Chapter 13
The Application of Rough Set Theory and Near Set Theory to Face Recognition Problem

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ABSTRACT

Computer vision is a process of electronically perceiving and understanding of an image like human vision system (HVS) do. Face recognition techniques (FRT) determines the identity of the individual by matching the facial images with the one stored in the facial database. The performance of FRT is greatly affected by variations in face due to different factors. It is interesting to study how well these issues are being handled by RST and near set theory to improve the performance. The variation in illumination and plastic surgery changes the appearance of face that introduces imprecision and vagueness. One part of chapter introduces the adaptive illumination normalization technique using RST that classifies the image illumination into three classes based on which illumination normalization is performed using an appropriate filter. Later part of this chapter introduces use of near set theory for FRT on facial images that have previously undergone some feature modifications through plastic surgery.

INTRODUCTION

In real world, human interaction with one another depends on their capability of recognition. This inherent capability to effortlessly identify and recognize human being is generally referred as human vision system (HVS). When such HVS is emulated through computer or machine it is referred as computer vision. Computer vision is a field that includes methods for acquiring, processing, analyzing, and understanding the images like HVS do. It is a process of electronically perceiving and understanding of

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an image. The image can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. Understanding of HVS helps to build a powerful computer vision system where some useful information is extracted from image by a machine that is necessary for solving a particular problem. Face recognition is one such problem from computer vision domain.

FRT determines the identity of the individual by matching the facial images with the one stored in the facial database. It brings together the promises of other biometric systems and familiar functionality of visual security systems. FRT has emerged as a rapidly growing application in various fields. For example, the law enforcement and surveillance applications include closed circuit television video (CCTV) analysis, post event analysis, drug offenders (M. Bryant, 2011) *etc*. The usage of FRT have also been extended to few prohibited and safety related public areas such as airport (Big Brother, 2010)8, railways (Vicente, Fernandez & Coves, 2009) *etc*. In order to maintain the authenticity of a person, FRTs have also been employed in login system, driver license, voter registration, smart cards immigration, access control to buildings, email authentication on multimedia, automatic teller machine (ATM) *etc*. Recently, the government of India has also launched the concept of Aadhar Card as national identity that also uses FRT along with other biometrics. Not limited to this face recognition is also used for different commercial purposes (Apple Invents Facial Recognition, 2012) (Face Recognition Toshiba, 2013) and available with a product as a software application such as Apple Facial Recognition Locking&Unlocking System (Apple Invents Facial Recognition, 2012), Toshiba Face Recognition (Face Recognition Toshiba, 2013) *etc*.

In most of the aforesaid applications, identifying or recognizing the person based on the facial image is an important task, called as face identification or face recognition (Zhao, Chellappa, Phillips, & Rosenfeld, 2003). FRT basically constitutes of four main stages (Zhao, Chellappa, Phillips, & Rosenfeld, 2003)*viz*;

1. Face localization,
2. Pre-processing,
3. Feature extraction, and
4. Face recognition as shown in Figure 1.

Face localization is the initial and most important stage, where face portion is cropped either manually or automatically from the input image in order to remove the irrelevant information present in the background. Face pre-processing enhances the quality of cropped face image either by reducing the

Figure 1. Face recognition system