Integrating Height and Fingerprint for Automated Personal Authentication

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Abstract
Person authentication using height and fingerprint is a rare and new combination in biometric authentication system. In this paper, height detection, height classification and fingerprint matching are carried out using appropriate algorithms.Usage of more than one primary biometric trait like fingerprint, iris, hand-geometry etc. produce higher recognition accuracy, but it is time consuming and requires costly equipment as well as complex algorithms to capture the biometric traits. To eliminate this problem, we are using a new multimodal biometric system that combines both primary biometric trait and soft biometric trait .Here we are giving prime preference to the soft biometry as a tool for personal identification. The experimental results, the ROC and CMC curves demonstrate the effectiveness of the proposed method; especially in large amount of images. The accuracy of 99% with no rejection is achieved, when tested on 320 fingerprint images and the experiment result shows that the method is reliable for secured personal authentication.

General Terms

Pattern Recognition.

Keywords

Height detection, Height classification, Fingerprint processing, Soft biometrics.

1.Introduction

Multimodal biometric systems have received much attention in recent literature. Soft biometric attributes help in indexing large biometric databases by limiting the number of entries to be searched in the database[5]. An automated technique to estimate soft biometric characteristics is an ongoing area of research and is likely to benefit law enforcement and border control biometric applications.

Soft biometric traits like gender, age, height, weight, ethnicity, and eye color cannot provide reliable user recognition because they are not distinctive and permanent.[4] However, such ancillary information can complement the identity information provided by the primary biometric traits (face, fingerprint, hand-geometry, iris, etc.)[2, 3]. This work describes a hybrid biometric system that uses fingerprint as the primary characteristic and height as the soft characteristic.

Jain et. al. used a method in[4], which didn't notice the fact that height of person won't change after a particular age. Hence height of a person can be considered as a non-varying quantity. Medical Science suggests that[14,15,16], human height can be considered as a unique feature for person authentication. This is because after a particular age, that is after 20 years a person's height wouldn't change, unless severe born deformation occurs and that is very rare. For accuracy we also consider that height may change with his/her shoe length, which is also not considered by Jain et.al[4]. So in this height classification based biometric authentication, different personalities are classified on the basis of their height. Fingerprints are assigned to the respective height class. Although fingerprints possess much discriminatory information, and significant progress in automating the verification process has been made, reliable automatic fingerprint verification is still a challenging problem. Here we have used fingerprint matching by extracting GLCM based feature extraction[1].

The validity of newly derived algorithms are tested on fingerprint images and height of a set of selected persons. The method significantly reduces the memory cost and processing time associated with verification, primarily because of the efficient use of soft biometric trait with primary biometric trait. The idea behind the paper is to throw light on the authenticity of height and thereby depict the efficient implementation of soft biometric trait-Height of a person- for biometric authentication. To the best of our knowledge, no one has attempted to implement this combination by giving higher weights to soft biometric trait-height of a person. Experiments conducted at two different workplaces show that the recognition performance of the primary biometric system can be improved significantly by making use of soft biometric information. The results also indicate that such a performance improvement can be achieved only if the soft biometric traits are complementary to the primary biometric traits. This paper is organized as follows: Section 2 describes the system design including height detection and classification, Section 3 describes the proposed method. Section 4 gives experimental results and Section 5 draws a conclusion.

2.System Design

The system consists of a soft biometric verification procedure which measures the height of a person using IR sensor, implementation of the height classification

algorithm and the significance of height as a tool for personal authentication. This section also utilizes a primary biometric verification system which extracts certain special characteristics of a fingerprint by using GLCM features[1] which is depicted in fingerprint processing part 2.5.

2.1.Height detection using IR distance sensor with Arduino

Electronics in multidisciplinary projects can be more easily accessible by a single-board microcontroller Arduino[11].Arduino, an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software, is used in the proposed system. Infrared proximity sensor SharpGP2Y0A21YK is a wide-angle distance measuring sensor, which can calculate the distance from object in the range of 10- 80 centimeters, is used for height measurement[9].GP2Y0A21YK is, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. They can have greater accuracy than ultrasonic sensors; though with a smaller range (a range of 10 cm to 1 m or 2 m is typical for IR sensors).For this work, the IR sensor is fixed at a door length above 203cm(6.7 feet). The sensor outputs an analog voltage corresponding to the distance that varies from roughly 2.8V at 10cm to 0.4V at 80cm. This value would be read by the Arduino using the analogRead() function. The data sheet shows a graph of Volts to Distance -the greater the voltage the shorter the distance.

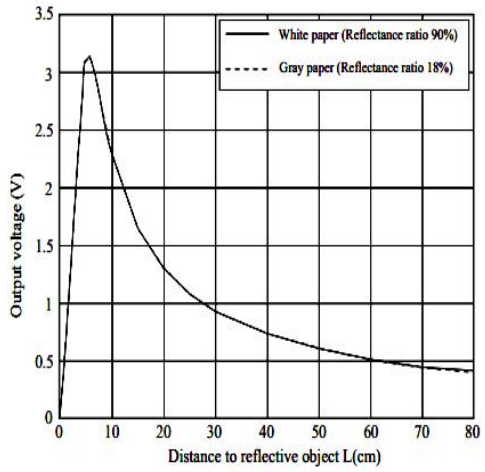

Figure1. Example of distance measuring characteristics(output)[9].

In the data sheet one can see a graph of Volts to Distance and greater the voltage shorter the distance. Hence, to measure distance one need to measure the voltage change as the distance changes. While using the analog pins it converts whatever arbitrary analog value supplied to a byte value which is between 0 and 1023 (1024 variations)[12].This converted value is of no use to us, so we need to convert this value back to the true analog value. For conversion, we take the voltage rating of the power supply and divide by 1024 to give us a value per step. So for instance:

5v/1024 = 0.0048828125

We take this value and multiply by what the sensor sends back to get our voltage reading. The next stage is to work out an equation from the graph on the data sheet to get the theoretical distance from the voltage reading. If we look at the graph between 5 and 80cm, you can see that it's exponential. For the exponential change we have to turn our value now into an exponent, a fancy way of saying x to the power of y. So our formula for distance from voltage reading is now like: a*x^y. First work out the distance ratio from the graph and then try changing the exponential until you get accurate results.

The equation newly derived for calculating distance is as follows :-

dist=(27.08*(e.analogRead(0)*(5/1024))^- 1.171);

ht=203-dist; ht=ht/30.48 .

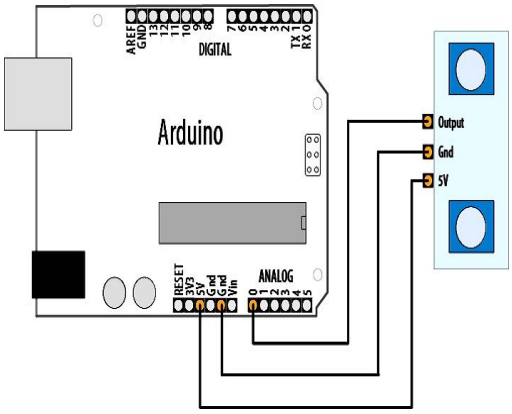

Figure 2. Connecting the Sharp IR distance sensor with Arduino

In this low cost multimodal identification system, the first part is the identification of the height class. In this work, we use Hamster IV Secugen Fingerprint scanner to capture fingerprint images.

2.2 Hamster IV Secugen fingerprint Scanner

SecuGen Hamster IV is the FBI and STQC Certified addition to SecuGen's popular and versatile fingerprint reader product line[13].

Packaged in a comfortable, ergonomic design, Hamster IV features the industry's most rugged and advanced optical sensor using patented SEIR fingerprint biometric technology.Auto-On™ is an Automatic Finger Placement Detection technology that automatically checks for the presence of a finger. When used with Auto-On-compatible software, the Hamster IV will turn on and scan your finger as soon as you touch the sensor - all without

having to prompt the system. Smart Capture™ ensures quality fingerprint scanning of difficult fingers. By automatically adjusting the brightness of the sensor, Smart Capture allows the Hamster IV to capture high quality fingerprints from a wide range of traditionally difficult fingers, including those from dry, wet, scarred or aged skin, and even in bright ambient conditions such as under direct sunlight.

Figure 3. Hamster IV Secugen Fingerprint Scanner

2.3 Height Classification Technique

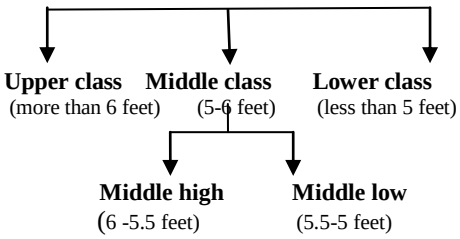

Figure 4. Height classes

Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals. The proposed method classifies the individuals based on different classes of height. The classification includes three major classes and two subclasses as shown in figure 4.Individuals are classified on this basis, where they are grouped into the respective class of height. Further identification process will make use of this class of an individual for the purpose of authentication. The algorithm which is used for height classification is as follows:

1. Compute the height using Arduino board and IR sensor.
2. Classify the height into respective class

A) If height is less than 5 feet then, Put the respected person into Lower class.

B) If height is less than or equal to 5.5 feet & greater than or equal to 5 feet then, Put the respected person into Middle Low class.

C) If height is less than or equal to 6 feet & greater than 5.5 feet then, Put the respected person into Middle High class.

D) If height is greater than 6 feet , then Put the respected person into Upper class.

2.4. Significance of Height in personal authentication process

This paper mainly focuses on the importance of height in the personal authentication system. The height is a soft biometry and which is a varying quantity. Jain et.al. also considering height as a varying quantity. But in this multimodal system we are considering the height as a non-varying quantity. That is one of main feature which is making difference from other multimodal biometric systems. With the support of Medical Science[14,15,16], here we are considering that after a particular age the height of a person does not vary. According to this concept the work is going on. The idea behind the work is to reduce the matching time by integrating one of the soft biometric features in least cost. That is, by using the height range stored, fingerprints are classified into High class, Low class, Middle High class and Middle Low class. By classifying the fingerprints to these classes the time needed for verification is reduced.

The main idea is that, to identify one person, we only required to search in the corresponding height class, thus eliminate the search time and feature extraction time .

2.5 Fingerprint Processing

In this part, we have improved the efficiency of fingerprint matching by combining GLCM based feature extraction with Euclidean based matching[1]. First, the fingerprint image is pre-processed and a unique reference point is determined to secure a Region-of- Interest (ROI). A feature vector consisting of 16 features are used to match the input image with different types of images stored in the database.Multiple GLCMs are computed for values of θ at 0◦, 45◦ , 90◦ , and 135◦. Based on each computed GLCM, four features that can successfully characterize the statistical behavior of a co-occurrence matrix are extracted. Matching of the fingerprint image is performed based on the minimum Euclidean distance between the input feature vector and the template feature vector [4].The working of fingerprint processing is depicted in figure.5(a) &5(b).The fingerprint matching is based on the Euclidean distance between the two corresponding fingerprints and hence is extremely fast. As the need of calculating the GLCM features and Euclidean distance for the entire fingerprint images in the database is eliminated by the use of height classifier, the computation time required for authentication is reduced to a further extent.

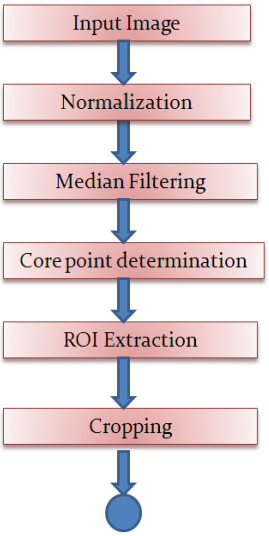

Figure 5(a).GLCM based fingerprint processing

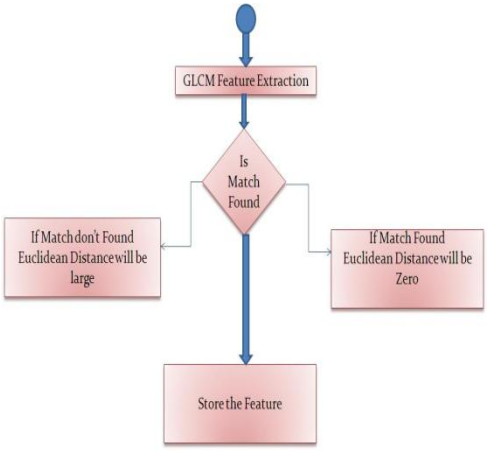

Figure 5(b).GLCM based fingerprint Processing.

3.Proposed Method

The proposed method deals with the inclusion of Arduino design board with distance sensor for height detection, a classification system for height followed by fingerprint matching algorithm for person authentication.

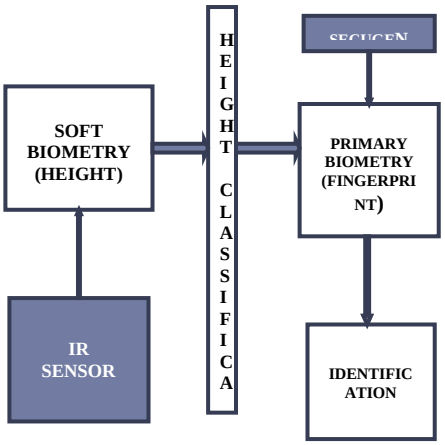

Figure 6. The proposed system

4.Experimental Results

Figure 7 shows that integration of soft biometrics with primary biometry can improve the performance of the authentication process. In [4] soft biometrics are taken as varying quantities. But by implimenting the proposed method we got very good results than the previous works. The results are explained with three CMC curves, where CMC1 obtained when height is considered as a non-varying quantity and feature extraction and matching of fingerprint is conducted first. CMC2 shows the graph, where height is taken as a non-varying quntity and considering height and fingerprint simultaniously. CMC3 provides the best result, where height is considered as a non-varying quantity and taking height at first which is evident from figure 8 .

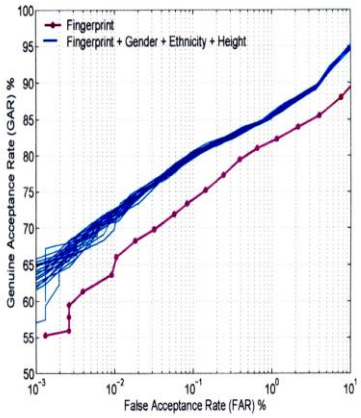

Figure7.ROC curve by taking height, gender, ethnicity as varying quantity[4] with fingerprint.

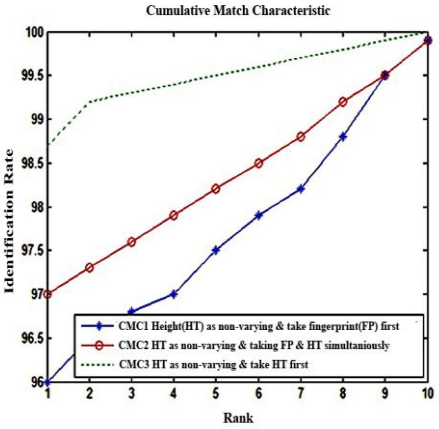

Figure.8. Improvement in identification performance of a fingerprint system when using height as a non-varying soft biometric trait.

4.1. Implication of the Study

This work is an exposition of the multimodal biometric person authentication system. The main scope of this work is applicable in Indian Fingerprint Bureaus where the fingerprint experts, even in this digital world, spend much time in searching and indexing the fingerprints of the actual convicts. In Indian police stations, the officials record the fingerprints of convicts while the DA Slip (Daily Arrest) are made. Now, by applying the proposed height detection technique, one can easily measure the height of a convict also from the crime site. By taking the height of a person as a soft biometric trait, the fingerprint experts can quickly find out the height

class he belongs and hence the fingerprint matching can be made easily.

5. Conclusion

Multi biometric systems are expected to enhance the recognition accuracy of a personal authentication system by reconciling the evidence presented by multiple sources of information. Using a combination of biometric identifiers like face, fingerprint, hand-geometry and iris makes the resulting multi biometric system more robust to noise and can alleviate problems such as non-universality and lack of distinctiveness, thereby reducing the error rates significantly. However, using multiple traits will increase the enrollment and verification times, cause more inconvenience to the users and increase the overall cost of the system. Therefore, here we proposed another solution to reduce the error rates of the biometric system without causing any additional inconvenience to the users.

The future scope of this paper is to identify a person more accurately and easily. By using one or more traits, the recognition rate can increase. One more trait which is used for identification may be a soft biometric or another primary biometric. The experiment shows that integrating fingerprint and height classifiers can be effectively used as a base for person authentication.

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