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Applications of Numerical Optimization Techniques in Iris Localization and Segmentation for Recognition Systems

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To my father . . .

You are always remembered and greatly missed.

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Abstract

Reliable automatic recognition of persons has long been an attractive goal. Much of the work in the field of biometrics has focused on identification applications. Iris biometric systems can function as extremely reliable means of personal identification due to several reasons. The iris is extremely data-rich characteristic trait with unique non-genetic patterns. Moreover, these patterns are stable throughout the adult life and are physically protected by the cornea that does not inhibit external viewability.

The first -yet critical- step in iris recognition is to isolate the iris region in the digital image of the eye. This process is called iris localization and segmentation, and is the focus of this thesis. Different image processing techniques that involve numerical optimization are used for iris segmentation and localization.

This thesis reviews and implements different iris localization and segmentation techniques and compares between them. The iris region can be approximated as two circles representing iris/pupil boundary and the iris/sclera boundary. Circular Hough Transform and Integro-Differential operator assume that the iris/pupil and iris/sclera boundaries are circular. Active contours, a newly utilized technique in iris segmentation, attempt to find the boundaries assuming that they are

arbitrary by iteratively evolving curves until they lock on nearby edges.

The different iris segmentation techniques are implemented and tested on database of irises provided by the Chinese Academy of Sciences Institute of Automation (CASIA).

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Chapter 1

Introduction

1.1 Biometric Technology

1.1.1 Biometric Systems

The aim of biometric systems is to uniquely recognize human individuals based on intrinsic physical traits. Examples of distinguishing features upon which some biometric systems are based include fingerprint, face recognition, DNA, voice, hand and palm geometry, retina and iris recognition.

A good biometric is characterized by distinctiveness, robustness and ease of measurability. Distinctiveness is a measure of the varia-

tions or differences in the biometric pattern among the general population. In other words, distinctiveness is a measure of how much distinguishing is the chosen physical trait. The iris and the retina have higher degrees of distinctiveness than hand or finger geometry. Robustness refers to the extent to which the characteristic feature is immune to significant changes over time. These changes can occur as a result of age, injury, illness, occupational use, or chemical exposure. A highly robust biometric does not change significantly over time. Ease of measurability means that the characteristic or trait can be easily presented to a sensor, located by it, and converted into a quantifiable, digital format. Ease of capture must be kept in consideration to provide convenience to the user and prevent misrepresentation of the feature [1].

Biometric systems works by first capturing an image of the feature, such as recording digital sound signal for voice recognition, or taking a digital colour image for face recognition. The image is then transformed using some sort of mathematical function into a biometric template. The biometric template will provide a normalized, efficient and highly discriminating representation of the feature, which an be objectively compared with other templates in order to determine identity. Most biometric systems allow two modes of operation. An en-

rollment mode for adding templates to database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates [2].

Human recognition can be classified to identification and verification. Verification is a one-to-one comparison of a captured biometric with a stored template to verify that the individual is who he claims to be. In a verification application, the biometric system requires input from the user, at which time the user claims his identity. This user input points the system to a template in the database. The system also requires a biometric sample from the user. It then compares the sample to or against the user-defined template. On the other hand, Identification is a one-to-many comparison of the captured biometric against a biometric database in attempt to identify an unknown individual. In an identification application, the biometric device reads a sample and compares that sample against every record or template in the database.

1.1.2 Performance of Biometric Systems

Performance of verification of Biometric systems is mainly measured by False Accept Rate (FAR) and False Reject Rate (FRR). FAR is the probability that the system incorrectly matches the input pattern to