

# Multimodal Biometric System Based on Feature Level Fusion of Palmprint and Fingerprint Using Gabor Hidden Markov Model

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**Abstract-** Biometric technology has become extensively popular and getting more importance due to the ever increasing demand on access control, public security, forensics and e-banking. The development of accurate and reliable security systems is a matter of wide interest, and in this context biometrics is seen as a highly effective automatic mechanism for personal identification. The hand based biometrics is one of the most popular biometric technologies and is used largely in the market of biometric. The main aim of this paper is consists of developing an accurate hand based biometric system. In this context, for developing an efficient multimodal biometric recognition system, palmprint and fingerprint are used collectively. The features for both modalities are computed using binarization. The Hidden Markov Model(HMM) is used for developing feature vector. The modalities are fused using feature level fusion. The proposed work is tested and evaluated using casia database. The proposed work is highly effective and reliable as results shows that it brings high accuracy and identification rate.

**Keywords –** Biometrics, Palmprint, Fingerprint, Binarization, HMM, Feature level fusion.

## I. INTRODUCTION

### 1.1 Biometrics

Biometrics is the study of automated methods for recognizing a person based on his physical traits such as fingerprint, palmprint, face and iris or behavioural traits such as voice, signature and keystroke [16]. Biometric is a reliable and natural method for identification of authorized users. The biometric system is a pattern recognition system which makes a personal identification by determining the authenticity of specific physical or behavioural characteristics possessed by the user[8]. The biometric traits used for identification must possess the characteristics of Universality, Uniqueness, Permanence, Collectability and Performance.

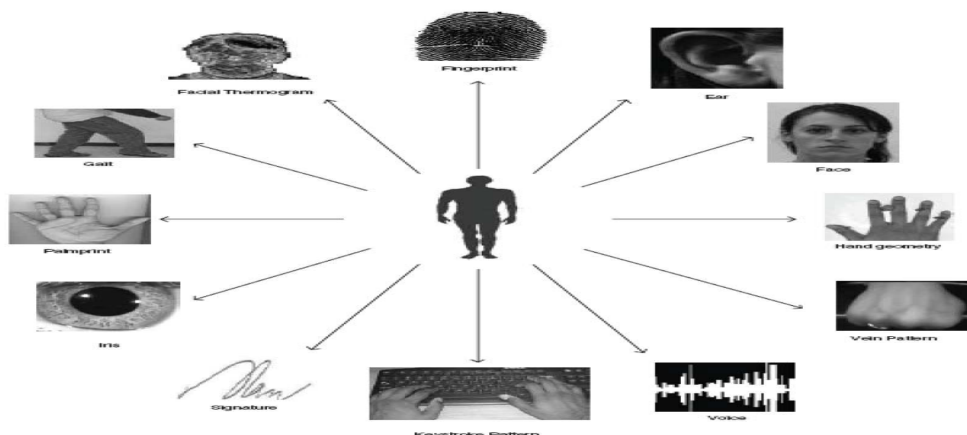


Figure1. Biological properties used for biometric[18]

## 1.2 Types of Biometric System

### 1.2.1 Unimodal Biometric System

Unimodal biometric system perform person identification by employing single biometric trait[14]. But unimodal biometric systems are often affected by the problems of noisy data, non-universality, intra class variation, inter class similarities and spoofing attacks. Due to these problems, the error rates occurred in unimodal biometric systems are quite high. These errors are can be eliminated by using multimodal biometric system.

### 1.2.2 Multimodal Biometric System

Multimodal biometric system refers to the combination of two or more biometric modalities. Problems arised in the unimodal biometric system can be resolved using multimodal biometric. Multimodal biometric can be achieved through the fusion of two or more biometric trait. The key task in multimodal system is fusion of two or more modalities. Various levels of fusion in multimodal biometric system are – Sensor level fusion, Feature level fusion, Score level fusion and Decision level fusion. Multimodal biometric fusion combines measurements from different biometric traits to enhance the strengths. The performance metrics for multimodal system are False accept rate (FAR), False reject rate (FRR) and Equal error rate (EER).

Multimodal biometric systems, consequently, provide an improved performance over unimodal system. In addition, multimodal biometric systems also provide improved security.

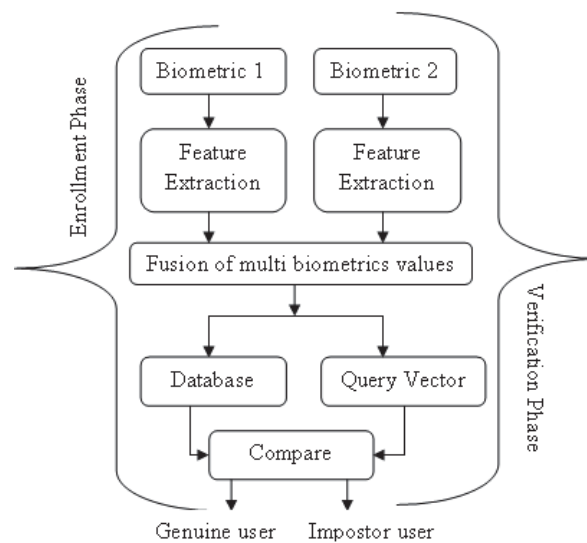


Figure 2. General diagram of multimodal biometric system[3]

## II. PROBLEM FORMULATION

Biometric Authentication System has been used for the purpose of authentication on the basis of different biometric traits. In this authentication system, various biometric traits are used. Most Biometrics are unimodal, Which rely on single source of information for authentication. But these systems are facing variety of problems such as: Noisy Data, Non universality, Intra class variation, Intra class similarities, Spoofing attacks, Unacceptable error attacks.

To overcome these drawbacks a new research area multimodal biometrics is emerged. Multimodal biometric systems consist of combining two or more biometric modalities in a single identification system. In this work, fusion of palmprint and fingerprint is purposed using feature level based on hidden markov model.

### III. PROPOSED SYSTEM

Biometric authentication system is used for various purposes in different fields. This authentication model has been used for security purposes in the different high security areas where unauthorized access is not possible. Various biometric traits have been used for development of biometric authentication model.

In the proposed work multimodal biometric authentication system has been developed that utilize more than one biometric trait. In the multimodal all the biometric trait have to be available for authentication process. In the proposed work fingerprint and palm print biometric trait has been used for development of multimodal system. The features have been computed for both biometric traits. These features have been computed using different binarization and minutia extraction approach. The images database for both traits has been used then images have been normalized using different resizing and normalization process. In this process the binarization has been done for the images so that after thinning and binarization the lines of the finger print and palm print images extracted. The thinning process completes the minutia lines that have been broken in the images. After this process the minutiae have been extracted from the images. Minutiae are the points available on that images that are treated as features. These points available on the images are mainly points that help in finding the feature vectors. Hidden markov model have been implemented on these points that develop a feature vector for both fingerprint as well as palm print images.

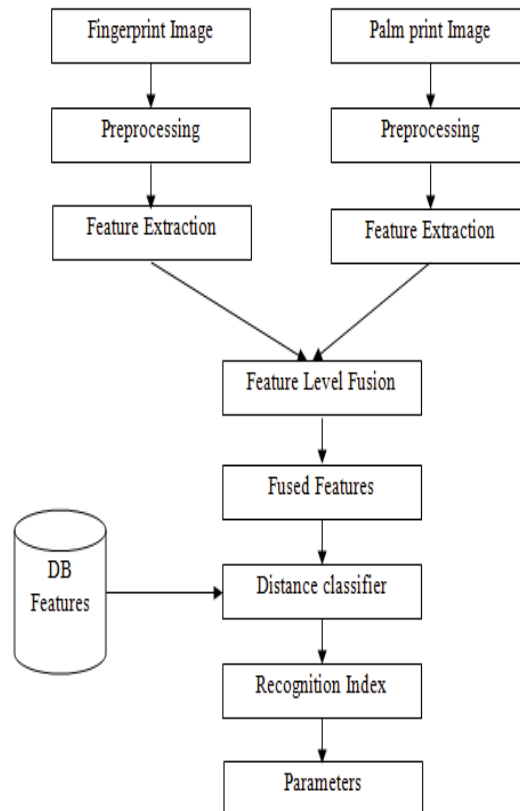


Figure 3. Flow diagram of proposed system

This flow graph represents the basic proposed design for development of multimodal system. In this flow graph different steps has been defined that have to be carried out for development of multimodal. In the first process the image has been captured by using the sensing devices. These captured images have been preprocessed using the normalization processes. In the process of normalization the images have been resized in a particular size of 128 \* 128. These images after pre processing steps undergo the process of binarization.

In the process of binarization the image has to be converted into the binary image from a gray scale image. In the binarization process a threshold value has been settled that is used for conversion of image into binary form. On the basis of the particular thresholding value the image available has been converted into black (0) pixels and white (1) pixels. In this process the image threshold is computed. The gray level thresholding method uses the Otsu's method for prediction of the threshold value that has been used for binarization process.

After the process of the binary conversion the binary image has to be thinned by using the thinning operation. In the thinning process different operations have been implemented. In the process of thinning various operations have been performed that convert the whole image into thin lines. Thinning operation is a morphological operation that uses different dilation, erosion functions.

After implementation of the thinning operation the bifurcation and rigid has been extracted from the image these images help to find out the points available in the image so that these images can be used for image matching purposes. After this the feature level fusion approach is implemented on the both fingerprint as well as palm print images. In the feature level fusion the different feature vector has been developed for the fingerprint images and palm print images. These both feature vectors that have been developed have been fused using the feature level fusion approach.

In the feature level fusion  $F_i = \{ f_{i,1}, f_{i,2}, \dots, f_{i,n} \}$  and  $H_i = \{ h_{i,1}, h_{i,2}, \dots, h_{i,n} \}$  are the feature vector of fingerprint images and palm print images. The fused feature vector  $G_i = \{ g_{i,1}, g_{i,2}, \dots, g_{i,n} \}$  is developed by fusion of both feature vectors. The normalized feature vector is developed by applying normalization approach that are min-max, z-score and median absolute deviation in order to ensure that the fusion for both the features is compatible. In this approach  $F_f$  and  $F_p$  is normalized index score that have been computed after implementation of min-max approach. This simple fusion can be done by using simple sum rule.

After fusion approach these fusion values have been stored in the database for all the training databases. After this the testing image has been captured and these images that are captured are implemented for feature extraction. These features have been fused using the feature fusion approach. The distance classifier is used for measurement of the distance between testing fused feature and training fused feature. On the basis of minimum distance the recognition index has been computed.

#### IV. RESULTS AND DISCUSSION

In the proposed work the CASIA database for fingerprint and palm print images have been used. In this process these images have been used for training and testing purposes. The system has been trained using the training images. The features have been computed for both fingerprint and palm print image. These features have been fused to develop single feature matrixes that are stored in the database features. The testing images have been taken for testing procedure that computes the features for both test image and fuses these features. After fusion distance has been measured. The minimum distance then the matching will be found.

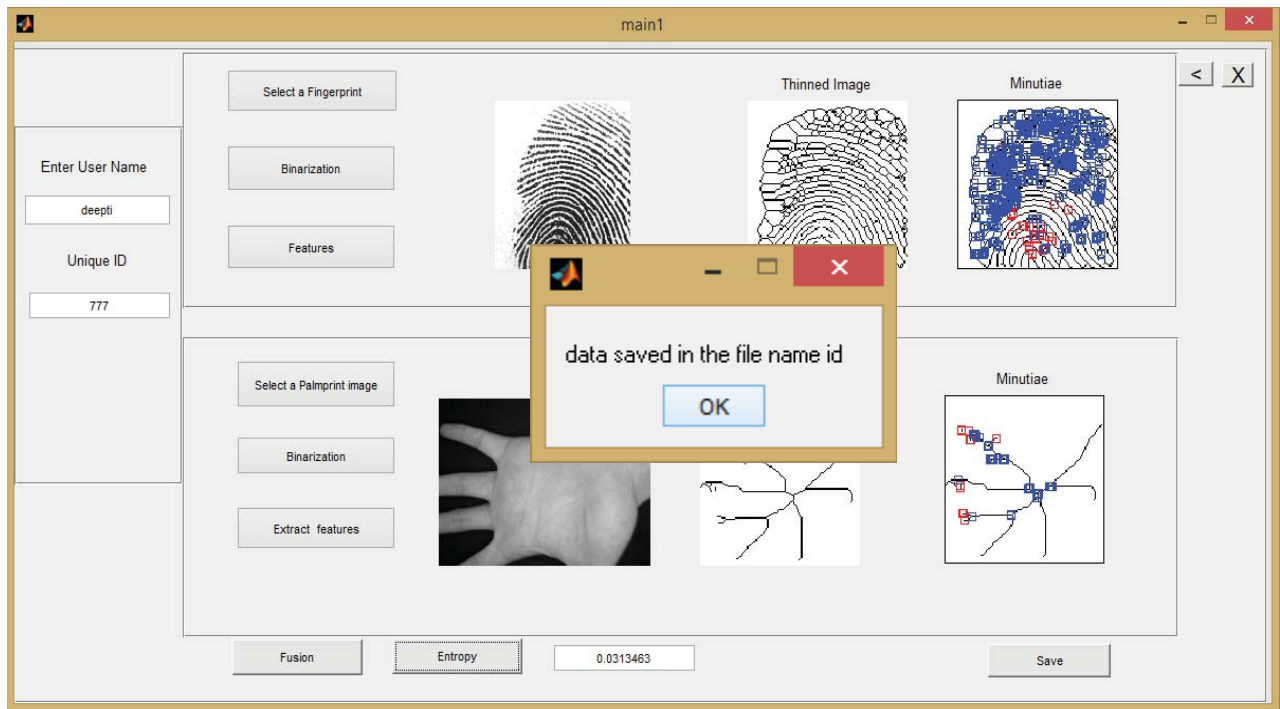


Figure 4. Enrolment Process

The figure 4 represents the enrollment process where the features of user will be saved to the database. For enrollment process the user have to enter unique id and password. After entering his/her id and password, user will input fingerprint image. The preprocessing will be performed on the image and minutiae features of fingerprint image will be extracted. Similar operations will be performed on palmprint image. After feature extraction, the features of both images will be fused to represent single feature vector of individual. Finally fused data will be saved to the database.

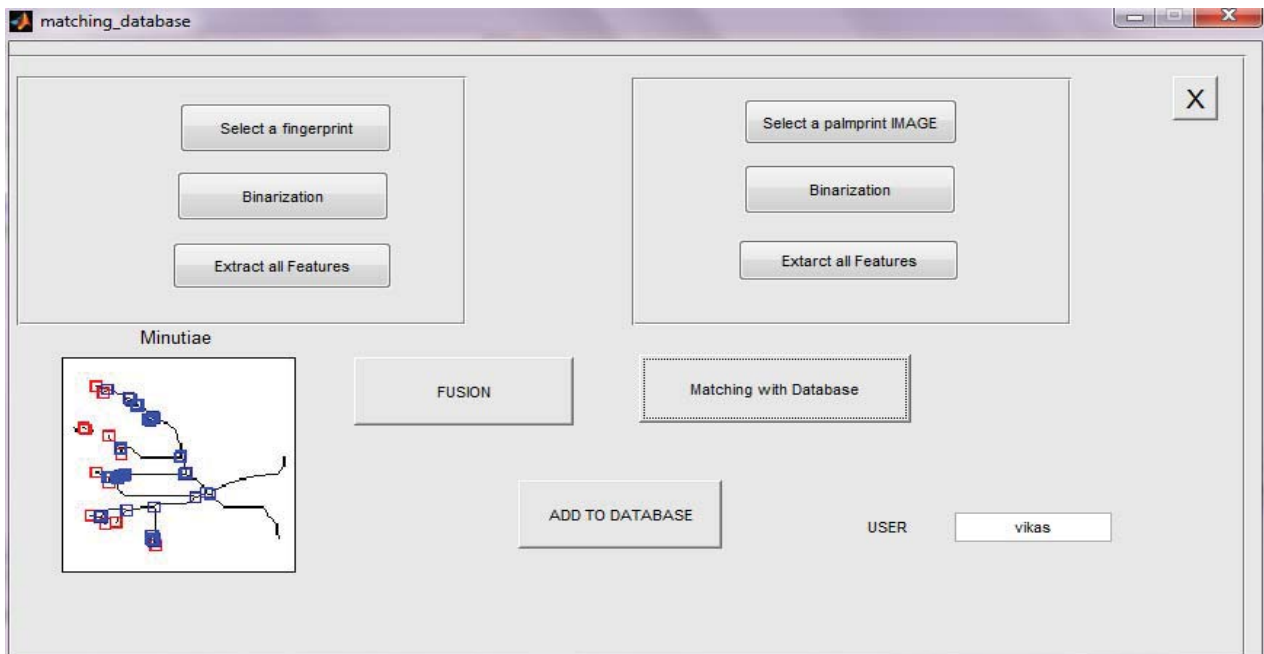


Figure 5. Matching Process

The figure 5 shows the matching process where the fingerprint and palmprint images will be loaded for testing purpose. After loading each image, preprocessing and feature extraction process will be performed. The features extracted will be fused using feature fusion approach. The distance classifier is used for measurement of the distance between testing fused feature and training fused feature. On the basis of minimum distance, it will be computed whether the user is authorized user or not.

The performance of this system is measured in terms of accuracy, false accept rate(FAR), false reject rate(FRR).

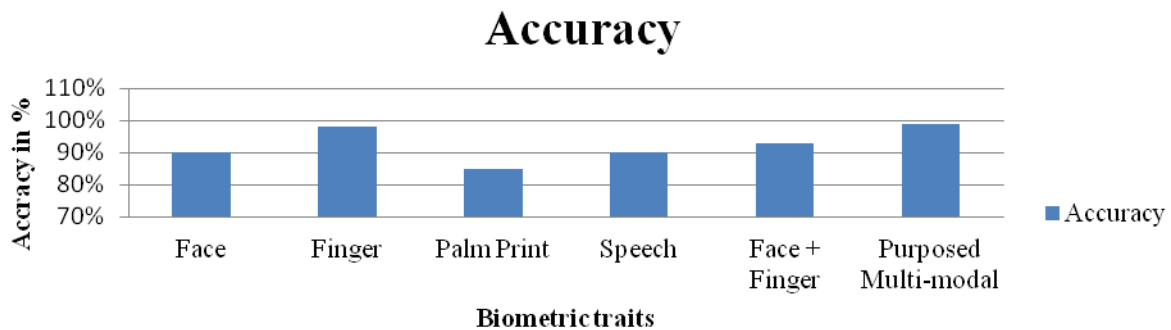


Figure 6. Accuracy

The figure 6 represents the accuracy that has been achieved by different biometric traits in the previous and proposed work.

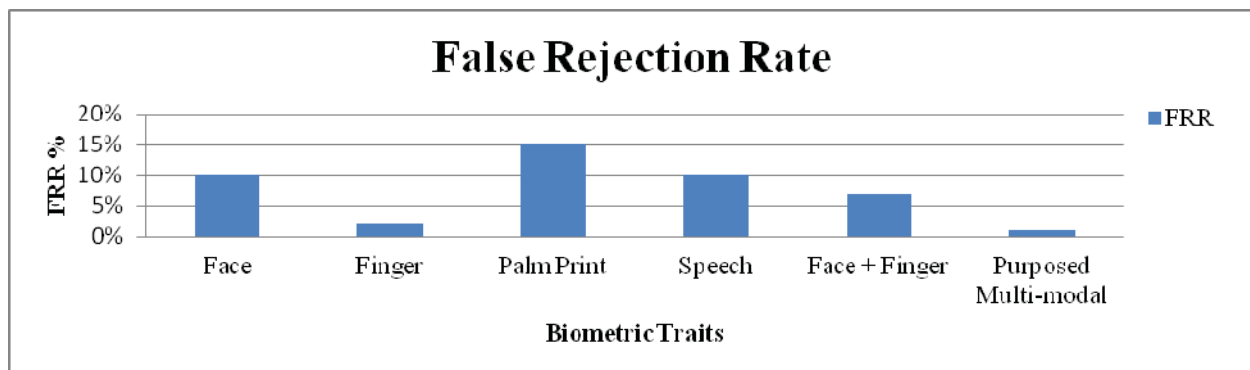


Figure 7. False Rejection Rate

The figure 7 represents the FRR that has been achieved by different biometric traits in the previous and proposed system.

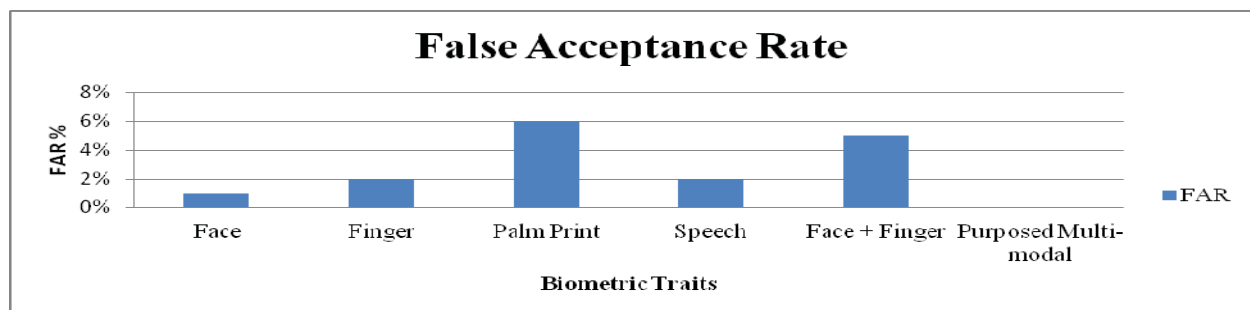


Figure 8. False Accept Rate

The figure 8 represents the FAR that has been achieved by different biometric traits in the previous and proposed system.

## V. CONCLUSION

In this work, a biometric authentication system is developed that is used to identify fingerprint and palm print images. In a basic biometric authentication system various traits such as finger print, palm print, iris etc is being used. In our proposed work the system which is developed includes palm print and finger print which are used for multimodal development. The features have been computed for both biometric traits. Hidden markov model have been implemented that develop a feature vector for both fingerprint as well as palm print images. Hidden markov model extract the features and fuses on the basis of fusion method. After fusion process, the distance between database and query features has to be computed. The distance classifier is used for measurement of the distance that is calculated between testing fused feature and training fused feature. On the basis of minimum distance the recognition index is computed and the result is displayed.

## REFERENCES

- [1] A. Meraoumia, S. Citroub and A. Bouridane, "Multimodal biometrics system by fusion of palmprint and finger knuckle print using Hidden Markov Model", IEEE. pp. 421-424, 2013.
- [2] A. Meraoumia, S. Citroub and A. Bouridane, "Multimodal biometric person recognition system based on fingerprint and finger knuckle print using Correlation filter classifier", IEEE International conference on communications, pp. 820-824, 2012.
- [3] A. Muthukumar and s. Kannan, "K-Means Based Multimodal biometric Authentication using Fingerprint and Finger Knuckle Point with Feature Level fusion", IJST, Transactions of Electrical Engineering, Vol. 37, pp133-145, 2013
- [4] A. Ross and A.K. Jain, "Multimodal biometrics: A Review" in proc. EUSIP conference, pp. 1221-1224, September 2004.
- [5] Audrey Poinot, Fan Yang and Michel Paindavoine, "Small Sample Biometric Recognition Based on Palmprint and Face Fusion", Fourth International Multi-Conference on Computing in the Global Information Technology, pp.118-122, 2009.
- [6] Chaikan, P., Karnjanadecha, M., "A Reference Point Detection Algorithm for Top-View Finger Image Recognition" 5th International Symposium on Image and Signal Processing and Analysis, 2007, pp. 347 – 350.
- [7] David Zhang, Zhenhua Guo, Guangming Lu, Lei Zhang, Yahui Liu and Wangmeng Zuo, "Online joint palmprint and palmvein verification", Expert Systems with Applications, Vol. 38, pp. 2621-2631, 2011.
- [8] David D. Zang, "Palmprint authentication", Kluwer Academic Publication, 2004.
- [9] Dr.S.Ravi and D.P.Mankame, "Multimodal biometric approach using fingerprint, face and enhanced iris features recognition", International conference on circuits, power and computing technologies, pp. 1143- 1150, 2013.
- [10] Jani, R. Agrawal, N., "A Proposed Framework for Enhancing Security in Fingerprint and Finger-Vein Multimodal Biometric Recognition" *International Conference on Machine Intelligence and Research Advancement (ICMIRA)*, 2013, pp. 440 – 444.
- [11] Md. Maruf Monwar & Marina, L. Gavrilova, (2009). Multimodal biometric system using rank-level fusion approach. *IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics*, Vol. 39, No. 4, pp. 867- 878.
- [12] Mingxing He, Shi-Jinn Horng, Pingzhi Fan, Ray-Shine Run, Rong- Jian Chen, Jui-Lin Lai, Muhammad Khurram Khan and Kevin Octavius Sentosa, "Performance evaluation of score level fusion in multimodal biometric systems", *Pattern Recognition* Vol 43, pp: 1789-1800, 2010.
- [13] Ola M. Aly, Gouda I. Salama and Hoda M. Onsi, "Multimodal biometric system using iris, palmprint and finger knucle" *International journal of computer applications*, pp. 1-6, 2012.
- [14] P. S. Sanjekar and J. B. Patil , "An Overview of multimodal biometrics", *Signal & Image Processing : An International Journal (SIPIJ)* Vol.4, No.1, February 2013.
- [15] Ross, A. & Anil, K. Jain, (2003). Information fusion in biometrics. *Pattern Recognition Letters*, Vol. 24, pp. 2115–2125.
- [16] S. Kaur and P.sharma, "Analysis of multimodal biometrics by feature level fusion: A Review", in *IJARCSSE*, volume 3, issue 7, july 2014.
- [17] S.R. Soruba and Dr. N. Radha, "A survey on fusion techniques for multimodal biometric identification", in *IJIRCCCE*, vol2, issue 12, dec 2014.
- [18] [www.google.co.in](http://www.google.co.in).
- [19] Young H. Park "A multimodal biometric recognition of touched fingerprint and finger vein", *International conference on multimedia and signal processing*, vol1, pp. 247-250, 2011.