2010 Seventh International Conference on Information Technology

Experiments with Simple Iris Recognition for Mobile Phones

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Abstract

Mobile phones play an increasingly important role on our everyday lives. It is becoming increasingly important to provide a reliable and easy to use method for securing these devices against unauthorized access. This paper describes an approach to adapt iris recognition for resource-constrained mobile phones by reducing its computational complexity. Experimental results indicate adequate run time and quality of recognition that is comparable to other, more complex iris recognition systems developed for mobile devices.

Keywords: iris recognition, mobile phones.

1. Introduction

Internet-enabled mobile phones have transformed themselves from a personal communication tool into a ubiquitous device that many people carry with them at all times and use to facilitate day-to-day activities, including shopping and entertainment. As a result, many users choose to store personal information on their mobile devices, which could range from email addresses and phone numbers to credit card accounts and user name/password combinations to various websites. This evolution of functionality increases the risks and the severity of consequences of loss, theft, and misuse of mobile devices. Despite much technological progress, security features of many mobile phones remain in the same state as they were a decade ago using a single 4-digit personal identification number (PIN). This kind of protection does not offer a sufficient degree of security since PINs can easily be forgotten or stolen, but especially because many users do not use their PINs or choose not to change their default values. Studies indicate that many users perceive PIN-based security solutions as inconvenient and cumbersome [6]. At the same time, using biometric characteristics is more convenient because they cannot be forgotten, lost, or stolen; they ensure a physical presence of the user while offering a significantly higher security barrier. This paper describes how iris recognition, a computationally expensive technology, can be adapted to resource-constrained mobile phones equipped with a camera.

2. Iris recognition on mobile phones

Iris is an internal organ, but it is easily observable from the outside; it is protected from the environment and does not change as the person ages. Acquiring a biometric sample for iris recognition is not intrusive since an image can be captured with no physical contact while the user is holding their camera-equipped mobile phone at a certain distance from the eye. Daugman [3] described a theoretical concept of iris recognition that has been central to the development of commercially viable iris recognition technologies in the last decade.

A biometric authentication system for a mobile phone will be used primarily in a verification mode when a biometric sample of the person trying to turn on or log in to the device is compared to that of a single rightful owner. Because such a system will not be required to compare a multitude of biometric samples, its computational complexity can be significantly reduced. None of iris recognition systems for mobile devices described in the literature take advantage of this factor [2,4,5,6]; instead, some of these approaches require additional hardware (a built-in infrared sensor) or data (taking several snapshots in a sequence). Here we describe an approach that uses a simplified iris recognition process tailored to resource constrained mobile devices, does not impose any additional hardware, data, or processing requirements, yet yields the results that are comparable to those reported in the literature. The remainder of this section describes the steps involved in the iris recognition process along with a number of corresponding adjustments.

Since mobile phones are used equally indoors and outdoors, iris recognition technology must be able to work equally well with images acquired in either setting. Images acquired outdoors may have more light and resulting iris images may have more ghost regions, while images acquired indoors may show dilated pupils, which makes it essential to reduce the level of noise in the image, e.g. with a 3x3 median filter. Eye region can be typically localized by limiting it to the area in the center of the image.

A standard edge detection followed by Hough transform can be used to find circles corresponding to the boundaries of the iris. Circular Hough transform is

978-0-7695-3984-3/10 $26.00 © 2010 IEEE
DOI 10.1109/ITNG.2010.75

simplified by making an assumption that the pupil is located in the central region of the eye image segmented at the previous step. Furthermore, inner and outer circles representing pupil boundaries are roughly concentric, which simplifies the computations further. Eyelid and eyelash occlusions are ignored here in order to reduce the overall computational complexity. Experimental results shown below indicate that this does not have a significant impact on the quality of recognition.

Iris images may be of different size because they represent different people, and may have been taken from different distances, at different angles and in different lighting conditions. Extracted iris image needs to be normalized to make them suitable for further processing. Most iris recognition systems described in the literature [1] "unfold" a circular iris image from polar coordinates into a rectangle whose radial coordinate corresponds to the vertical axis, and the angular coordinate to the horizontal axis. After this transition, the pupillary boundary of the iris is on the top of the rectangle while the limbic boundary is on the bottom. Such a transformation enables an efficient application of Gabor filter used to extract the texture information from the iris image [4]. However, we chose to bypass these two steps by working with polar coordinates and create a feature vector directly out of the extracted iris image, which significantly reduces the run time of the application.

8 tracks and 32 sectors are used to partition the extracted iris image and calculate the iris code. Using polar coordinates, each pixel is mapped to the corresponding section at the intersection of the corresponding track and sector. An average grayscale color value is calculated for each of the 256 sections, thus forming a feature vector. During matching, feature vectors are compared using a thresholding technique, such as Hamming Distance. In our approach, we measure the average percentage difference between the values of two feature vectors.

3. Experimental performance

An experimental setup of the system was tested using a resource-constrained virtual machine to closely emulate the computational environment of a mobile phone. The system was implemented using C# running on .NET Compact Framework. Iris recognition system described here was tested using CASIA iris image database. The system run time was consistently under three seconds.

Recognition quality of biometric systems is usually described by the false-accept rate (FAR) and the false-reject rate (FRR). Receiver Operating Curve (ROC) shows the relationship between the ranges of different values of FAR and FRR depending on the level of the decision boundary that is used to discriminate between the authentic user and the impostor. Equal Error Rate (EER) is a general measure of a biometric system that indicates the equal values of both FAR and FRR at some level of the decision boundary. As shown in Figure 1, the tested system achieves EER of approximately 3.5%, which is comparable to EER values (e.g. 1.2% in [6]) reported in the literature describing other iris recognition systems for mobile devices.

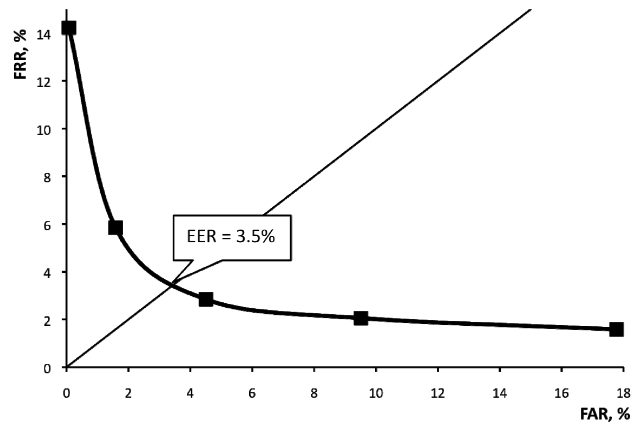

Figure 1. ROC curve showing EER.

Acknowledgements

The authors wish to thank Institute of Automation, Chinese Academy of Sciences for granting access to CASIA iris image database.

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