FUSION OF MULTIMODAL BIOMETRICS

JYOTSANA GROVER

DEPARTMENT OF ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY DELHI

OCTOBER 2014

FUSION OF MULTIMODAL BIOMETRICS

by

JYOTSANA GROVER

DEPARTMENT OF ELECTRICAL ENGINEERING

Submitted

in fulfillment of the requirements of the degree of

DOCTOR OF PHILOSPHY

to the

INDIAN INSTITUTE OF TECHNOLOGY DELHI

OCTOBER 2014

CERTIFICATE

This is to certify that the thesis titled **"Fusion of Multimodal Biometrics"** being submitted by **Ms. Jyotsana Grover** to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by her under our guidance and supervision. In our opinion, the dissertation has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this dissertation have not been submitted to any other university or institute for the award of any degree or diploma.

Prof. M. Hanmandlu
Supervisor
Electrical Engineering Department
Indian Institute of Technology, Delhi
New Delhi-110016

Prof. H. M. Gupta
Supervisor
Electrical Engineering Department
Indian Institute of Technology, Delhi
New Delhi-110016

ACKNOWLEDGEMENTS

It is my pleasure to record deepest gratitude to my supervisors, Prof. M. Hanmandlu and Prof. H. M. Gupta for giving me this opportunity to work under their supervision and for making my research a beautiful journey. I am thankful to their consistent encouragement and constant advice.

I am thankful to IIT Delhi authorities for providing me the necessary facilities for the smooth completion of my work. I would like to give special thanks to my SRC members for their valuable suggestions and feedback during my research.

I would also like to thank all my friends at IIT Delhi for their constant support and encouragement throughout my PhD days. Most importantly, I would like to express my heart-felt gratitude to my parents and my closed ones. None of this would have been possible without the love and patience of my family.

I would like to thank my thesis examiners for their valuable suggestions for improving the thesis.

Finally, my greatest regards to the Almighty for bestowing upon me the courage to face the complexities of life and complete this thesis.

Jyotsana Grover

ABSTRACT

The thesis considers the multimodal biometric fusion of different instances of finger-knuckle-prints and also of multiple representations of the palmprints. The instances of finger-knuckle-prints (FKPs) consist of left index, left middle, right index, and right middle FKPs whereas the multiple representations of palmprints include its multispectral bands such as Near-Infra-Red (NIR), Red, Blue, and Green. The thesis considers four types of fusion methodologies, viz., feature level, score level, rank level, and decision level. In addition we have devised error level fusion.

To accomplish the multimodal biometric fusion, we have proposed new textural features: topothesy-fractal dimension, Hanman Transform, and structure function based transform features for FKPs and multispectral palmprints. To evaluate these features we have proposed T-norm based classifier whose performance measured in terms of Equal Error Rates (EER) is at par with that of SVM. Moreover these features outperform the existing features like Gabor filter using the proposed classifier.

As part of feature level fusion, the filter based feature selection is achieved using new generalized fuzzy entropy. It is shown to be more effective than the commonly employed wrapper and embedded techniques.

Score level fusion is accomplished using the T-norms as these norms take care of the uncertainty associated with the scores and this approach is found to be more efficient than the existing classification based and the likelihood ratio based approaches for the score level fusion. This fusion has been extended to hybrid fusion by combining with the feature level fusion.

The rank level fusion is improvised by using the entropy function and in addition some non linear functions like logarithmic, sine hyperbolic inverse and sigmoid are also

investigated for the rank level fusion. We have also adapted the Choquet integral for the rank level fusion as it takes care of the overlapping information between the modalities. A hybrid learning algorithm called Reinforced hybrid Bacterial Foraging Particle Swarm Optimization is devised to learn the fuzzy densities and the interaction factor needed in the Choquet integral.

In order to take care of the uncertainty in the decisions (accept/reject), the adaptive fuzzy decision level fusion is formulated. Further, the hybridization of score level fusion and adaptive fuzzy decision level fusion is also carried out with a view to reduce the complexity of finding the best fusion rule when the number of modalities increases.

The error level fusion is proposed using the Choquet integral whose role in this is to fuse the error rates of different modalities by taking care of the overlapping information present among the modalities.

All the fusion methodologies have been tested on publicly available databases of FKPs and multispectral palmprints and their effectiveness has been ascertained using the proposed features and classifier.

Table of Contents