Aayushi International Interdisciplinary Research Journal (AIIRJ)

VOL- VIII	ISSUE- XII	DECEMBER	2021	PEER REVIEW e-JOURNAL	IMPACT FACTOR 7.149	ISSN 2349-638x

Post-mortem Iris Reorganization System using Support Vector Machine (SVM)

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Abstract

Iris recognition algorithms have recently been shown to be highly successful at recognising humans. Because of the rich iris texture, which gives robust criteria for identifying persons, iris identification systems have attracted a lot of interest among authentication methodologies. Despite this, there are a number of challenges in instances when recognition is unconstrained. In this paper, the researchers discuss the methodologies used in various stages of the iris image recognition system. The acquisition phase in which iris images are acquired, the preprocessing phase in which the iris image quality is improved, the segmentation phase in which the iris region is separated from the image background, the normalisation phase in which the segmented iris region is shaped into a rectangle, the feature extraction phase in which the features of the iris region are extracted, the feature extraction phase in which the features of the iris region are extracted, the feature extraction phase in which the features of the iris region are extracted,The classic technique to iris recognition, which employs Support Vector Machines, is also discussed in this article. This work may be seen as a first step in a broader iris recognition research project.

Keywords: Iris Reorganization System, Biometric System, Image Extraction, Image Acquisition, Support Vector Machine

1. Introduction

The term "biometric" refers to the process of identifying and verifying a person's identity based on their unique qualities or attributes [1]. Biometric systems incorporate physiological and behavioural factors. Physiological characteristics are a subset of biometrics that includes physiological and biological properties impacted by a biometric system. It contains, among other things, DNA, Hand, Face, Earlobe, and Iris. Behavioral characteristics are a subset of biometrics that deal with non-physiological or non-biological qualities impacted by a biometric system. The four categories are signature, voice, gait, and keystroke recognition [2].

Personal IDs are becoming more important to meet today's networked world's security demands. The two most common techniques for creating personal IDs are token-based approaches and knowledge-based methods. Token-based procedures utilise keys or ID cards for authentication, while knowledge-based methods use the user's predetermined code or password.

Conventional systems, on the other hand, become problematic if the token is misplaced or the password is forgotten, necessitating the development of new and more trustworthy methods for personal identification. The iris is one of the most dependable techniques of identifying individuals since it is stable and does not change during life. Furthermore, even for twins, finding two persons with identical iris features is challenging. The iris is a circular anatomical structure that resides between the cornea and the lens of the eye, as shown in Figure 1-1. The iris' role is to control the quantity of light that enters the pupil via the sphincter and dilator muscles, which control the size of the pupil. The usual iris diameter is between 11.6 mm and 12.0 mm, while the pupil size is between 10% and 80% of the iris diameter. The human iris is made up of two layers: the epithelial layer, which contains strong pigmentation cells, and the stroma layer, which contains blood vessels. It is in charge of reducing the size of the pupil. This layer is followed by the epithelial layer.

Iris identification is a method of identifying people based on the unique qualities of their iris. Iris recognition is a kind of biometric authentication [3], and the iris is commonly grey, blue, brown, or green in colour. In 1987, Flom and Safir proposed the first iris recognition concept. They showed a set of highly controlled and non-functional lighting settings for adjusting the illumination such that the pupil size is the same in all images for accurate Iris segmentation. They covered picture capture, preprocessing, iris segmentation, iris analysis, feature extraction, classification, and suitable image processing and pattern recognition methods, as well as image processing and pattern recognition techniques. All practical Iris recognition system methodologies [4] are based on this theoretical work on Iris recognition systems. The following are the six critical steps of a typical iris recognition system: [5]. The first phase is image acquisition, which entails taking many shots of the iris using cameras to ensure that the best images are obtained, allowing for more flexibility and identification. The second phase is picture preparation, which entails adjusting the image's size, colour, and brightness before segmentation.

Segmentation is the third phase, which entails identifying the iris and pupil borders, as well as eyelids and eyelashes. The fourth stage, normalisation, comprises changing the iris region into a rectangular shape. The final phase, feature extraction, extracts properties from the normalised iris image and encodes them into a recognisable design. An iris recognition system's classification stage compares the characteristics acquired by photographing the iris with database attributes.

The demand for greater information on post-mortem iris identification arose primarily for forensic and law enforcement purposes. The most common uses of post-mortem iris recognition are to identify unknown deceased people or to authenticate a decedent's identity. If an iris template for the individual had been previously enrolled, even if additional identifying qualities were absent, the person might be quickly recognised or authenticated. While Trokielewicz investigated the performance of post-mortem iris recognition, none of the studies involved autopsy procedures.

3. Previous research involves the use of an iris recognition system after death

3.1 Common notions and viewpoints

For a long time, both the scientific and industrial sectors have theorised that iris identification after a person's death is difficult or impossible. "Immediately after death, the pupil dilates substantially, and the cornea becomes obscured," said John Daugman, the "Father of Iris Recognition," in an interview with the BBC in 2001. While this allegation is moderate, others make far more forceful claims. "The iris (...) decays within a few minutes after death," according to Szczepanski et al. Commercial items also feature allusions to post-mortem iris identification, such as: (...) it is scientifically impossible to take someone's iris after death. After death, the iris relaxes completely, leaving a fully dilated pupil with no visible iris. The iris of a dead individual is just unusable!' [6], or 'after death, a person's iris features diminish along with pupil dilation.' [7]. However, none of these assertions are backed up by scientific data or testing.

3.2. Observational studies

Due to technical and ethical problems in acquiring biometric data from cadavers, only a few researchers have employed scientific methodologies to examine the post-mortem iris identification issue. Sansola [8] studied 43 individuals who had their irises scanned at different post-mortem time periods using an IriShield M2120U iris recognition camera and IriCore matching software. Depending on the post-mortem duration, the method generated 19-30% false non-matches and no false matches. She found a connection between eye colour and post-mortem comparison scores, with blue/gray eyes having a lower proportion of correct matches (59%) than brown or green/hazel eyes (82 percent). (a whopping 88%) Saripalle et al. [9] reported that irises decay slowly after being removed from the corpse and lose their biometric capabilities 6 to 8 hours after death using ex-vivo eyes of domestic pigs (2015).

Eye degeneration in ex-vivo, on the other hand, is expected to occur more quickly than while the eye is still linked to the body. Ross observed a fadeout of the pupillary and limbic borders, as well as corneal opacity, in post-mortem iris pictures from all of the samples tested.

After thereafter, the tests were broadened to a wider database [10], which included samples taken up to 17 days after death. A study of samples obtained up to 60 hours after death indicated that the top-performing IriCore technique may still provide

EER as low as 13%, suggesting that iris recognition may still be a viable identifying tool after all these years. A long-term analysis of all samples collected over a 17-day period, however, reveals that iris deterioration is rapid over such a long time horizon, and while correct matches can still be expected after these 17 days, they are rare and cannot be considered a reliable proof of one's identity after death. In this publication [11], we also published the first publicly available database of 1330 near-infrared and visible light post-mortem iris images from 17 cadavers.

Bolme et al. [11] wanted to monitor biometric capabilities of the face, fingerprint, and iris throughout human decomposition. Twelve participants were sent outdoors to examine how their biometric performance was affected by the environment and time. Despite the fact that fingerprints and faces are somewhat resistant to deterioration, the irises degraded rapidly regardless of temperature. Irises typically became useless from a recognition aspect after a few days of being exposed to outside settings, according to the researchers, and the appropriate verification rate was just 0.6 percent in their study when the corpses were kept outside for 14 days. According to the researchers, the chance of detecting an iris in real life is less than 0.1 percent. The most recent work in this area was reported by Sauerwein et al., who discovered that irises may be read for up to 34 days after death when cadavers are housed outdoors throughout the winter. Despite the fact that no iris recognition algorithms were used in this study, it suggests that low temperatures boost the chances of detecting an iris even in a body that has been left outside for a longer length of time.

4. Recommendations based on the literature study

The lack of data available to academics has limited previous studies' evaluations. Before 2016, there was no publicly available database of iris images acquired from deceased patients. Notably, none of these publications provide any suggestions for enhancing the resilience of iris biometrics to post-mortem changes in the human eye. As a consequence, the question of how to make iris recognition work reliably in these circumstances has remained unresolved. This research paper proposes the first of these strategies.

5. Design and Implementation

For the purpose of postmortem Iris Reorganization following architecture is used.

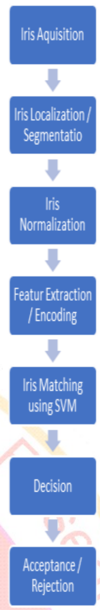

Fig. 1: Post-mortem Iris Reorganization System

5.1 Post-mortem Iris Acquisition

The "Warsaw-BioBase-Post-Mortem-Iris v3.0 and v4.0" dataset used by the Post-mortem Iris Detection System is a collection of data generated by Warsaw University of Technology and Medical University of Warsaw in Poland in collaboration. Photos of post-mortem irises taken in visible and near-infrared light are included in the dataset. The Dataset was created with the purpose of assisting researchers in their attempts to increase the accuracy of iris recognition for post-mortem samples. WUT owns the rights to the Dataset and is the only place where you may get this information.

5.2 Iris Localization / Segmentation

In the second stage of an iris identification system, the real iris region of a digital eye is separated. The technique of identifying an image that corresponds to an iris is known as iris localization. Two circles, one for the iris/sclera border and the other for the iris/pupil boundary, may be used to estimate the iris area. The top and bottom portions of the iris are usually obscured by the eyelids and lashes. Eyelids and eyelashes are eliminated from the detected iris image by treating them as noise since they impact the system's performance.

5.3 Iris normalization

To provide it specified dimensions and avoid visual disparities, the localised iris component is converted into a polar coordinates system. When the annular iris area is transformed into a rectangular region, the iris texture is examined. The Cartesian to Polar transform for the iris area is based on Daugman's Rubber Sheet model. The rubber sheet model takes into account pupil dilation and size characteristics. As a consequence, the iris is shown as a flexible rubber sheet placed in the centre of the pupil as a reference point.

A technique based on Daugman's rubber sheet model was employed to normalise iris regions in the proposed approach. Radial vectors pass across the iris region, using the pupil's centre as the reference point.

5.4 Feature Extraction and Coding

The iris' structure is fascinating since it holds a great deal of textural information. In order to accurately separate the individuals, the most distinguishing qualities found in the region must be extracted. Only the most crucial iris characteristics must be encoded. Feature extraction methods include wavelet encoding, Gabor filters, Log-Gabor filters, zero-crossings of the 1D wavelet, Haar wavelet, and Laplacian of Gaussian filters, to name a few. The suggested system used Masek's approach for feature encoding, which involved convolving the normalised iris pattern with 1D Log-Gabor wavelets.

5.5 Iris Matching using SVM

SVM (structural risk minimization) is a new learning machine technique based on the concept of structural risk reduction (minimizing classification error). A SVM is a binary classifier that effectively categorises data into two categories (Burges, 1998). There are two important factors to consider while developing SVM as a classifier. The first stage is to choose the optimal hyperplane for dividing the two classes, and the second is to transform a non-linearly separable classification problem into a linearly separable one.

6 Result and Conclusion

The SVM classification model is trained and tested for the four categories of the post-mortem iris images present in the dataset using Stratified K Fold Cross Validation where k is taken as 5. The data are given to the classification model with the help of Stratified k fold cross-validation, where the data is divided into training and testing.

	Accuracy	Precision	Recall
Split 1	93.3%	93.8%	95.4%
Split 2	95.2%	95.6%	96.5%
Split 3	93.5%	95.2%	92.1%
Split 4	97.3%	98%	96.5%
Split 5	96.2%	96.4%	93.6%
Average	95.1%	95.8%	94.7%

Table 1: Results Support Vector Machine

The validation results (Table 3) indicate better prediction results from SVM, with a prediction accuracy of 95% than from Random Forest 91%.

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