CHAPTER 9

CONCLUSION

9.1 SUMMARY OF THE THESIS

Biometric recognition is essentially pattern recognition which involves feature extraction and classification. Feature extraction is the extraction of dominant information from the pattern. The pattern is obtained by pre-processing the biometric images to make them suitable for feature extraction. The primary information in palmprint which helps in discrimination are the principal lines, wrinkles and ridges and those in fingerprint are the ridges. These lines, wrinkles and ridges form line structures in the pre-processed fingerprint and palmprint images. It is observed from these images that the shape of the lines in the fingerprint is different from those in palmprint. Hence shape descriptors are proposed to extract the shape information in the biometric images for their representation. These descriptors are also made robust to affine transformations of the biometric image which may occur during real time acquisition. The classification accuracy obtained for these descriptors using probabilistic classifiers is tested both for unimodal and multimodal systems.

9.2 CONTRIBUTIONS OF THE THESIS

The major contributions of this thesis are

1. The introduction of orthogonal moments for invariant feature extraction from palmprint and fingerprint biometrics.
2. The introduction of the significance of line structures in a biometric image for representation of the image.

3. The proposal of Legendre moments for representing palmprint and pseudo-Zernike moments for representing the fingerprint for feature extraction due to certain inherent properties of the two moments.

4. The proposal of localising an image to extract local information with global descriptors.

5. The proposal of several fusion schemes using fingerprint, palmprint and face.

6. The proposal of a high performance unimodal system, namely a palmprint biometric authentication system that uses Legendre moments for feature extraction and BBN for classification, that outperforms several other fusion schemes.

9.3 ORTHOGONAL MOMENTS FOR REPRESENTATION AND BAYESIAN BELIEF NETWORK FOR CLASSIFICATION OF BIOMETRIC IMAGES

Fingerprint and palmprint authentication systems that use the continuous orthogonal moments namely the pseudo-Zernike and Legendre moments and the discrete orthogonal moment namely the Chebyshev moments for representation and the Bayesian Belief Network for classification are developed.

The orthogonal moments are able to provide a translation, scale and rotation invariant representation of the biometric images. Higher classification accuracy is obtained when the biometric images are divided into sub-images.
before feature extraction. Among the orthogonal moments used, the Legendre moments are more suitable for representing the palmprint biometric and the pseudo-Zernike moments are more suitable for representing the fingerprint biometric.

Among the fingerprint and palmprint systems, the palmprint authentication system using Legendre moments for feature representation gives the highest accuracy. This is compared with the accuracy of biometric authentication obtained using Kernel Principal Component Analysis and Gray Level Co-occurrence Matrices and is found to be much higher. Face authentication system is developed using the Legendre moments for representation of face images and a BBN for classification.

9.4 FACE RECOGNITION

Face images from the ORL database are used for the experiment. After enhancement and segmentation of the region of interest, Legendre, Pseudo-Zernike and Chebyshev moments are extracted from these images. The classification is done using Bayesian Belief Net as well as Random Forest Classifier. The former is observed to give better classification performance in terms of accuracy, TP and FP.

9.5 FUSION

In this research, fusion of same or different feature sets from multiple biometrics as well as the fusion of multiple feature sets from single biometric are tested for their performance. The feature sets in all the cases are concatenated and fed to the Bayesian Belief Network for classification, in case of multi-algorithmic systems. The multiple biometric systems are found to offer better classification accuracy than the latter.
Table 9.1 Comparison of Unimodal and Multimodal Palmprint systems

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unimodal Palmprint System using Legendre Moments of order 3</th>
<th>Multimodal System using Legendre Moments of Order 3 from Palmprint and Pseudo-Zernike moments of order 3 from Fingerprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAR</td>
<td>0.307</td>
<td>1.33</td>
</tr>
<tr>
<td>FRR</td>
<td>2.54</td>
<td>3.8</td>
</tr>
</tbody>
</table>

It is observed from Table 9.19 that the unimodal palmprint system that uses Legendre moments gives lower FAR and FRR than the multibiometric system.

9.6 SCOPE FOR FUTURE WORK

The following are suggested as future work in continuation of the work done in this research:

1. Similar to the fingerprint and palmprint images which are line structure based images, the face biometric can also be converted to a form made up of line structures and it can be tested whether the classification accuracy of the Legendre moments increases.

2. The classification accuracy of Chebyshev moments in spite of being discrete moments is consistently lesser than the continuous orthogonal moments for the fingerprint and palmprint images. The reasons for this could be analysed and the performance of other discrete orthogonal moments such as Racah, Krawtchouk moments can be tested for the biometric images.