Hyper Spectral Face Recognition Using KPCA

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Abstract—Biometric security is a challenging task in day to day life because it is difficult to avoid the fraud. In this research paper emerging biometric trait, i.e. Hyper Spectral Face is considered for human authentication system. There are various visible spectrum of electromagnetic spectral bands are considered for face recognition instead of only three RGB bands. Hyper Spectral gives band wise more finite detail information of face. It is very novel and more accurate than ordinary face recognition system. Hong Kong PolyU Hyper Spectral Face Database used for Face recognition. Kernel Principle Component Analysis (KPCA) algorithm gives prominent features of the Hyperspectral Face Dataset. Extracted features are classified by Mahalinobis Cosine (Mahcos) similarity measurement technique. The Recognition rate calculated on the basis of One Rank Level it furnishes 69.20%.

Index Terms—Hyper-Spectral, Face Recognition, PCA, KPCA, Biometrics

1 INTRODUCTION

THE Biometric is a process of human authentication system through their physical, behavioral or chemical properties.

Face recognition is a biometric trait used to identify the person on his physical appearance. Face recognition is a very interesting area in biometrics, Seong G. Kong [1] show the sensor imaging with different modalities. Dermal texture of skin is unique and stable throughout the life of a human being. The Dermal texture of facial skin can be used to discriminate between individual peoples. Skin based light reflection having random in nature but unique to every individual in that required higher spectral reflectance band.

There are various electromagnetic spectral bands are used for different purposes; in biometrics visible spectrum band is used because below the visible band radiation is very harmful to the human body, such as X-rays, ultraviolet, etc. Some researcher used Thermal IR imagery as an alternative source [2]. For face recognition visible spectrum is applied in which the range of electromagnetic energy of camera is 0.4–0.7µm.

The infrared spectrum comprises the reflected IR and the thermal IR Wave bands. The reflected IR band (0.7–2.4 µm) is associated with reflected solar radiation that contains no information about the thermal properties of materials.

The near-infrared (NIR) (0.7–0.9 µm) and the short-wave infrared (SWIR) (0.9–2.4µm) spectra are reflective and differences in appearance between the visible and the reflected IR are due to the properties of the reflective materials. This radiation is far more visible to the human eye. As the world is becoming increasingly more insecure, people are looking for new forms of security which are more reliable and less vulnerable against intruder attacks. One such emerging technology is the field of Biometrics. The main reason for the acceptance of the biometrics as a tool for security is its universality, distinctiveness, permanence and collectability. Main issues to be considered at the time of implementing a biometric system is performance, acceptability and circumvention.

2 FACE RECOGNITION

Face recognition is an active research area for pattern recognition and computer vision. It is a difficult and complex problem and due to its potential use in a wide variety of commercial and law enforcement applications including access control, security monitoring, and video surveillance. Unlike other biometric identification systems based on physiological characteristics, face recognition is a passive, non-intrusive system for verifying personal identity in a user-friendly way without having to interrupt user activity [1]. It has many application areas, i.e. human computer interaction, security, person identification [3],[4]. One of the factors that affect the performance of the recognition system is the training sample size [5],[6],[7]. Sufficient number of training samples are always needed to train the classification system well [8]. If only one image per person is available, the recognition process gets more difficult. This problem is called one sample problem [9]. Traditional methods will suffer or fail when a single image per person is available [10],[11],[12]. Several algorithms have been proposed to overcome this difficulty [5],[13],[14],[15],[16],[17].

3 EXPERIMENTAL METHODOLOGY

3.1 Proposed Methodology

![Fig. 1. Hyper Spectral Face Recognition System.](http://www.ijser.org)
• Input:
Take the input as Hyper-Spectral face image. Hyper-Spectral image consist of 33 bands in the visible spectrum. Hyper-Spectral images from PolyU Hyper-Spectral face database (PolyU-HSFD).

• Separation of Band:
After taking the input from the system separate 33 bands on the basis of band region, each band having certain reflection in a specific visible spectrum.

• Extract Features:
Feature extractions play an important role in finding any pattern. Face features extracted by using KPCA technique which is formulated in 3.2. Features show the exact reflection and region of active spectra where we are interested from separate bands.

• Feature Band Fusion:
Then formulate the fusion of features of all bands and make the single feature for a single image to take the decision.

• Decision:
The main outcome of the overall process is to find the person is genuine or not for that classification or distance matching techniques is used therefore we can match with the existing database template. Matching decision depending on the features is related to the person or not. In this research Mahcos similarity based distance applies to the feature set.

3.2 Kernel Principal Component Analysis (KPCA)
KPCA is a nonlinear generalized PCA, which performs on an arbitrarily large dimension to select an appropriate feature space. There is no need to provide a number of features to select in advance like PCA, and it gives elucidation very clear when data is in high dimension [18]. Step by step explanation of KPCA algorithm is given below:

I. Get the Data in the form of a matrix
\[ K_{m \times m} \] (1)

II. Performa Dot Product
\[ K_{ij} = (k(m_i, m_j))_{ij} \] (2)

III. Diagonal \( K \) and normalize the Eigenvector Expansion coefficients
\[ l = \lambda \alpha_n \] (3)
Where \( \alpha \) denotes the column vector with entries \( \alpha_1 \ldots \alpha_n \). As \( K \) is symmetric, it has a set of Eigenvectors which spans the whole space.

IV. Compute Projection Matrix
\[ (kPC)_n = (Vn, \phi(m)) = \sum_{i=1}^{n} \alpha_i^2 k(m_i, m) \] (4)

Where, \( \phi \) is input face. The contour lines of constant projections onto the principal Eigenvector become nonlinear in input space.

3.3 Mahalinobis Cosine (Mahcos)
Here \( m \)-by-\( n \) data matrix \( X \), which is treated as \( m \) (1-by-\( n \)) row vectors \( x_1, x_2, \ldots, x_m \), the various distances between the vector \( x_i \) and \( x_i \) are as follows:

\[ d^2_{ij} = (x_i - x_j)\nu^{-1}(x_i - x_j)^T \] (4)

4 RESULT & DISCUSSION
For this work The Hong Kong Polytechnic University Hyper-spectral Face Data-base (PolyU-HSFD) is used. This database included 300 Hyper-Spectral image cubes of 25 subjects. This database was collected in two different times and sessions on an average span of five months. The spectral range is from 400nm to 720nm with a step length of 10nm, total 33 bands.

On Hong Kong PolyU Database, KPCA as a feature extraction technique and Mahcos for similarity measure [19], [20] the rank one recognition rate is 69.20%. Fig. 2 & 3 shows the ROC and CMC graph.

5 CONCLUSION
Hyper Spectral Face Recognition novel emerging biometric trait is used. KPCA gives elucidation very clear when data is in high dimension. KPCA as a feature extraction technique and Mahcos for similarity measure apply on Hong Kong PolyU Database the rank one gives a recognition rate as 69.20%. It may be possible to improve recognition rates using Gabor + KPCA or any other feature extraction techniques with different distance measurement.
ACKNOWLEDGMENT

The Authors would like to acknowledge and thank to the Programme Coordinator for providing me all necessary facilities and access to Multimodal Biometrics System Development Laboratory to complete this work under UGC SAP (II) DRS Phase-I & II F. No.-3-42/2009, One Time Research Grant F. No. 4-10/2010 (BSR) & No.F.19-132/2014 (BSR). We would like to acknowledge and thank to University Grants Commission (UGC), New Delhi for awarding me “UGC Rajiv Gandhi & BSR Na-tional Fellowship”.

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