Advances in Intelligent Systems and Computing 340

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Anirban Mukhopadhyay *Editors*

Information Systems Design and Intelligent Applications

Proceedings of Second International Conference INDIA 2015, Volume 2

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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 thorough 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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Prof. J.K. Mandal received his M.Sc. in Physics from Jadavpur University in 1986 and M.Tech. in Computer Science from University of Calcutta. Professor J.K. Mandal was awarded the Ph.D. in Computer Science and Engineering by Jadavpur University in 2000. Presently, he is working as Professor of Computer Science and Engineering and former Dean, Faculty of Engineering, Technology and Management, Kalyani University, Kalyani, Nadia, West Bengal for two consecutive terms. He started his career as lecturer at NERIST, Arunachal Pradesh in September 1988. He has teaching and research experience of 25 years. His areas of research include coding theory, data and network security, remote sensing and GIS-based applications, data compression, error correction, visual cryptography, steganography, security in MANET, wireless networks and unify computing. He has produced nine Ph.D. degrees, one submitted (2013) and eight ongoing. He has supervised 3 M.Phils. and 26 M.Techs. He is life member of the Computer Society of India since 1992, CRSI since 2009, ACM since 2012, IEEE since 2013 and Fellow member of IETE since 2012, Executive member of CSI Kolkata Chapter. He has chaired 17 sessions in various international conferences and delivered 20 expert/invited lectures. He is reviewer of various international journals and conferences. He has over 284 articles and 5 books published to his credit.

Dr. Suresh Chandra Satapathy is currently working as Professor and Head, Department of CSE at Anil Neerukonda Institute of Technology and Sciences (ANITS), Andhra Pradesh, India. He obtained his Ph.D. in Computer Science and Engineering from JNTU Hyderabad and M.Tech in CSE from NIT, Rourkela, Odisha, India. He has 26 years of teaching experience. His research interests include data mining, machine intelligence and swarm intelligence. He has acted as program chair of many international conferences and edited six volumes of proceedings from Springer LNCS and AISC series. He is currently guiding eight scholars for PhDs. Dr. Satapathy is also a Sr. Member of IEEE.

Dr. Manas Kumar Sanyal obtained his M.Tech. in Computer Science from Calcutta University in 1989. He worked in industries for about four years and joined as Lecturer at BCKV in the year 1994 and obtained his Ph.D. in 2003.

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Dr. Partha Pratim Sarkar obtained his Ph.D. in Engineering from Jadavpur University in 2002. He obtained his M.E. from Jadavpur University in 1994 and B.E. in Electronics and Telecommunication Engineering from Bengal Engineering College in 1991. He is presently working as Senior Scientific Officer (professor rank) at D.E.T.S, University of Kalyani, India. His areas of research include microstrip antenna, microstrip filter, frequency selective surfaces and artificial neural network. He has contributed over 210 research articles in various journals and conferences of international repute. He is a life fellow of IETE, and fellow of IE (India).

Dr. Anirban Mukhopadhyay is Associate Professor and former Head of the Department of Computer Science and Engineering, University of Kalyani, West Bengal, India. He did his B.E. from National Institute of Technology, Durgapur, India, in 2002 and M.E. from Jadavpur University, Kolkata, India, in 2004, respectively. He obtained his Ph.D. in Computer Science and Engineering from Jadavpur University in 2009. Dr. Mukhopadhyay is a recipient of the University Gold Medal and Amitava Dey Memorial Gold Medal from Jadavpur University in 2004. He also received Erasmus Mundus fellowship in 2009 to carry out post-doctoral research at University of Heidelberg and German Cancer Research Center (DKFZ), Heidelberg, Germany during 2009–2010. Dr. Mukhopadhyay visited I3S laboratory, University of Nice Sophia-Antipolis, Nice, France in 2011 as a Visiting Professor, and University of Goettingen, Germany, as a Visiting Scientist with DAAD scholarship in 2013. He has received Institution of Engineers, India (IEI) Young Engineers Award (2013–2014) and Indian National Academy of Engineering (INAE) Young Engineer Award (2014). He has co-authored one book and more than 100 research papers in various international journals and conferences. He is a senior member of IEEE, USA, and member of Association for Computing Machinery (ACM), USA. His research interests include soft and evolutionary computing, data mining, multiobjective optimization, pattern recognition, bioinformatics and optical networks.

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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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, Luettin 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

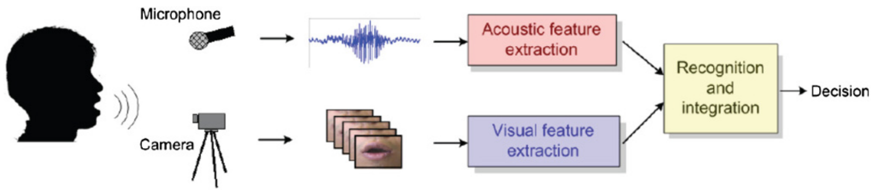

Fig. 1 Organization of AVSR

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.

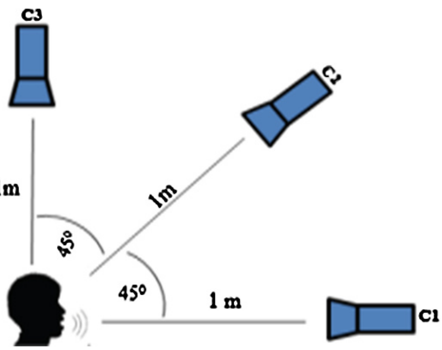

Fig. 2 Acquisition of utterances

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.

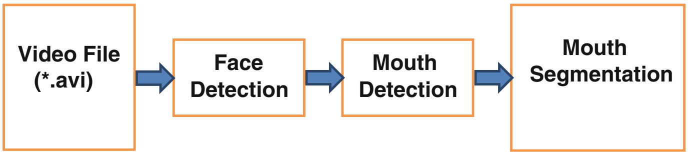

Fig. 3 Overall structure of mouth detection and segmentation

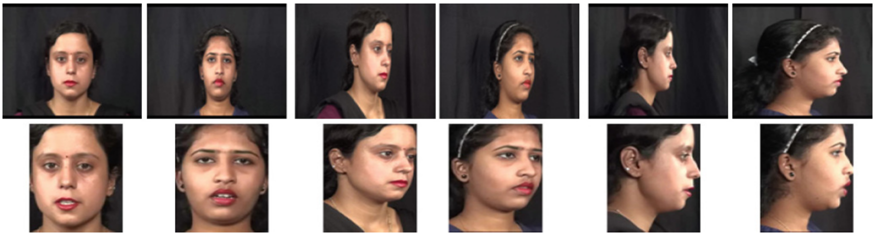

Fig. 4 **a** Front face detection. **b** 45° face detection. **c** Side face detection

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 measurment 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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