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A Demonstration of Multimodal Biometrics: Fingerprint and Signature Recognition

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Abstract*— In Biometric System, features of modalitieslike fingerprint, signature etc. are extracted using various techniques for identification purposes. To enhance more security and reliability, a new technology was introduced as combination of two or more biometrics is called Multimodal BiometricSystem [8] such as Face & Voice, Signature & Fingerprint and many more [1]. Unimodal Biometrics are those which contain only single biometric trait, usually suffer from problems like hacking or imposters' attack, noisy data, intra-class variations, restricted degrees of freedom, non-universality, spoof. Hence, they just rely on the proof of a single source of information for authentication as single fingerprint or face. So these limitations can be addressed by deploying multimodal biometric systems. So to attain the quality of authenticationwe have discussed the fusion of dynamic fingerprint and static signature at feature level.

Keywords*— Multimodal Biometrics, Unimodal Biometrics, SIFT, SURF, FAST, VPP/HPP, Fusion, Fingerprint Recognition, Offline Signature Recognition, Feature level fusion.

I. INTRODUCTION

As in today's era person's requirements increases day by day, he has to remember lots of pin codes, tokens, account numbers, passwords and other security codes for authentication [11]. And more important to identity of a person is becoming critical in our interconnected society. Questions like "Is this person authorized to use this facility?" are routinely being used in a variety of systems ranging from issuing software's license to gaining entry into a country, attendance system in various departments etc [4]. We are discussing about the fingerprint recognition and offline-signature recognition. Properties that make fingerprint popular are its wide acceptability in public, ease in collecting the fingerprint data and long time stability [11].
Biometric recognition of a person based on two types [10]:

A. Anatomical Biometrics

Anatomical characteristics are related to the body of the person. The traits that has been used the longest are fingerprints [6], hand geometry, iris recognition, other examples are face recognition, ear recognition.

B. Behavioral Biometrics

Behavioral characteristics are related to thebehavior of a person. It identifies the patterns of human activities. The first widely used behavioral characteristic is the signature that may be online or offline.

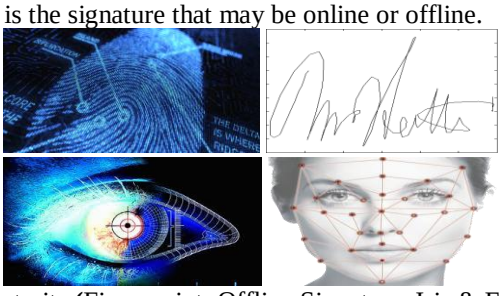

Fig 1: Biometrics traits **(**Fingerprint, Offline Signature, Iris & Face Recognition)

Advantages of Multimodal system over Unimodal system are:-

- It improves the recognition performance in terms of accuracy by improving deterring spoof attacks, population coverage, reducing the failure-to- enroll rate, increasing the degrees of freedom.
- The unimodal biometric gives a single biometric trait to identify the user but any problem may happen with that single biometric Somultimodal biometric system provides more than one trait which overcomes this issue.
- It provides less vulnerability and more security than unimodal biometric.
- As multimodal biometric systems are more accurate, reliable, have larger security options, these systems are more widely accepted in many countries that cover large to larger deployments.

II. PROCESSING UNDER BIOMETRIC DETECTION

A. Biometric Sensor

In order for a biometric measurement to be used for authentication, a specialized piece of hardware must be in place to scan a user's body part, known as biometric sensor. Which is used to extract the features fromdigital image of the fingerprint pattern. For exampleWatson Mini sensor is used for fingerprint recognition [12].

B. Preprocessing

Pre-processing enhances the quality and produces an image in which minutiae can be detected correctly.

C. Feature Extractor

When input data to an algorithm is too large to be processed and it is suspected to be redundant then it can be transformed into a reduced set of features. This process is called feature extraction [12].

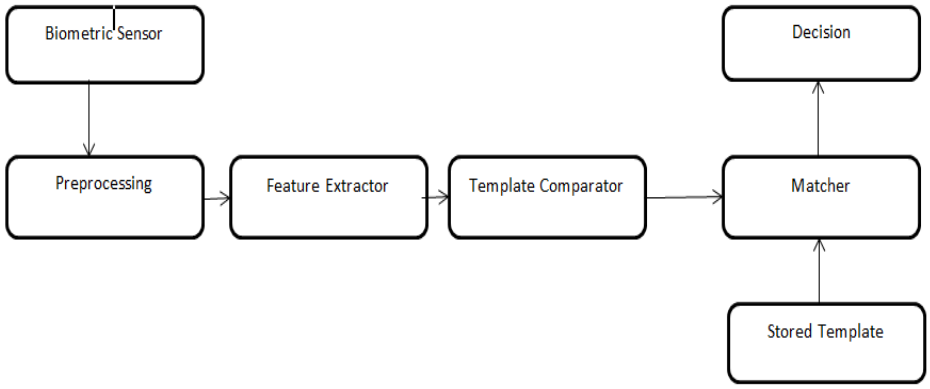

Fig 2: Block diagram of Biometric Detection System[1]

D. Stored Template

The templates, afterfeature extraction are stored in the database and used to authenticate the person in future.

E. Template Comparator

It this step the extracted templates are compared with stored templates.

F. Matcher

In this step the matching is checked that extracted features match with stored features or not.

G. Decision

If the features match then the person is valid for service otherwise he is not valid user for service.

III. FINGERPRINT RECOGNITION

Nowadays, fingerprint recognition is one of the most important biometric technologies based on fingerprint uniqueness [15], endurance and ease of acquisition.The most widely used techniqueof biometric recognition is fingerprint [3]. Even twins have different fingerprints' patterns, loops, lines, whorls, arcs [13]. A fingerprint sensor is an electronic device used to extract features with a digital image of the fingerprint pattern. The digital captured image is called a live scan. This live scan is digitally preprocessed to create a biometric template (using different techniques) that is stored and used for matching.As there are many techniques are used for fingerprint recognition like SIFT, SURF, FAST etc. Although SURF and FAST have good speed in feature extractions but SIFT extracts much number of features than SURF and FAST [9]. So at the time of comparison there would be many features to compare. So it gives better valid result than SURF and FAST. So here, SIFT technique is suggested for fingerprint recognition.

SIFT (Scale-invariant feature transform) Technique:

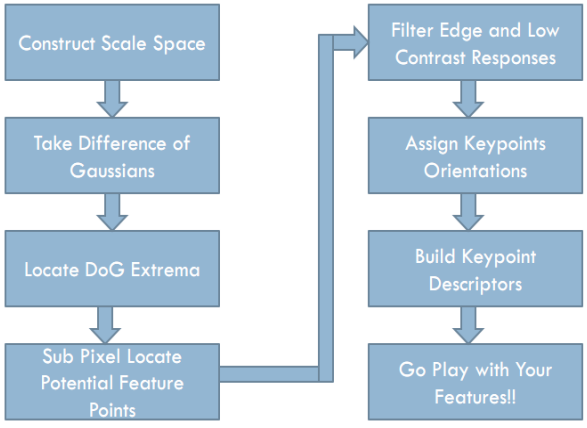

Fig 3: Algorithm for Fingerprint Recognition[9]

A. Why SIFT is preferable

- Due to its strong matching ability, SIFT has many applications in different fields, such as image retrieval, image stitching, and machine vision.
- Variants of SIFT such as DoG accurate, stable, scalable and rotational invariance are approaching.

IV. OFFLINE SIGNATURE RECOGNITION

Signature has been used the most even from the ancient times. In banks, schools or even in entrance exams signature recognition is required.Signature recognition is the process of verifying a writer's identity by checking the signature with previously stored samples in the database [5]. Signatures are of two type Online & offline. Online signature need electronic device to capture it so Online signature recognition is possible only if we have electronic device like digital Biometric Tablet Offline signatures don't need any electronic device. So using offline signature is cost effective and easy to implement. As there are many techniques used for offline signature recognition like MFCC, WOCOR. But for signature recognition VPP/HPP is much better than MFCC and WOCOR [7]. VPP/HPP(Vertical Projection Profiles/Horizontal Projection Profiles) algorithm:

- Split the image with vertical/horizontal line at the middle of image to obtain left/right & top/bottom parts of an image.
- Find geometric centers from left/right & top/bottom parts of image.
- Split left/top part with vertical/horizontal line & find geometric points for respective portions.
- Split right/bottom part with horizontal/vertical line & find geometric points for respective portions.
- Geometric centers are stored as extracted feature vector.

A. Why VPP/HPP is better

- The offline handwritten signatures are acceptablefrom scanned images of any formats like jpg, png etc. in image file using VPP/HPP [2].
- It gives us 255 feature pointsfrom a fingerprint & shows 100% accuracy in results[2].

V. FUSION

Two or more biometrics are combined then there must be some technique to combine them, so fusion is used to combine them. Fusion is the process to combine the extracted feature vectors corresponding to modalities using different ways. For example, fusion of audio video features for call taken for interview of any person for job is more effective in detecting the person thatwould otherwise not be possible by using a single medium. Feature vectors of two traits are merged using various techniques like sum, max, min, mean and others. Here, we are using **sum rule** to add up feature vectors.

Levels of fusion: One of the earliest considerations is to decide what strategy to follow when fusing multiple modalities. The most widely used technique is feature level. The other approaches are decision level, matching score level which fuse multiple modalities in the defined space. A combination of decision level and feature level is also known as the hybrid fusion technique [14].

A. Sum technique is preferable

- It is easy to implement, understand & faster as compare to others.

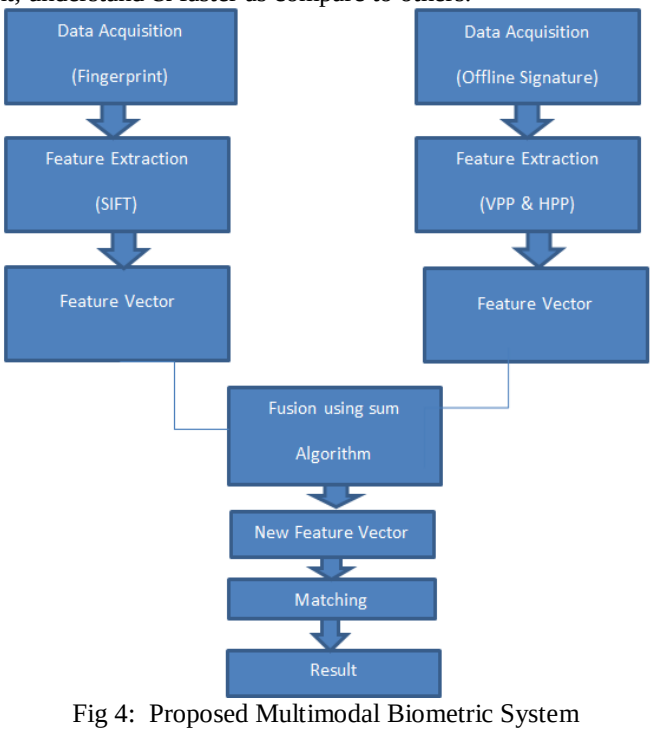

Fig 4: Proposed Multimodal Biometric System

B. Fusion at the data or feature level

- Fusion at the feature level is better than other levels because more number of features are extracted at this level. It also extracts all the minor & basic kind of features before the matching process.
- The feature level fusion is good in that it can manage the connection between multiple features from different modalities at any early age, which helps in better achievements.

VI. CONCLUSION

This paper provides an overview of multiple features based biometric systems, including both physiological characteristics and behavioral characteristics. In this proposed system a multimodal approach is put forward using fingerprint and offline signature traits. Here, SIFT features are analyzed best for fingerprint & VPP/HPP features are suggested for offline signature. Then extracted feature vectors are fused using sum rule at feature level. By combining multiple biometrics these increase population coverage, improve matching performance, deter spoofing, and facilitate indexing. Multimodal system brings systematically a clear improvement of the results in comparison to either modality used alone.

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