. Satapathy

Simulation Tool for Assignment Model: ASSOLVE. 807
 Pratiksha Saxena, Shabana Urooj, Abhinav Chaudhary, Sanchit Kumar and Satyavan Singh

Pharmaco-Informatics: An Interaction Study of Herbal Compounds with Receptors Implicated in ADHD 815
 Preenon Bagchi, R.S. Manasa, K.S. Shwetha, S.C. Harshitha, M. Mahesh and R. Somashekhar

Restoration Algorithm for Gaussian Corrupted MRI Using Non-local Averaging. 831
 Aditya Srivastava, Vikrant Bhateja, Harshit Tiwari and S.C. Satapathy

Multi-objective Optimization Based Software Testing Using Kansei Quality Approach. 841
 Shilpa and Kavita Choudhary

Prediction of Occurrence of Heart Disease and Its Dependability on RCT Using Data Mining Techniques 851
 Pinky Bajaj, Kavita Choudhary and Renu Chauhan

An Artificial Neural Networks Model by Using Wavelet Analysis for Speaker Recognition 859
 Kanaka Durga Returi and Y. Radhika

Author Index 875

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Analysis of Induced Color for Automatic Detection of ROI in Multipose AVSR System

Amarsinh Varpe, Prashant Borde, Sadhana Sukale,
Pallavi Perdeshi and Pravin Yannawar

Abstract Visual speech information plays an important role in *automatic speech recognition (ASR)*, but the problem of visual speech decoding remained open in pose variation. Face detection proposed by ‘*Viola-Jones*’ based on image statistic is most popular, but the accuracy of the method is not enough to detect facial features in multipose scenario. In this paper we compared and proposed advanced skin color detection method for automatic isolation of region-of-interest based on induced and non-induced lip color over ‘*Viola-Jones*’ algorithm for multi-pose audio visual speech recognition system. The ‘*Viola-Jones*’ algorithm was widely used for detection of face components (eyes, nose and mouth) and offers accurate face detection for full frontal visual stream but it’s performance dramatically degrades for non-frontal poses whereas the efficiency of our proposed system for induced lip-color based isolation scheme is 100 % each and ROI isolation for non-induced lip color is 100, 92.67 and 93.4 % each applicable for full front, 45° and side pose profile respectively.

Keywords Skin color pixels · Facial feature · Mouth detection · Multi-pose state mouth

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525

1 Introduction

In recent years, there have been many advances automatic speech recognition systems. The incorporation of visual input in recognition of speech has added a new dimension in typical automatic speech recognition system and gives birth to Audio-visual speech recognition system. Multi-pose AVSR is widely preferred due to its robustness. Face detection and mouth localization is an important aspect in multi-pose AVSR system. Robust and accurate analysis of facial features requires for coping with the large variation in appearance across subjects and appearance variability caused due to changes in lighting, pose. Accurately and robustly tracking lip motion in image sequence is especially difficult because lips are highly deformable, and they vary in shape, color, secularity, and relation to surrounding features across individuals. Lip tracking methods based on a single cue about the scene are insufficient for robustly and accurately tracking lips therefore in multi-pose AVSR the movements observed in the mouth region were recorded and analyzed from different angles [1]. Face detection proposed by ‘Viola-Jones’ based on statistic methods is most popular among the face detection approaches. This face detection is a variant of the *AdaBoost* algorithm which achieves rapid and robust face detection [2]. They proposed a face detection method based on the *AdaBoost* learning algorithm and *Haar* features that detected the face successfully with high accuracy, but the accuracy of the method is still not enough when this method is used to detect facial features under multipose scenario.

This paper addresses, automatic detection/isolation of region of interest for multi-pose AVSR using ‘Viola-Jones’ and skin color segmentation approach. Due to the *appearance variability* the task of isolation of ROI becomes complex. The process of ROI extraction was applied over ‘vVISWa’ (*Visual Vocabulary of Independent Standard Words*) data set of isolated words captured from different angles were considered. The content of the paper is organized in five section, Sect. 2 deals with related work, Sect. 3 deals with methodology adopted, Sect. 4 provides detailed experimental analysis, and Sect. 5 is conclusion of work followed by acknowledgement and references.

2 Related Work

Many method have been proposed by researchers in-order to enhance speech recognition system by synchronization of visual information with the speech as improvement on automatic lip reading system which incorporates dynamic time warping, and vector quantization method applied on alphabets, digits and the recognition was restricted to isolated utterances and was speaker dependent [3]. Later Bergler [4] had worked on how recognition performance in automated speech perception can be significantly improved and introduced an extension to existing Multi-State Time Delayed Neural Network architecture for handling both the

modalities that is acoustics and visual sensor input [4]. Similar work have been done by Yuhas et al. [5] and focused on neural network for vowel recognition and worked on static images. Duchnowski [6] worked on movement invariant automatic lip-reading and speech recognition, Luetin et al. [7] used active shape model and hidden markov model for visual speech recognition, Sum et al. [8] proposed a new optimization procedure for extracting the point-based lip contour using active shape model, Capiler [9] used Active shape model and Kalman filtering in spatiotemporal for noting visual deformations, Matthews et al. [10] has proposed method for extraction of visual features of lipreading for audio-visual speech recognition, Hong et al. [11] used PCA based DCT features Extraction method for lip-reading, Saitoh et al. [12] has analyzed efficient lip-reading method for various languages where they focused on limited set of words from English, Japanese, Nepalese, Chinese, Mongolian. The words in English and their translated words in above listed languages were considered for the experiment [12]; Li et al. [13] has proposed A Novel Motion Based Lip Feature Extraction for Lip-reading problems. The redundancy in the visual cues in audio-visual speech recognition have been examined by Yannawar et al. [14]. Similarly Estellers et al. [15] has addressed use if multi-pose lip-reading system for audio visual speech recognition system. They have proposed pose normalization for generating virtual frontal view form non-frontal images [15]. An active contour model is used for lip tracking and for lip reading proposed a geometrical feature extraction approach. Effect of individual features are compared and a joint feature model is obtained by combining weighted decision obtained by a feature vector of difference in inner area, height and width of lip [16]. A new lip detection method extract lip color using novel color segmentation based-on normalized RGB chromaticity diagram [17]. A multi-modal speech recognition method using optical-flow analysis for lip images. Since the optical flow is computed without extracting the speaker's lip contours and location, robust visual features can be obtained for lip movements [18]. By using a template matching and motion information, a robust tracking of facial features, in particular, lip contours, by using a multistate mouth model and combining lip color, shape and motion information [19].

3 Methodology

The typical audio visual speech recognition system accepts the audio and visual input as shown in Fig. 1. The audio input is captured with the help of standard audio mic and visual utterance is captured by using standard cameras. The place between camera and individual speaker is kept constant in order to get proper visual utterance. Once the input is acquired, it will be preprocessed for acoustic feature extraction and visual feature extraction separately and further used for recognition and integration of utterance.

Visual features can be grouped into three general categories: shape-based, appearance-based, and combinational approaches. All three types require the

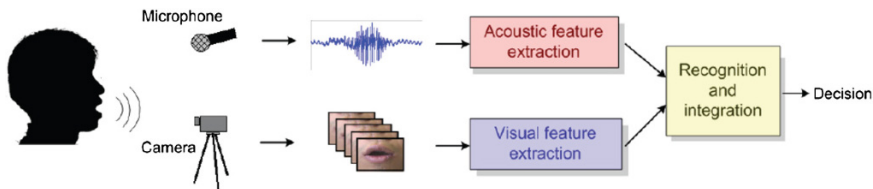
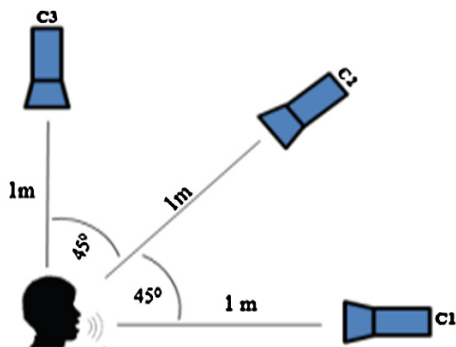


Fig. 1 Organization of AVSR

localization and tracking of Region of Interest (ROI). Region of interest for computation of visual feature will be concentrated towards the movement of lips (opening and closing of mouth) over the time frame which is observed to be very complex in nature. In-view of this, calculating good and discriminatory visual feature of mouth plays an important and vital role in the recognition process. Many researchers have defined their own dataset and very few of them are available online freely. Indeed it is very difficult to distribute the data base freely on the web due to it's the size. The video sequences used for this study was collected in the laboratory in a closed environment. The 'vVISWa' (*Visual Vocabulary of Independent Standard Words*) database consists set of independent/isolated standard words from Marathi, Hindi and English languages. The dataset of isolated city words for non-induced color is formulated for words like ('Aurangabad', 'Beed', 'Hingoli', 'Jalgaon', 'Kolhapur', 'Latur', 'Mumbai', 'Osmanabad', 'Parbhani', 'Pune', 'Satara', 'Solapur'.) and for induced color the words are ('Namskar', 'Abhipray', 'Udaharan', 'Mahatwapurn', 'Swayampak'). These word set have been acquired in Marathi language and were considered for this experiments. Each visual utterance was recorded for 2 s. The database consists of 10 individual speakers, (4 male and 6 female) and each speaker uttering each word for 10 times in close-open-close constrain without head movement. The database comprised of 3,600 utterance ($10 \times 10 \times 12 \times 3$) for non-induced color and for induced color 750 Utterance ($10 \times 5 \times 5 \times 3$) captured from source C1, C2 and C3. Figure 2 shows the experimental arrangement of acquisition of utterances from individual speaker in multi-pose environment.

Fig. 2 Acquisition of utterances



3.1 Multi-pose Face Detection

Every utterance stored in ‘vVISWa’ database was called for automatic detection ROI. The sampling rate was 25 fps for all visual utterance. In order to detect region of interest from each frame ‘Viola-Jones’ algorithm and ‘Skin color detection algorithm’ have been used. ‘Viola-Jones’ algorithm detect face and face components based on Haar-like features comprising of two edge features, line feature and rectangle feature. Each detected component is marked by *bounding-box* and their presence have been marked. The ‘Viola-Jones’ algorithm works fine for full frontal visual profile of utterance in multi-pose AVSR and was found effective in isolation of ROI for the same. ‘Viola-Jones’ algorithm was tested over 45° pose visual stream where some portion of mouth was not visible, the performance of algorithm was found to be degraded. Similarly as, face is symmetrical object therefore the detection of mouth from side pose was also difficult for ‘Viola-Jones’ algorithm because almost half of the mouth portion was not at all visible. In view of this for isolation of ROI based on lip-color was preferred. Automatic isolation of region of interest based on lip-color is a recursive process where every frame was processed for face detection based on skin color. The process identified or selects only the skin color component and omits non-face skin color component information like static background, hair portion etc., from a frame. Once the face detection is over, the algorithm searches for mouth based on lip-color from the skin color face image/frame. Figure 3 presents mouth detection process based on skin color information, Fig. 4 show the original image from the visual stream and the result of face detection using skin color detection method.

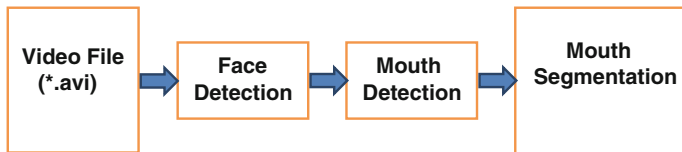


Fig. 3 Overall structure of mouth detection and segmentation

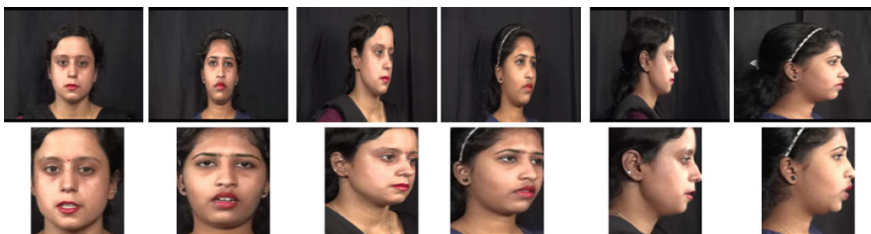


Fig. 4 a Front face detection. b 45° face detection. c Side face detection



Fig. 5 a Front mouth detection. b 45° mouth detection. c Side mouth detection

3.2 Region-of-Interest (ROI) Detection/Localization

The proposed method of mouth detection is based on fundamental aspects of facial geometry. It was easily understood from facial geometry that, the approximate horizontal width of the mouth is equal to the distance between center of right eye and center of left eye. The ‘y’ coordinate value of mouth starts after the nose tip and ‘x’ coordinate was calculated as the distance between two eye centers x-locations. The height of the mouth is estimated at 3/4 of the nose height detected. The height can also be taken as equivalent to the height of the nose to avoid the elimination of lower lips edges, especially when a person is smiling. To identify the Mouth position from the face image, we divide image into two part i.e. Upper and Lower face part. On the lower face frame we used a color spaces separation RGB into luminance (Y), hue (I), and saturation (Q) information. Then gray threshold range is calculated and every frame is converted into binary by applying the filter on the resultant image so to get the actual Region-of-Interest (ROI) of containing only the portion covered by lips as shown in Fig. 5.

4 Experiment and Result

The experiment design for this research work is applied over ‘vVISWa’ (*Visual Vocabulary of Independent Standard Words*) Database. The set of 10 samples uttered by 5 individual’s speakers (3 female and 2 male) have been considered. The ‘Viola-Jones’ and Skin color based ROI isolation method were tested on sample of ‘vVISWa’ database and its accuracy was measured. It was seen that for all five speakers we obtained total 10 samples and 2,500 frames for each channel with rate of 25 frames/s, resulted into total volume of 7,500 frames for induce color and 7,500 frames for non-induce color. Table 1 shows the mouth detection for full frontal profile for induce color, Table 2 shows the mouth detection for 45° profile for induce color and Table 3 shows the mouth detection for side pose profiles of visual streams for induce color.

The performance of ‘Viola-Jones’ algorithm and skin color based algorithm on Non-Induce color visual stream are shown in Tables 4, 5 and 6. Table 4 shows the Non-Induce color for full frontal visual profile, Table 5 shows the Non-Induce color

Table 1 Mouth detection for full frontal visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm			Skin color based segmentation algorithm				
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
Front side	Speaker 1	10	500	498	2	99.60	500	500	0	100
	Speaker 2	10	500	482	18	96.40	500	500	0	100
	Speaker 3	10	500	499	1	99.80	500	500	0	100
	Speaker 4	10	500	500	0	100.00	500	500	0	100
	Speaker 5	10	500	499	1	99.80	500	500	0	100
Over all		50	2,500	2,478	22	99.12	2,500	2,500	0	100

Table 2 Mouth detection for 45° visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm			Skin color based segmentation algorithm				
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
45°	Speaker 1	10	500	235	265	47	500	500	0	100
	Speaker 2	10	500	30	470	6	500	500	0	100
	Speaker 3	10	500	28	472	5.61	500	500	0	100
	Speaker 4	10	500	63	437	12.75	500	500	0	100
	Speaker 5	10	500	110	390	22	500	500	0	100
Over all		50	2,500	466	2,034	18.64	2,500	2,500	0	100

Table 3 Mouth detection for side pose of visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm			Skin color based segmentation algorithm				
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
Side pose	Speaker 1	10	500	0	500	0	500	500	0	100
	Speaker 2	10	500	0	500	0	500	500	0	100
	Speaker 3	10	500	0	500	0	500	500	0	100
	Speaker 4	10	500	0	500	0	500	500	0	100
	Speaker 5	10	500	0	500	0	500	500	0	100
Over all		50	2,500	0	2,500	0	2,500	2,500	0	100

Table 4 Non-induce color mouth detection for full frontal visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm			Skin color based segmentation algorithm				
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
Front side	Speaker 1	10	500	500	0	100	500	500	0	100
	Speaker 2	10	500	500	0	100	500	500	0	100
	Speaker 3	10	500	500	0	100	500	500	0	100
	Speaker 4	10	500	500	0	100	500	500	0	100
	Speaker 5	10	500	500	0	100	500	500	0	100
Over all		50	2,500	2,500	0	100	2,500	2,500	0	100

Table 5 Non-Induce color mouth detection for 45° visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm		Skin color based segmentation algorithm					
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
45° side	Speaker 1	10	500	53	447	10.6	500	470	29	94
	Speaker 2	10	500	93	407	18.6	500	472	28	94
	Speaker 3	10	500	107	393	21.4	500	473	27	95
	Speaker 4	10	500	92	408	18.4	500	410	90	82
	Speaker 5	10	500	109	391	21.8	500	494	56	98
Over all		50	2,500	454	2,046	18.16	2,500	2,319	230	92.76

Table 6 Non-induce color mouth detection for side pose visual profile

Channel	Speakers	Total sample	Viola-Jones algorithm			Skin color based segmentation algorithm				
			Total frames	True detection	False detection	Accuracy	Total sample	True detection	False detection	Accuracy
Side pose	Speaker 1	10	500	0	500	0	500	472	28	94.40
	Speaker 2	10	500	0	500	0	500	474	26	95
	Speaker 3	10	500	0	500	0	500	478	22	96
	Speaker 4	10	500	0	500	0	500	471	29	94
	Speaker 5	10	500	0	500	0	500	440	60	88
Over all		50	2,500	0	2,500	0	2,500	2,335	165	93.4

Table 7 Performance measurement of ‘Viola-Jone’and skin color detection algorithm of Induce and non-Induce visual stream

Algorithms	Frontal camera (%)	45° camera (%)	Side pose camera (%)
Viola Jones algorithm on induce color	99.22	18.64	0
Viola Jones algorithm on non-Induce	100	18.16	0
Skin color detection algorithm on induce color	100	100	100
Skin color detection algorithm on non-Induce color	100	92.67	93.4

mouth detection for 45° visual profile and Table 6 shows the Non-Induce color mouth detection for side pose visual profile.

After applying both ‘Viola-Jones’ algorithm and Skin color detection algorithm on each speaker’s sample, total frames are grouped into true detection and false detection set i.e. correctly recognized and an incorrectly recognized frames. Table 7 show the result of ‘Viola-Jones’ algorithm and our Skin Color Detection Algorithm result. It was seen that for ‘Viola-Jones’ algorithm, the performance was observed to be 99.22, 18.64 and 0 % for full frontal, 45° and side pose visual profiles of induce color stream respectively. Similarly 100, 18.16 and 0 % for full frontal, 45° and side pose visual profiles of Non-Induce color stream. The performance of Skin Detection Algorithm was observed to be 100 % for all full frontal, 45° and side pose of Induced color visual stream. Similar for Non induced color visual stream, the performance of Skin Color detection algorithm was observe to be 100, 92.67 and 93.4 % for Front, 45° and side pose visual profile respectively. It was further seen that when the eyes of subjects/speakers closed the performance of ‘Viola-Jones’ algorithm degrades whereas the Skin color detection based algorithm works fine.

5 Conclusion

This paper presents the method for automatic isolation of region-of-interest for multi-pose AVSR. The results were produced on ‘vVISWa’ dataset clearly indicates that the performance of skin color based isolation of region-of-interest is found to be efficient on induced color and non-induced color as compare to ‘Viola-Jones’ algorithm and for all frontal and non-frontal visual profiles. The skin color based method is found to be significant in computing robust features for multi-pose AVSR.

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