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FRVIWF: Face Recognition using Virtual Images based on Weighted Fusion

Arunalatha J S[a], Suvarna C[a], Tejaswi V[b], Shaila K[a], Raja K B[a], Dinesh Anvekar[c], Venugopal K R[a], S S Iyengar[d], L M Patnaik[e]

[a]University Visvesvaraya College of Engineering, Bangalore University, Bangalore 560 001, India. Contact: aruna_veeresh@yahoo.co.in

[b]National Institute of Technology, Surathkal, Karnataka, India

[c]Nitte Meenakshi Institute of Technology, Bangalore, India

[d]Florida International University, USA

[e]Indian Institute of Science, Bangalore, India

Face recognition subject to uncontrolled-blur, illumination, occlusion errors are challenging and which gives negative impact on face recognition accuracy. Hence, error removal is necessary in face recognition methods before the application of other techniques for face classification. To achieve this we propose a new method called Face recognition using virtual images based on weighted fusion that makes use of histogram equalization and morphological operations. Using mirror image technique the virtual images for both training and test samples are generated. The conventional and inverse representation methods on these images are applied separately, further, they are combined to achieve better accuracy using weighted fusion. The experiments are carried out on publicly available FERET, ORL and GT normal and corrupted face data bases. The results show that FRIVWF is an improvement over conventional and inverse representation based linear regression classification (CIRLRC). It is demonstrated that FRVIWF performs better than the basic LRC and other state-of-the-art conventional representation based Face classification Methods.

Keywords : Conventional Representation, Face Recognition, Inverse Representation, Linear Regression Classification, Morphological Functions.

1. INTRODUCTION

A wide variety of systems requires reliable personal recognition schemes to either confirm or determine the identity of an individual using biometrics that refers to any human physiological and/or behavioral characteristic used for the identification of a person [1]. A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual extracting a feature set from the acquired data and comparing this feature set against the template set in the database. The physiological characteristics of a person include the features like fingerprints, face, hand geometry, voice and iris *etc.*, which are unique to a person and would always remain same throughout the lifetime. Hence, these biometrics features can be used for authentication purpose in computer based security systems, which operate either in verification or identification mode [2].

Most face recognition methods are classified as either holistic or component based. Holistic method use the whole face image as the input to a linear transformations exemplified eigen value and fisher face which maps the image to the point in a lower dimensional space called face subspace [3][4]. The general idea of most component based methods is to divide each face image into smaller parts and perform

All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position. We used all images, named as orl001, orl002 up to orl400. The first two, three and four face images of each class are considered as original training samples and the rest of face images are considered as test samples. The classification accuracy (%) on ORL database for the test samples 2, 3 and 4 when, w1=0.6 are 93.30, 98.88 and 93.30, for w1=0.7 are 94.00, 99.98 and 91.02 and for w1=0.8 are 93.50, 99.10 and 90.21 as shown in Table 9. It shows that, the result obtained by the FRVIWF is better than CIRLRC [8] by 2% to 8% in accuracy.

6.5. Georgia Tech Database

The Georgia Tech (GT) database [33] was built at Georgia Institute of Technology. This database includes Face images of 50 people taken in two or three sessions. All people in the database were represented by 15 color JPEG images with cluttered background taken at the resolution of 640480 pixels. We used 20 face images with the background removed. The first three, four and five face images of each class are considered as original training samples and the rest of face images are considered as test samples. The classification accuracy (%) on GT database for the test samples 3, 4 and 5 when, w1=0.6 are 62.67, 68.39 and 74.87, for w1=0.7 are 62.23, 68.25 and 75.03 and for w1=0.8 are 61.71, 68.11 and 75.20 as shown in Table 9. It shows that, the result obtained by the FRVIWF is better than CIRLRC [8] by 2% to 8% in accuracy.

6.6. Experiments on Corrupted Database

To verify the sturdiness of the proposed FRVIWF method, experiment is conducted on corrupted face images of the same database and the set of test and training samples are same as those in section 6.1 to 6.5 respectively. Figure 2 shows samples of Normal and Corrupted images of FERET database. The classification accuracy (%) on GT corrupted database for the test samples 3, 4, and 5 when, w1=0.6 are 57.58, 64.71 and 67.03, for w1=0.7 are 58.60, 65.58 and 66.97 and for w1=0.8 are 59.62, 66.45 and 66.90. FERET and ORL and GT corrupted database classification accuracies are shown in Table 9. It indicates that, the result obtained by the FRVIWF for Corrupted images is better than CIRLRC [8] by 2% to 6% in accuracy.

7. CONCLUSIONS

In this paper, we propose Face Recognition using Virtual Images based on Weighted Fusion for face classification, which effectively exploits the dissimilarity between the test image and all classes of training images. First, it assigns the test image to the class that has minimum dissimilarity. Second, Histogram equalization and Morphological operations are applied to reduce an error / noise from erroneous, occluded face images before the application of other techniques. Third, to avoid insufficient training samples we generate virtual images by using mirror image concept. Finally, combining conventional and inverse representation techniques using weighted fusion, better face classification accuracy is achieved. The FRVIWF is tested on FERET, ORL and GT normal and corrupted databases and the results shows that it is better than the CIRLRC method. Further, face recognition accuracy can be improved by using various types of filters and noise, advanced techniques and the state-of-art of algorithms.

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Table 8
Classification Accuracies (%) of FRVIWF on Normal FERET, ORL and GT database

FRVIWF	FERET Database			ORL Database			GT Database		
	1	2	3	2	3	4	3	4	5
W1=0.8	71.00	93.07	98.44	93.50	99.10	90.21	61.78	68.11	75.20
W1=0.7	66.00	86.45	91.58	94.00	99.98	91.02	62.23	68.25	75.03
W1=0.6	61.00	79.82	84.72	93.30	98.88	93.30	62.67	68.39	74.87

Table 9
Classification Accuracies (%) of FRVIWF on Corrupted FERET, ORL and GT database

FRVIWF	FERET Database Corrupted			ORL Database Corrupted			GT Database Corrupted		
	1	2	3	2	3	4	3	4	5
W1=0.8	71.00	81.70	92.96	89.00	97.07	85.28	59.62	66.45	66.90
W1=0.7	66.00	75.58	86.19	89.80	97.91	86.00	58.60	65.58	66.97
W1=0.6	41.00	61.00	69.46	88.80	96.86	95.08	57.58	64.71	67.03

Table 10
Comparison of Classification Accuracies (%) of FRVIWF on Normal FERET, ORL and GT database

Methods	FERET Database			ORL Database			GT Database		
	1	2	3	2	3	4	3	4	5
LRC[14]	44.92	64.20	59.62	79.06	81.79	85.00	51.00	55.27	59.40
CRC[10]	44.33	58.40	44.37	83.44	86.07	89.17	45.33	47.09	48.80
RCR[11]	41.67	55.10	46.12	77.19	81.07	82.08	36.67	38.36	40.80
SRC[6]	50.25	64.80	60.00	85.00	85.71	90.00	52.00	56.73	59.80
CIRLRC[8]	55.17	78.10	78.63	86.88	90.36	90.83	57.00	60.36	62.20
FRVIWF	61.00	79.82	84.72	93.30	98.88	93.30	62.67	68.39	74.87

Table 11
Comparison of Classification Accuracies (%) of FRVIWF on Corrupted FERET, ORL and GT database

Methods	FERET Database			ORL Database			GT Database		
	1	2	3	2	3	4	3	4	5
LRC[14]	19.75	39.00	38.00	74.06	77.14	83.33	45.67	48.91	51.60
CRC[10]	25.67	27.90	18.63	81.56	82.56	89.17	37.50	42.00	41.60
RCR[11]	18.58	16.80	12.50	74.69	76.79	79.17	24.17	24.00	3.80
SRC[6]	34.50	46.90	43.00	82.81	83.93	89.58	46.17	49.27	51.20
CIRLRC[8]	36.92	55.50	54.13	85.00	88.57	90.00	52.33	57.09	57.60
FRVIWF	41.00	61.00	69.46	88.80	96.86	95.08	57.58	64.71	67.03

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Arunalatha J S is an Associate Professor in the Department of Computer Science and Engineering at University Visvesvaraya College of Engineering, Bangalore University, Bangalore, India. She obtained her Bachelor of Engineering from P E S College of Engineering, Mandya, in Computer Science and Engineering, from Mysore University and she received her Master's degree in Computer Science and Engineering from Bangalore University, Bangalore. She is presently pursuing her Ph.D programme in the area of Biometrics. Her research interest is in the area of Biometrics and Image Processing.

Suvarna C is currently working in Cyient Limited. She obtained her Bachelor of Engineering and Masters of Engineering in Computer Science and Engineering from Bangalore University, Bangalore. Her research interest is in the area of Biometrics and Image Processing.

Tejaswi V is a student of Computer Science and Engineering from National Institute of Technology, Surathkal. She completed her B.Tech in Computer Science and Engineering from Rastriya Vidyalaya College of Engineering, Bangalore. Her research interest is in the area of Wireless Sensor Networks, Biometrics, Image Processing and Big Data Analysis.

Shaila K is currently Professor and Head in the Department of Electronics and Communication Engineering at Vivekananda Institute of Technology, Bangalore, India. She obtained her B.E in Electronics and M.E degrees in Electronics and Communication Engineering from Bangalore University, Bangalore. She obtained her Ph.D degree in the area of Wireless Sensor Networks in Bangalore University. She has authored and co-authored two books. Her research interest is in the area of Sensor Networks, Adhoc Networks and Image Processing.

K B Raja is an Assistant Professor, Department of Electronics and Communication Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his BE and ME in Electronics and Communication Engineering from University Visvesvaraya College of Engineering, Bangalore. He was awarded Ph.D. in Computer Science and Engineering from Bangalore University. He has over 85 research publications in refereed International Journals and Conference Proceedings. His research interests include Image Processing, Biometrics, VLSI Signal Processing, computer networks.

Dinesh K Anvekar is currently working as Head and Professor of Computer Science and Engineering at Nitte Meenakshi Institute of Technology, Bangalore. He obtained his Bachelor degree from University of Visvesvaraya college of

Engineering. He received his Master and Ph.D degree from Indian Institute of Technology. He received best Ph. D Thesis Award of Indian Institute of Science. He has 15 US patents issued for work done in IBM Solutions Research Center, Bell Labs, Lotus Interworks, and for Nokia Research Center, Finland. He has filed 53 patents. He has authored one book and over 55 technical papers. He has received Invention Report Awards from No.kia Research Center, Finland, Lucent Technologies (Bell Labs) Award for paper contribution to Bell Labs Technical Journal and KAAS Young Scientist Award in Karnataka State, India.

Venugopal K R is currently the Principal, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his Bachelor of Engineering from University Visvesvaraya College of Engineering. He received his Masters degree in Computer Science and Automation from Indian Institute of Science Bangalore. He was awarded Ph.D. in Economics from Bangalore University and Ph.D. in Computer Science from Indian Institute of Technology, Madras.He has a distinguished academic career and has degrees in Electronics, Economics, Law, Business Finance, Public Relations, Communications, Industrial Relations, Computer Science and Journalism. He has authored and edited 51 books on Computer Science and Economics, which include Petrodollar and the World Economy, C Aptitude, Mastering C, Microprocessor Programming, Mastering C++ and Digital Circuits and Systems *etc.*, He has filed 53 patents. During his three decades of service at UVCE he has over 400 research papers to his credit. His research interests include Computer Networks, Wireless Sensor Networks, Parallel and Distributed Systems, Digital Signal Processing and Data Mining.

S S Iyengar is currently Ryder Professor, Florida International University, USA. He was Roy Paul Daniels Professor and Chairman of the Computer Science Department of Louisiana state University. He heads the Wireless Sensor Networks Laboratory and the Robotics Research Laboratory at USA. He has been involved with research in High Performance Algorithms, Data Structures, Sensor Fusion and Intelligent Systems, since receiving his Ph.D degree in 1974 from MSU, USA. He is Fellow of IEEE and ACM. He has directed over 40 Ph.D students and 100 post graduate students, many of whom are faculty of Major Universities worldwide or Scientists or Engineers at National Labs/Industries around the world. He has published more than 500 research papers and has authored/co-authored 6 books and edited 7 books. His books are published by John Wiley and Sons, CRC Press, Prentice Hall, Springer Verlang, IEEE Computer Society Press *etc.*, One of his books titled Introduction to Parallel Algorithms has been translated to Chinese.

L M Patnaik is currently Honorary Professor, Indian Institute of Science, Bangalore, India. He was a Vice Chancellor, Defense Institute of Advanced Technology, Pune, India and was a Professor since 1986 with the Department of CSA, Indian Institute of Science, Bangalore. During the past 35 years of his service at the Institute he has over 700 research publications in refereed International Journals and refereed International Conference Proceedings. He is a Fellow of all the four leading Science and Engineering Academies in India; Fellow of the IEEE and the Academy of Science for the Developing World. He has received twenty national and international awards; notable among them is the IEEE Technical Achievement Award for his significant contributions to High Performance Computing and Soft Computing. His areas of research interest have been Parallel and Distributed Computing, Mobile Computing, CAD, Soft Computing and Computational Neuroscience.