

Design of Multi-Biometrics for Fake Fingerprint Detection through Body Odor



Pratharan Sai Rupak Reddy, Nimmoju Arun Kumar Chary, Kiran Jeedi

Abstract: This work proposes the modernistic multi-biometric recognition system for detecting artificial fingerprints and new biometric recognition system to use it in some real-time scenarios. In the recent studies of multi-biometrics, the usage of fingerprint and body odor recognition system stays untouched. This proposed design of a multi-biometric system includes a body odor recognition system along with a fingerprint recognition system that will improve the results in terms of accuracy. The reason behind proposing this model is to detect artificial fingerprints by differentiating the odor of human skin from other materials that are employed in the preparation of artificial fingerprints. This multi-biometric system can be used in forensic labs to identify criminals and to improve the standards of security in authentication of an individual. This multi-biometric system will completely eradicate the use of fake fingerprints and this proposed work will make a remarkable place in real-time applications and the history of multi-biometric systems.

Keywords: fingerprint, body odor, multi-biometrics, recognition system, biometrics, e-nose, fingerprint spoofing.

I. INTRODUCTION

Biometrics is the term which states that human characteristics are considered as a form of identification and access control. Every human has characteristics that are unique and specific. Based on the recognizable and verifiable data, Biometrics allows a person to be identified and authenticated. Biometric authentication is put to use as it links his or her claims of recognition and authorization with a particular application. The biometric technology invigorated the level of security in various fields. Various physiological features face; fingerprints, hand geometry, iris, DNA and some of the behavioural characteristics are keystroke, signature, and voice. The fingerprint recognition system is one of the most used human recognition systems due to its uniqueness and reliability. Some attributes like persistence, distinctiveness,

high confidence matching rates and ease of acquisition are the primary reasons for the domination of the fingerprint recognition system in the biometrics market. It was believed that the authentication using the fingerprint was fool proof. Concomitantly, some recent studies have shown that most of the devices which are used for fingerprint recognition can be fooled by using a three-dimensional mold or by making fake fingerprints with the help of different mediums (such as gelatine and glue impression).



Figure 1: a)Original fingerprint b)Fake fingerprint with different a medium.

The ridges are exactly reproduced on the fake fingerprint which makes the deceased fingerprint to defeat the various fingerprint scanners available in the market. It is not an easy task to manufacture an artificial fingerprint unless the finger owner cooperates. Production of latent fingerprints with an adequate quality clone is quite difficult, in any case, a sufficient solution for prevention must be provided. To date, many approaches were referred for the enhancement of liveness in fingerprint detection but those approaches couldn't bring meticulous results. Some studies described the approach of adding extra hardware features like blood pressure, body temperature, pulse oximetry and perception of the skin and even these methods couldn't bring better results. This work suggests that the detection of fake fingerprint can be done with the help of the body odor and how odor analysis helps detect the liveness of fingerprint.

II. E-NOSE

An E-nose is a device that is used to detect the odor by identifying the specific chemical components of that odor. E-nose is capable of identifying different odors with the help of an array of electronic sensors. It can also recognize the pattern of odor with the help of the neural network. Simply, E-nose can be defined as an electrical nose that resembles the work of a human nose. E-nose identifies the odor of every individual by a volatile organic compound called odorants which are found in the human body. E-nose uses many sensors like metal-oxide semiconductors-MOS, Quartz crystal microbalance MOSFET, surface acoustic wave, conducting polymers, piezoelectric sensors.

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Reactions of all these sensors are combined and final results are obtained based on the odor reaction to the sensors e-nose recognizes the odor, based on the changes in Electrical properties like fluctuations in voltage and changes in chemical properties when the odor gets reacted with different polymers.[1]

This E-nose is employed in various fields like Alcoholic measure, drug detection, NASA Space application, medical diagnosis and also used for quality test of food productions.

A. Process of Odor Acquisition:

Electrical Nose recognizes the odor in several steps such as:

- *Acquisition:* In this method, when an object is placed near the sensors the air in that particular environment is inhaled and transferred to an array of sensors.
- *Detection:* Various reactions occur with chemical sensors and identification occurs through artificial neural networks. Different features like electrical properties, chemical properties, and organic compounds detection are extracted from the odor to detect it.
- *Storage:* The Extracted features are formatted into a pattern and the recognized pattern is stored in a database.
- *Testing:* In testing, the odor which is acquired from the object is extracted and detected. This detected odor is matched with the existing data in the database.
- *Delivery:* After all the processes, the outcome will be processed into a signal. The signal can be in any form which is used notifying us.[2]

The reason behind discussing in detail is that not the same e-nose will be used but the functionality of e-nose will be applied in the proposed model.

III. FINGERPRINT AUTHENTICATION WITH ODOR ANALYSIS:

Working Principle of Proposed Model:

In some recent studies, either Fingerprint recognition or Body Odor recognition was taken as a Biometric authentication System.[3] But those were not able to bring effective results. To improve the accuracy and to take measures to detect a fake fingerprint, we are going to propose a method of Fingerprint Authentication along with Odor Analysis.

The methods of spoofing a fingerprint have been increasing day-by-day. So, this scenario demands an increase in the uniqueness of a fingerprint. There were many recent approaches to increase the liveness by various factors but they couldn't bring appreciable results. One factor i.e. body odor which brings uniqueness as body odor is a unique characteristic present in every human being. So, a biometric authentication system with both fingerprint and finger odor will bring more effective results. Nowadays, fingerprints can be spoofed using different mediums like silicone, gelatine, and latex [4]. The impressions on a fingerprint can be made on the mediums using wax with no difficulty. Then any person can be authenticated by the fingerprint scanner with the help of those mediums. This is called as Fingerprint Spoofing.

The disadvantage of a fingerprint scanner is that it cannot detect those silicones, gelatine, and rubber latex mediums. The characteristic which is used to identify those mediums is their odor. So, the introduction of odor detection with fingerprint recognition will give a solution to the above-discussed problem. The only device which is present in the market to detect and identify any smell is Electrical Nose. If the working principle of E-nose is combined with the working principle of the fingerprint scanner, then both odor and fingerprint will become the main characteristics in the case of biometrics. If a person wants to get identified and authenticated then both the characteristics have to match with the data in the database.

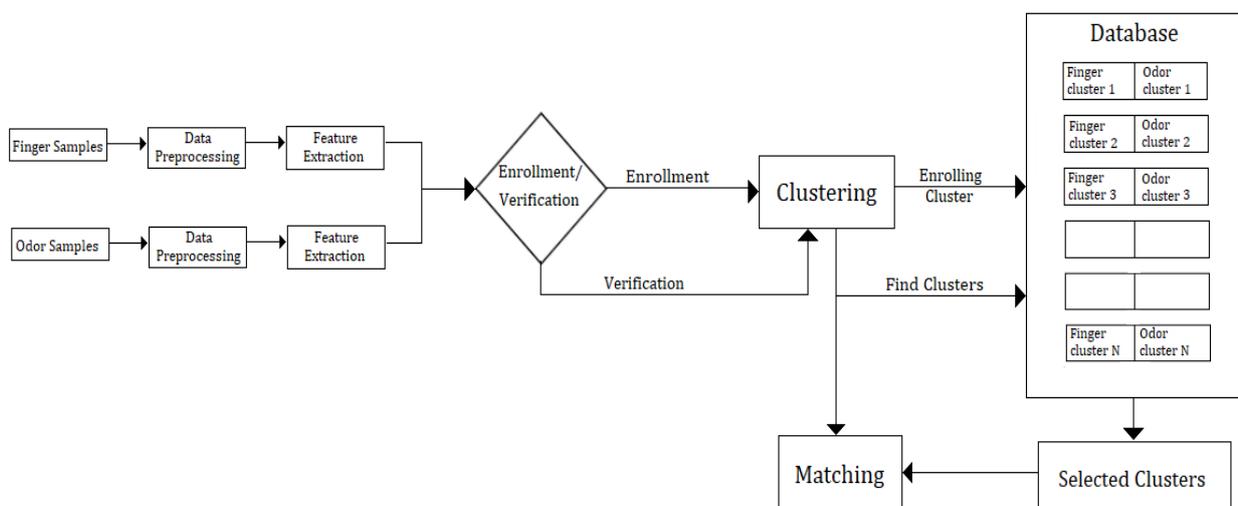


Figure 1: A proposed design for Multi-modal biometric system.

This model includes the functionalities of two individual devices. Those devices are Fingerprint Scanner and E-nose. The main aim of this model is:

- To enhance the accuracy rate of fingerprint authentication by using Odor analytics.
- To avoid the occurrence of spoofing of fingerprints.
- To propose a new method of biometric authentication.

One of the important aspects before discussing is to remember that every phase in the proposed model works simultaneously for both fingerprint and odor recognition systems.

A. Sensing

In this model fingerprint and odor, samples are required for authentication. These samples can be taken from their individual prescribed sensors. Samples of the fingerprint are acquired using the fingerprint scanner. Those scanners take the image of a fingerprint with the help of LED light based on light and dark areas which are caused by ridges and valleys present on a finger. In the same way, odor samples are acquired from an array of gas sensors. Those sensors detect the chemical constituents that contribute to the odor. Once the samples are acquired from both the sensors, those are sent for data pre-processing. While acquiring the samples for body odor, care must be taken to assure that the same part of the skin on the finger which is sensed for fingerprint samples, the same part of skin must be used for sensing for odor analysis.

B. Data Pre-processing

Pre-processing in case of fingerprint samples: - Initially, only a photocopy of a fingerprint is taken by a sensor. Later on, the image is enhanced to improve the quality and obtain some specific features present in a fingerprint.[5] Those specific features are helpful in the case of pattern recognition of fingerprint. After completion of image enhancement; segmentation is performed on those enhanced images of fingerprint samples.[6] In this process, the foreground and background regions in the images are differentiated. This process is used to highlight the ridges and valleys from the background region of the initial image.

Pre-processing in case of odor samples: - In this pre-processing, the intensity of response from sensors is reduced to differentiate from initial odor samples. The intensity of response can be reduced in many ways like noise-cancellation etc... The reason behind reducing the intensity is to normalize the response from an array of sensors so that the new pre-processed odor samples can easily undergo feature extraction in the next step.

C. Feature Extraction

Feature Extraction in Fingerprint samples: The enhanced and segmented fingerprint samples undergo a process called Image binarization. It is a process of conversion of a grayscale image into a binary image for further feature detection. Another feature extraction process is thinning. This is an operation that completely erodes the foreground pixels until they become one pixel wide. There are some standard algorithms [7] for performing this thinning operation. In this process, a skeletonized version of the binary image is formed for preserving the connectivity between the ridges. Another important process in feature extraction is the extraction of minutiae points as these points

represent the uniqueness of every fingerprint. Some algorithms have been proposed in some recent studies for the extraction of minutiae points. [8, 9]



Figure 3: Minutiae Extraction from Fingerprint Sample.

Feature Extraction in Odor samples: Feature Extraction is performed on odor samples to reduce the dimensionality of measurement space. The chemical constituents which contribute to the odor can be identified easily by focusing on the important part from where the odor comes. After identifying the chemical constituents some specific characteristics from the odor samples are detected. From the specific characteristics, some selected characteristics give relevant information which is required for pattern recognition. [10]

According to the model, once the pre-processing and feature extraction is completed for the acquired samples then the resultant will face a conditional statement whether the samples are acquired for enrolment or verification.

D. Enrolment

The resultant of acquired samples undergo the enrolment phase only when the acquired samples are not present in the Database. If the details of acquired samples are present in the database then it enters another phase called verification phase to check and verify whether the acquired samples are matching with the samples in the database. The detailed description of the verification phase will be discussed later. Before entering into the enrolment phase, the acquired samples will be in the form of minutiae points and reference points. For storing those points into the database, they have to be clustered into a single cluster. That cluster will be stored in a template along with an odor cluster in the database.

E. Clustering

Clustering is a process of the grouping of similar items. Here the similarity is checked in such a way that a cluster contains the same items concerning the other items in the cluster itself. Some specific clustering algorithms are used in the case of biometric authentication. In the case of fingerprint, the resultant after pre-processing and feature extraction will be in the form of minutiae points and reference points. So, these points must be clustered and those clusters will be under one cluster called a finger cluster. This finger cluster will be stored in the form of a template in the database.

In the case of odor, the resultant of Principle Component Analysis (Feature Extraction) consists of different gas components. Those will be clustered and will be stored under one cluster called an odor cluster. The Odor cluster will be stored along with the finger cluster as a template in the database.

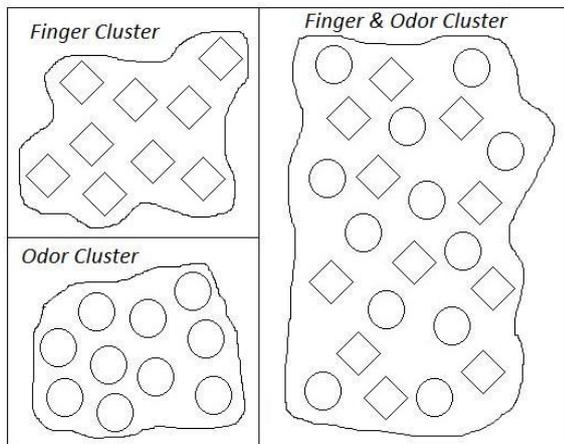


Figure 4: Clustering of finger and odor samples

F. Verification

The acquired samples will undergo the verification phase when those samples do not enter the enrolment phase and when the samples are already present in the database. The next step in verification is also clustering.

The explanation for clustering is already given above. After clustering the next step is finding the template which has a cluster which is the same as acquired clusters. Once the templates are selected those are sent into the matching phase which is the final stage of this model.

G. Matching

Matching is the final stage in this model. This process is carried out by using pattern matching algorithms in the fingerprint recognition system. Here matching is done between samples acquired and samples already present in the database. The results of this module are in terms of the match score [11], which will be high when both fingerprints are the same and low when the fingerprints are different. The two main categories of fingerprint matching are minutiae-based and pattern matching. The minutiae-based algorithm [12] is the most widely used for matching fingerprints in most of the devices. In this minutiae-based algorithm, minutiae are clustered and then compared with clustered samples in the database.[13]

For obtaining results in the matching phase for the body odor samples, a specific pattern matching algorithm is used. This pattern-matching algorithm works on calculating the success rate. The evaluation procedure compares the acquired odor samples with odor samples that already exist in the database which are stored in the enrolment phase. The high percentage of success rate shows that the samples match accurately else the samples do not match accurately.

IV. CONCLUSIONS

A major impact in the arena of biometrics is made by the fingerprint authentication system. One of the main aspects of fingerprint authentication technologies is its accuracy in the final results and this aspect is the reason that

it is employed in various fields. Several biometric systems were introduced in past decades but they could not bring effective results due to the defects or loopholes which led to fingerprint spoofing which is done by using various mediums. Body Odor Acquisition was proposed as a solution for fingerprint spoofing but to overcome the defects in the fingerprint authentication system [14], we have proposed a unique multi-biometric system. This model is designed with the functionalities of both the fingerprint authentication system and e-nose. The main reason for including functionalities of e-nose is that the recent developments in e-nose are in such a way that it differentiates body odor of human beings even though they maintain same lifestyles and activities and it is also developed in such a way that it concentrates on human body odor even if the acquired odor sample has some traces of other external odors like perfumes and deodorants.[15,16] As to future research, we intend to implement and develop the proposed model. It is hoped that the design proposed in this paper will open the door to the field of the multi-biometric system with fingerprint and body odor recognition.

The finger and odor samples match accurately only when both fingerprint and body odor samples match with the samples present in the database. If either fingerprint samples or odor samples do not match with the samples present in the database then the matching phase gives a result that the samples are not matched. This feature of this phase will empower the complete design as this will not allow the authentication for fake fingerprints.

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