Analysis of Biometric Identification Methods for Classroom Attendance Monitoring

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Abstract: Digitization of records has resulted in newer techniques being developed every day. Biometric systems offer a secure and robust option to identify an individual's identity. This paper explores various biometric identification methods and tries to relate it to a live classroom environment. From the various methods available we have outlined advantages and disadvantages for a classroom application with a proposed solution.

Index Terms – **Biometric, Fingerprint, Face Recognition, Iris Scanning, Retina Scanning, Voice Recognition, Palm Mapping, Signature Matching, Microcontroller**

I. INTRODUCTION

A recent increase in the need for digitization of many forms of records has kicked off an innovation race to implement new and better systems to record and digitize records. Out of the many new innovations, some of the new forms are biometric ones. The biometric identification of a person has proved to be one of the most fool proof methods of identifying an individual. Biometrics is a generic term for features that relate to an individual and seem unique.

The recent biometric boom has been made popular due to increase in handheld devices supporting various features like fingerprint sensors and face recognition. A need for more secure and accurate ways to log in to our own personal devices has made this scenario possible. The increase in biometric authentication and identification has been used by human resource managers to accurately map the efficiency and timelines laid out by the organizations with the use of fingerprint attendance systems or access key cards.

II. BIOMETRIC IDENTIFICATION

Biometric identification is the process of accurately registering, mapping and recognizing the unique features on an individual. Some of the most popular biometric identification techniques are:

1) Fingerprint
2) Face recognition
3) Voice recognition
4) Retina scanning
5) Iris scanning
6) Palm mapping
7) Signature analysis

The above given techniques might seem different but in essence, every technique follows the same procedures to register and analyze the given individual.
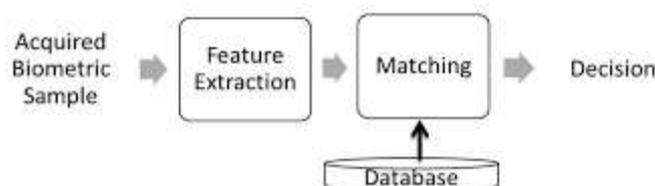

Figure 1: A Typical Biometric System

The acquired biometric sample may vary from your typical fingerprint to the pattern of presssure and strokes on the signature of an individual. The feature extraction part of things includes mapping of various features like the minutiae of a finger or even the tonal and pitch analysis of a sound. Mathcing and decision making is purely based on how robust your mapping and feature extraction has been done in the initial biometric registration stages.

III. THE APPLICATION

As students, one of the major metrics to gauge one's progress can be the individual's attendance in the given course. Marking and mapping attendance in form of paper has often resulted in erroneous figures from both ends, the teachers and students as well. To tackle this issue, we can introduce biometric systems to ensure minimum mistakes are made and accurate reports can be generated. Biometric systems introduce a certain degree of accuracy and certainty that traditional systems cannot offer. These advantages do come at a cost, but selecting an implementation method that suits your purpose best is what makes a biometric identification system successful.

IV. ANALYSIS OF METHODS

1) Fingerprint:

Fingerprint is one of the most unique identity a person can have. This makes this one of the most unique and accurate methods. Traditional methods were the ink and paper approach where the ink make a fingerprint on the paper to be scanned for digital use. This system has been taken over by optical scanners which enable extracting and mapping fingerprint templates on the device itself.

Figure 2: Fingerprint Template

2) Face Recognition:

Face recognition is an application of the upcoming computer vision domain. Face recognition is an application that involves many tasks of image processing and image correction. The base features to be considered for mapping are the face symmetry, the edges of the face, jaw line length and position, the position and size of the forehead, the position of the eyes, nose and ears, etc. Various implementations of face recognition algorithms have been done but the most simple one is the Eigenface algorithm, where Eigen vectors of the facial features that are extracted are used to map and model one's biometric identity.
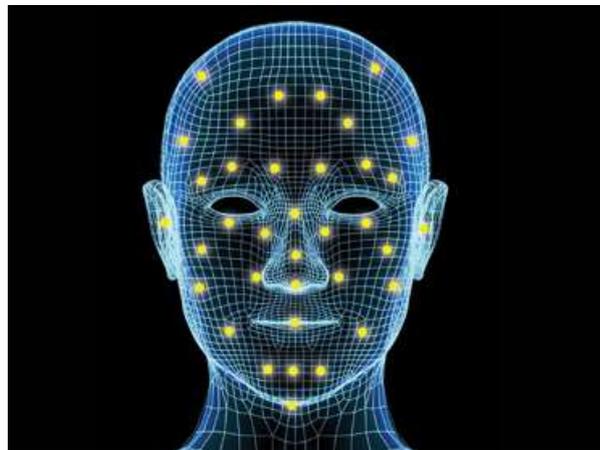

Figure 3: Face Recognition

3) Voice Recognition:

Voice is a typical physiological trait that always varies from person to person. Every person has their own pitch, tone and voice frequency that is unique to their own. This degree of uniqueness can be mapped and used for biometric systems. Existing systems include voice assistants like Alexa by Amazon. The behavioral changes in an individual can potentially change the entire voice template all together.

Figure 4: Voice Template

4) Retina Scanning:

Retina is a part of the eye that actually enables vision in an individual. The complex mesh of blood vessels is responsible for creating images and is unique, just like fingerprints. Retina scanners maps the retina by using a low intensity coherent light source. Faking retinal biometric is almost impossible as it is not possible to recreate a human eye. This makes retinal scanning one of the most secure methods to biometric identification.
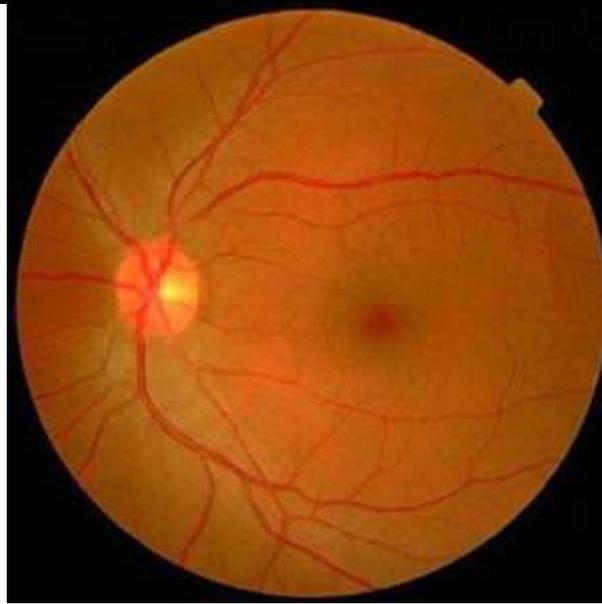
Figure 5: Retina Scan

5) Iris Scanning:

Iris is that part of the eye that controls the pupils and the amount of light that reaches the retina. Iris patterns are unique to each human but can be overcome with the use of lens. The iris scanning is done by a gray scale camera, typically 10-50 cms away. This camera maps the various features of the iris, that is rings, freckles, pits, furrows, etc. The camera calculates the Hamming distance between the model saved and the eye that is scanned. The model which has the least Hamming distance is selected to be the biometric identity of the individual.

Figure 6: Iris

6) Palm mapping:

An important assumption that is taken into consideration for this technique is that every person's hands are shaped differently. Estimation of length, width, thickness and surface area of hand is done in this technique. The aforementioned measurements are used to make a 3D model of the hand that is the mapped hand of a biometric identity of a person. Palm mapping requires some image processing to process the given hand for features.

Figure 7: Palm Mapping

7) Signature Analysis:

A signature can be said to be the mark of an individual since old times. A signature is unique to a person in the sense of number of strokes and the pressure patterns they make. Even if a signature is given, faking a signature pattern is quite difficult with nothing more given. A tablet with a capacitive touch screen and a special pen can be used to make such a system. The only drawback of this system is that the accuracy and cost might be lower than expected for all users. Also, the use of such system is not different from the pen and paper system.
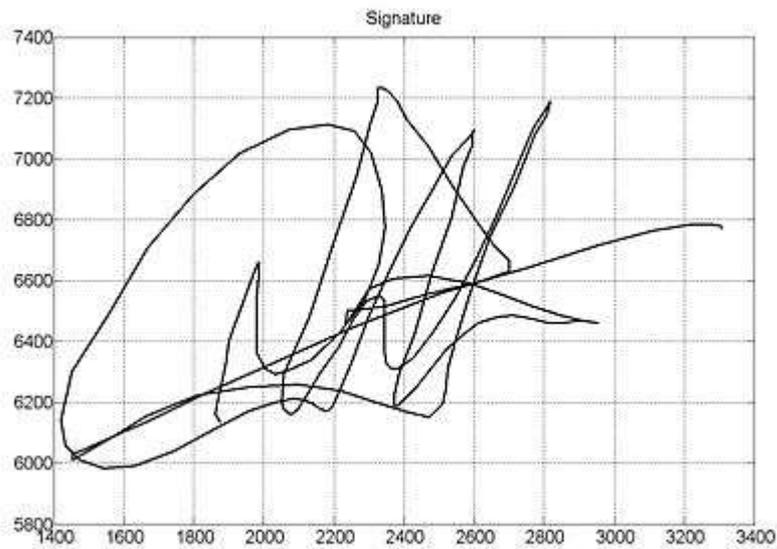

Figure 8: Signature Matching

The above methods can be summarized as follows:

Type/Parameter	Portability	Efficiency	Cost Effectiveness	Versatility	Security
Fingerprint	H	H	M	H	H
Face Recognition	H	M	M	H	M
Iris Scanning	L	H	L	M	M
Retina Scanning	L	H	L	M	H
Voice Recognition	H	L	H	H	L
Palm Mapping	L	M	L	M	M
Signature Analysis	L	M	M	L	L

V. PROPOSED SYSTEM

The basic issues regarding the application of attendance monitoring are practical application issues such as product cost and implementation details. Factors like acceptability and ease of use also come into picture as the end users need not be well versed with technology to use a proposed biometric system. Considering all the above-mentioned factors, the use of fingerprint impressions seem to be the most viable technique to implement biometric identification in a classroom environment.

This application can be developed by the use of a portable device which can be used as an attendance register with fingerprints serving as placeholders for signatures. This portable device can be made using any generic microcontroller and any fingerprint sensor mounted on it. The purpose of using microcontroller along with the fingerprint sensor is to make the system highly portable as well as cost efficient and easy to use.

This portable device can be used to register/enroll fingerprints into the system for the respective candidates. This device is then used to mark and track attendance for the respective candidates. Interfacing of the portable device with a web application can be made possible, thus making the management easier as well as the system user friendly.

VI. RESULTS

The study and analysis of various biometric identification techniques has bought to light the robust use of fingerprint matching for classroom environments. The use of such systems would result in easier record management of students in an educational institution along with automated report generation. Also use of such techniques in a live environment will reduce additional time and efforts required by the management.

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