

Analytic Study on the Latest Biometric Technologies for Human Recognition: an Overview

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ABSTRACT : Modern technology makes extensive use of biometrics, hence bio-data analysis is crucial. Individual analysis methods, including Face, fingerprint, iris, retina, voice, Face, and ECG, are based on physiological, behavioral, or physical characteristics. Biometric technologies can be used to determine an individual's identity. Numerous sectors, including forensic science, security, and the system for identifying and licensing individuals, now use biometrics effectively. Numerous studies have been conducted over the past three decades to develop biometrics systems based on fingerprints, voice, iris, face, etc. However, new biometrics have been implemented recently. This paper examines biometric systems comprehensively, including their uses, disadvantages, and benefits. Different types of biometric recognition systems exist.

KEYWORDS - Biometrics, Technique, Physiological, Recognition Systems.

I. INTRODUCTION

Biometrics is the study of how to verify or identify people by using measurements and analyses of their biological data. Biometrics is the study of what makes a person unique, like how their body works or how they act. Since ancient Egypt, people have been using biometrics. Biometrics is the science of figuring out how to identify someone by measuring and analyzing their unique physical or behavioral traits. The word "biometric" comes from two Greek words: "bios," which means "life," and "metric," or "metrics," which means "measurement." Face, fingerprint, DNA, ear, iris, retina, and hand geometry are all parts of a person's body that have to do with its shape or size. Behavior traits are things like a person's signature, voice, and gait, which have to do with how they act or move. There are both good and bad things about each biometric trait[2].

The right biometric feature should be used for an authentication application based on what it needs. Different apps can be used to check a person's identity, depending on the reason for the verification or identification. For a long time, people have used passwords, PINs, and ID cards to protect systems by limiting who can use them[3]. Still, it's easy to make these methods work for you. Passwords are hard to remember, and someone could steal your identity. Biometrics, on the other hand, can't be lost, stolen, borrowed, or faked. Security can also be improved by using biometric traits[4]. Biometrics are a better way to prove your identity than other methods. People, walls, and big forts are used to keep people safe and give them privacy through authentication. The goal of a method of authentication based on Knowledge, Possession, and Property is to stop people who shouldn't be able to get into a system[5]. To keep information private, only verified users can access it, and the verified person must be there during the authentication process. Biometric authentication is based on who you are, while traditional authentication is based on what you have and what you know. So, biometric authentication is the safest method [6].

II. CATEGORIES OF BIOMETRICS

Biometrics refers to physiological or behavioral [7]; the following type figure(1) shows the Subdivisionsof biometrics.

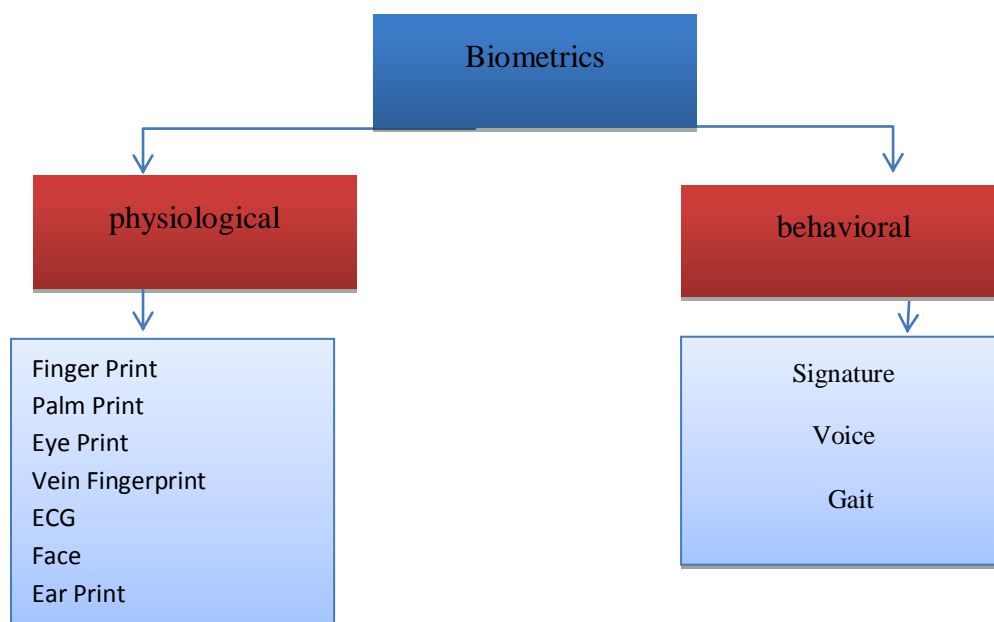


Figure (1): Type of Famed Biometrics[6].

Biometrics provide better security and are a better way to identify people than traditional methods. In a small number of situations, biometrics can improve or replace the technology that is already in place. Biometrics is an old idea, and there have been ways to identify people based on their physical or behavioral traits for hundreds of years[8]. Face recognition is an example of an old and basic biometric. Since the beginning of civilization, people have used faces to tell the difference between known and unknown people. In the next point, I'll talk about the benefits of biometric technology[9][1].

- Requires no user cooperation for recognition.
- Ensures the presence of the subject at the time of authentication.
 - High data transmission, even with fake IDs or some types of fraud.
 - It's hard to forget because it uses your body or your personality.
 - You can't lose or steal it.
 - It can't be given to anyone else.
 - Costs can be cut with good implementation.
 - Authentication improves access control because it looks at the user's body and how they act.
 - The biometric system can use enrolled biometric traits to quickly and accurately identify people.
 - Identity theft is less likely to happen when biometric authentication is used.
 - Accepted by all users without any complaints
 - How easy it is to use a substitute, or to cheat.

The limitation of system biometrics are shown in the following point[10]:

- Environment and use can change how measurements are taken.
- The systems are not always right.
- Need to be integrated and need more hardware.
- Once it's been broken into, it can't be reset..

III. The Biometrics System Domain

There are several applications for biometric technology, which can be categorized into three broad categories: commercial, government, and forensic [11]. Table 1 demonstrates that biometrics are utilized in numerous ways.

Table (1): Domain Of Biometrics System[12][13].

Commercial	How to get in (Logical Access and Physical Access)
	Time and Personnel Management Services for banks and money
	Airports and Immigration
Government	Verifications for safety and immigration Systems for communication Public health and care
	How to get in (Logical Access and Physical Access)
	Time and Personnel Management Services for banks and money
	Justice / Keeping the law
Forensic	Observation
	How to get in (Logical Access and Physical Access)

IV. BIOMETRIC METHODOLOGIES

A biometric is a vital, unique, measurable, physical or behavioral trait of a person that can be used to identify that person. Any biometric trait must be unique, easy to change, and change less over time. For example, voice is a biometric trait that is different for each person [13]. In the same way, a person's iris doesn't change over the course of their life. Biometric systems are based on technologies that can recognize patterns. Cognitive biometrics is a modern method that uses bio signals to verify or identify a person based on how their brain reacts to a certain stimulus. Here, the different biometrics methods are talked about [14]. Table (2) shows the pros and cons of each method, as well as how it can be used. Based on the needs of the application, the best method can be chosen.

Table (2): Biometric System Techniques[15].

Technique	Security level	Cost	Sensor	Pros.	Cons.	Size of Template	Long term stability	Accuracy
Face	Normal	Low	Non-contact	Captured from a Remote area	Lighting conditions	Large	Low	Medium

Voice	Normal	Low	Non-contact	Natural and Convenient	Noisy	Small	Low	Low
Iris Scan	Medium	High	Non-contact	High accuracy	Cracks	Small	Medium	High
Fingerprint	Good	Low	Contact	Greatly applied	Skin	Small Size	Bottom	High
ECG	GOOD	High	Contact or not Contact	High accuracy	Wave of hart	Small or big size	low	High
Hand Vein	good	High	Contact or not Contact	Greatly applied	Skin	Small or big size	Bottom	High

V. FACE STRUCTURE

Face recognition is a new discipline in which research and development are taking place all the time. Face recognition has piqued the interest of researchers in a variety of fields, including security, psychology, optics, neural networks, machine learning, image processing, computer vision, and pattern recognition[16]. Engineers and neuroscientists have contributed to its development, with image analysis and understanding being the most important application. Face-recognition is a frequent and non-intrusive method of tracking, measurements, dimensions, and other physiological aspects of the face are used to identify a person. Face proportions, including things like nose and lip size and placement in relation to other face features like the chin and jawline. Facial traits are something that people take notice of and use to their advantage. Researchers use both specific and general criteria for facial recognition. Face recognition can be achieved using the following methods

- i. Facial metric: This is a way to measure the location and shape of facial features. For instance, the distance from the nose to the lip or from the eye to the chin.
- ii. Eigenfaces: The overall face image, which is the set of weights that describe the canonical faces, is looked at.
- iii. Analysis of the skin's texture: This is a new way to recognize a person's face, along with other ways to look at the skin. Finding the spots, lines, and patterns that are unique to each person. Generally,



Figure (2): Face System Type[7].

VI. IRIS

This connective tissue in the eye is called the iris and governs the size and shape of the pupil, as well as how much light is allowed in. It develops and matures throughout the initial stage of its life, referred to as morphogenesis. You'll never have to change it. Even identical twins' irises have distinctive patterns that are unique to them. Also, a person's left and right irises are distinct and not identical. The cornea protects the iris from view from the outside. The color of the iris, which might be blue, brown, or green, determines the "color of the eye." In certain cases, the color is a mixture of light brown, green, and gold. Depending on the individual, the eye may have a variety of distinct features, including freckles, filaments and corona, striations, pits, rings, and furrows. Eye surgery, eyeglasses, and contact lenses cannot alter the shape of the iris. There is a very low incidence of acceptance and rejection [19]. Iris patterns are captured using a specific grayscale camera that measures between 10 and 40 centimeters. Iris detection can be done using a variety of different methods, and a net of curves can then be created to cover it, along with the appropriate iris code. It is influenced by two factors: the overall darkness of the image, and the size of the iris. With the hamming distance and the difference in the number of bits, comparing two iris codes is a cinch using this method. Another option is to utilize the template-matching approach. In order to compare the newly acquired iris template to the previously stored one, it employs statistical analysis. When iris recognition is needed, it is employed [20].

- border control
- passports
- Identity cards
- other government purposes

Iris identification is one of the safest ways to authenticate and identify someone. The fact that Iris's guess was right is very encouraging [21]. Figure 3 shows an example of an eye image.

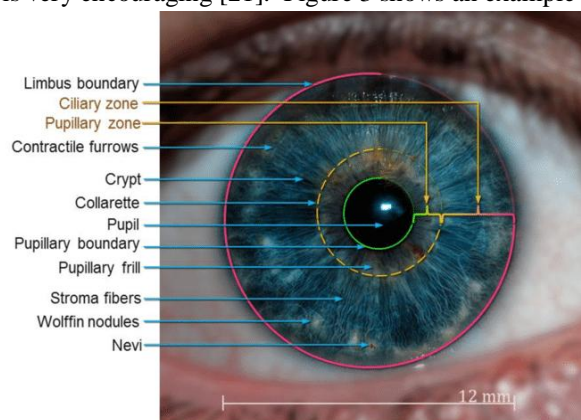


Figure (3): Sample Eye Image[6].

VII. EAR RECOGNITION

Ear geometry recognition uses the shape of the ear to tell who someone is. People say that the characteristics and conditions of the human ear should be easy to tell apart. To get rid of hair, you can use infrared light and the ability to see from a distance. Using earmarks found at crime scenes, law enforcement software can figure out who a person is. We don't yet know how useful this technology will be for controlling access. Optophone is a device made by ART Techniques that checks the shape of the ear. It looks like a phone handset and has a light and camera to take pictures of the ear. Figure 4 shows how the Ear is put into different groups.

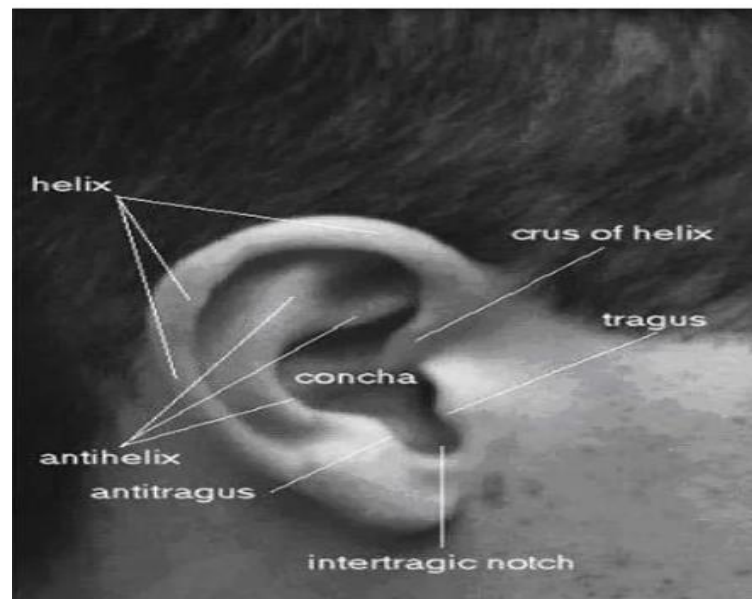


Figure (4): Taxonomy Of Ear[23].

VIII. LIP BIOMETRICS

Lips aren't as frequently employed as other biometric features. It is the most exciting and new method of identifying a person, and lip prints are frequently employed in forensic science. Biometric lip recognition Lip features are unique to each individual and do not change with age. Although lip movement is one of the biometrics used to identify speakers, it is only one of many [24]. As with fingerprints, each person's lip prints are distinctive. There is no possibility to arrive at the correct answer if only one factor is considered. In general, lips can be described as having three characteristics: texture, shape, and motion. Other methods of determining a person's sexuality, such as lip prints, were also discovered. Lip biometrics are shown below. Anatomically-based hybrid biometrics are present on the lips, and they are passive, visible, and oftentimes audible. Fig. 5

depicts the lip's morphology as well as its markings and movements.[7]

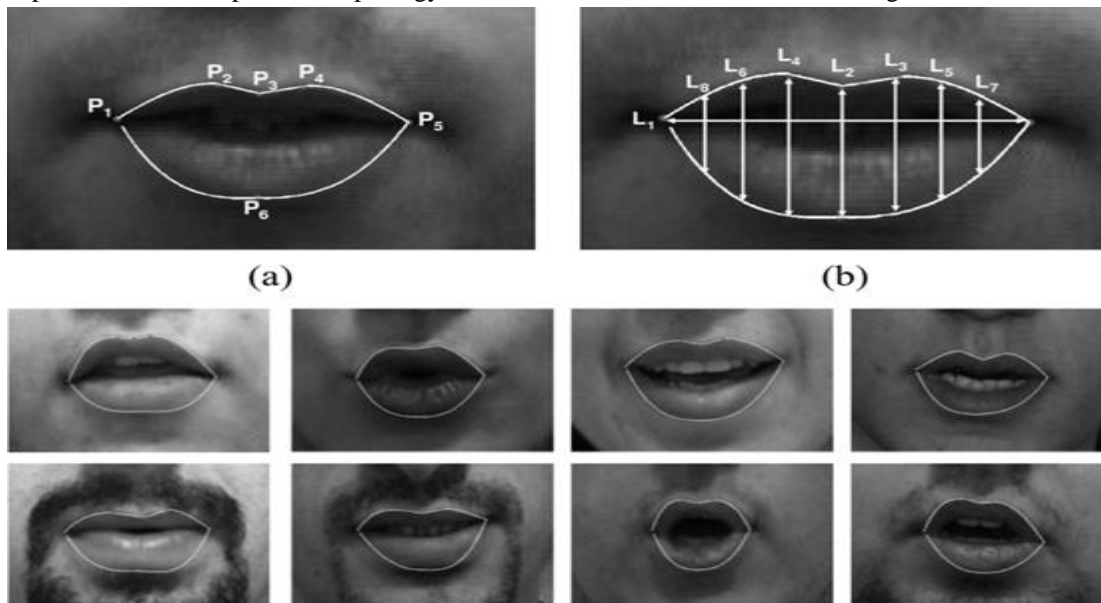


Figure (5): Shape, Prints And Movements Of Lip[7].

IX. HAND PRINT

The hand has a number of distinct lines and patterns, including main lines, wrinkles, and ridges. It's the primary lines that connect everything together: the veins, the arteries, and, of course, the words. Physiological biometrics refers to the distinctiveness of an individual's line patterns. Hand and finger ridges are close together because of the patterning. It is not the same thing to take a fingerprint from the tip of the finger and a hand print from the inside of the hand. Figure 6 shows the palm print.

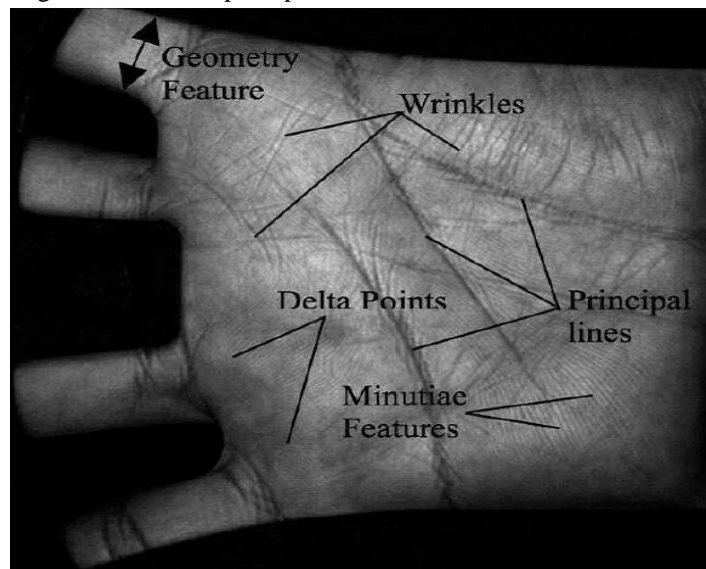


Figure (6): Palm Print[26].

X. The Hand Vein

A new type of biometric technology is the vein recognition system. Most vein recognition systems focus on the veins on the hands of the user. It's also known as vascular biometrics. Vein recognition systems are interesting to researchers because they have some features that other biometrics technologies don't have. There is a high level of safety. Blood gets to the heart through the veins, which are blood vessels. The veins in each person are different. Also, each twin's veins look different, and their left and right hands are different. Very

accurate systems can read veins [27]. The veins are pretty strong and solid, and they were made before you were born. Figure shows how the hand veins look (7).

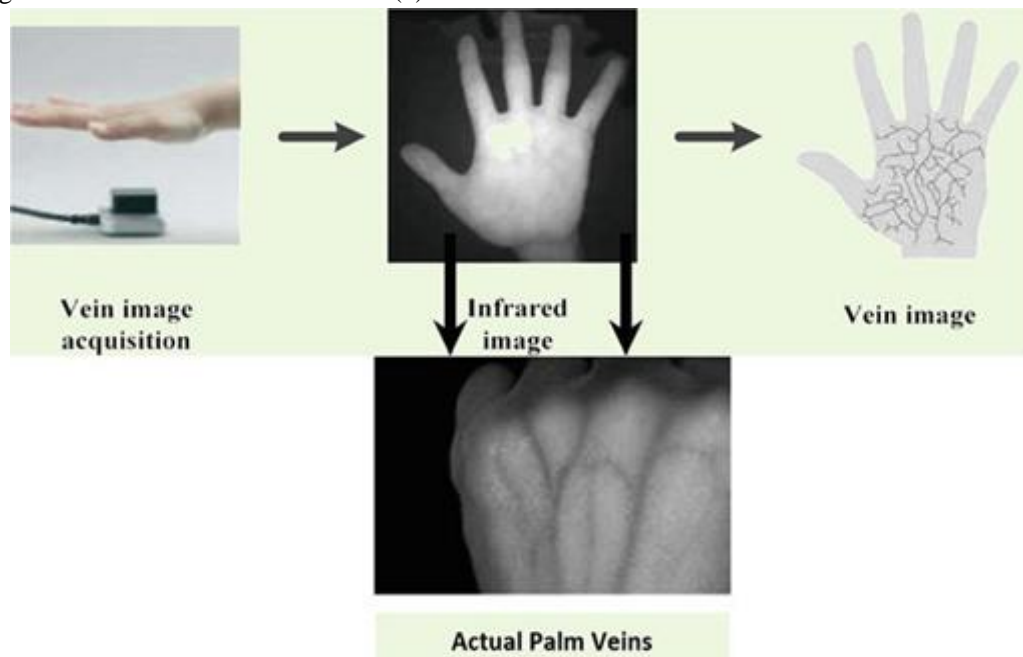


Figure (7): Hand Vein Patterns[15].

XI. THE FINGER VEIN

Finger vein recognition is a method of determining a person's identity based on their veins. Vaginal vein patterns appear as a series of black lines because blood deoxyhemoglobin absorbs near-infrared light. Using near-infrared lights and a specific camera, vein patterns can be caught on film. Finally, the image is converted into pattern data and saved as a biometric authentication template. The vein on the user's finger is photographed and compared to a saved template during authentication. In order for finger vein recognition to function, the following elements must be present [28].

- Each person's finger veins are different, even if they are twins. The rate of false acceptance is low (it's close to zero).
- Placing a hand or finger is less invasive than other biometric technologies.
- Since veins are inside the body, they are hard to read or steal from. There isn't much chance of theft or forgery.
- During the authentication process, finger veins leave no trace and can't be copied.
- Finger vein patterns don't change much as a person gets older, so once a vein pattern is registered, it won't need to be registered again.
- Changes in the weather or a person's health are less likely to make finger veins look different.
- Rushes are broken, and having rough skin does not change the result of the authentication.

Figure 8 shows the vein in the finger.

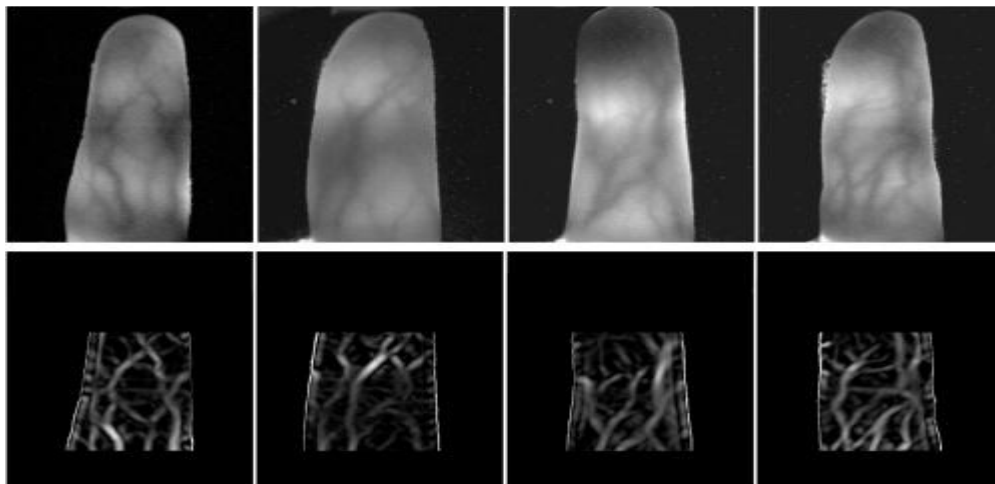
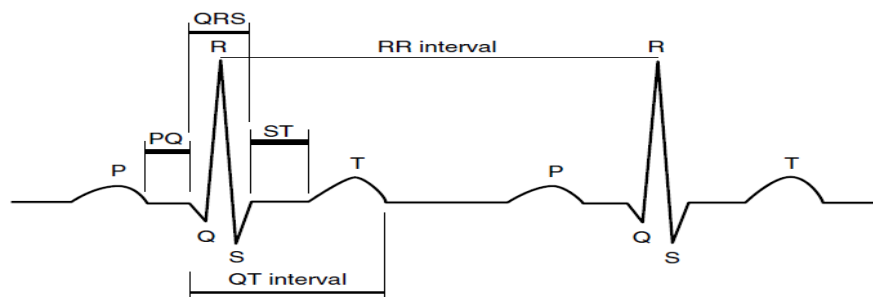


Figure (8): Finger Vein[28].

XII. AN ELECTROCARDIOGRAM (ECG)

Researchers found out more than 100 years ago that the electrical currents in the heart could be watched. Willem Einthoven, a Dutch scientist who won the 1924 Nobel Prize in physiology or medicine, was the first to create the ECG as we know it today. Consider A cardiac electrocardiogram (ECG) is one of the necessary additional medical tests that can be done with a cardiograph to find and evaluate heart problems by recording changes in electrical potential between two points that happen when the heart is electrically active. An ECG is one of the most important tests that a cardiograph can do to find and evaluate problems with the heart [30].



Figure(9) : Electrocardiogram ECG in Human Healthy[31].

XIII. THE BIOMETRIC OF SIGNATURE DYNAMICS

There are many different types of behavioral biometrics, and one of the most common is signature biometrics. Signing one's name in a distinctive way is what makes a person stand out. The way a signature is used, not its aesthetics, is what matters most. When it comes to using signature recognition, there are two options: static and moving. See the signature's biometrics down below [33]. Using a camera or optical scanner, a paper signature is converted into a digital file in the static or offline approach. The system is able to identify the signature based on the signature's speed, pressure, and velocity. An online signature is taken in real time using a digital tablet, which records factors like speed and pressure as well as stroke direction and signature size, the time it takes to sign is also recorded [32].



Figure (10) : Signature Biometrics[7].

XIV. THE SPEAKER RECOGNITION BIOMETRICS BY VOICE BIOMETRICS.

One of the most essential biometrics is voice recognition. Voice biometrics is sometimes known as "biometric speaker recognition." They're used in mobile applications. Even identical twins' voices differ in almost every detail, and the complete sound of a person's voice may be reconstructed. Individual differences in speech are the result of a unique mix of anatomical and behavioral characteristics. Physical characteristics include things like the vocal cords, lips, nose, and the size and shape of the mouth. Pronunciation, emphasis, tempo of speech, and accents, on the other hand, are all instances of behavioral characteristics. This does not necessitate any high-end or specialist gear. Using the acoustic pattern of a person's speech, including how they talk and the pitch of their voice, and also their throat or mouth shape and size, voice recognition may tell them apart. Even if you have a cold, your voice box will not be affected. Consequently, the accuracy will not be affected. In order to prevent unauthorized access, people are required to repeat a series of short sentences [33]. Microphones, phones, and PC microphones can all be used to record voices. With the help of an analog-to-digital (ADC) converter, the electrical signal made by the microphone is turned into a digital signal and stored as a digital sample. For identification, the suitable matching algorithm compares the speech that is input to the digital voice that has been stored. There are two kinds of voice recognition: ones that depend on the speaker and ones that don't. Speaker-dependent systems depend on knowing what makes each person's voice unique. Voice training, accent training, and tone training are all ways to learn and train these traits [4]. Voice recognition that doesn't depend on the speaker can understand the words and phrases spoken by more than one person at the same time. The system doesn't need any training to work. The speech system uses three different kinds of spoken input: text-dependent, text-prompted, and text-independent. It is hard to make systems that can recognize voices based on who is speaking. A speech recognition system's performance is judged by a number of factors, such as background noise, changes in speaker and tone, the sensitivity of phonetic input systems, distance, and regular changes. Healthcare, government, banking, entertainment, PIN smart cards, access control, customer authentication, and other security-related duties all make use of voice recognition software. Voice changes as we get older necessitate an adaptable system. Recognizing a speaker and comprehending what they have to say are two very different things. The process of identifying the speaker by analyzing the tonality, accent, and pitch of the speaker's voice is known as voice recognition. In menu or map navigation and hands-free computing, speech recognition is utilized to decipher what is being said [34].

VOICE RECOGNITION



Figure (11): Biometrics that use voice or speaker recognition [35].

XV. FINGERNAIL

Fingernail Bed One of the new technologies that is still being researched is nail identification. One of the most important parts of a fingernail is the nailbed. It is a layer of the epidermis that moves over the nailbed as the fingernail grows. It looks like little bumps on the outside of the nail. This RFID-based method was made by FnBiometrics. Depending on the person, the chip can measure the electrical capacitance of the nail and skin below it[36]. Figure 12 shows the nailbed..

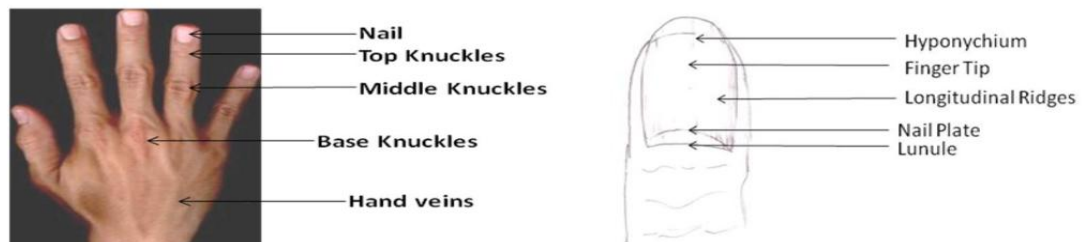


Figure (12) : Fingernail[35].

XVI. CONCLUSIONS

In its most basic form, biometric technology is based on a number of methods for recognizing patterns. Biometrics is a new technology that is being used more and more in many different areas, such as security, forensics, ATMs, smart cards, personal computers, and computer networks. Biometrics gives a higher level of security than more traditional ways of proving who you are. Traditional security systems have flaws that can be worked around with biometric recognition. But biometric systems have some problems that can be solved by making new biometric technology. Several different situations and uses have shown that the biometric recognition system works well and is accurate. Getting a person's biometric information is a simple process that can be done right in front of them. Biometric recognition will have a big effect on how we do things every day. Several biometric approaches are explained and compared in this study. Even though some problems still need to be fixed in biometrics systems, the field of biometrics is getting better and better. Biometric technology has become more accurate and cheaper to use thanks to recent changes. Now that biometric technologies have improved, it's easy and quick to prove who you are. There are many ways that biometrics will be useful. Right now, there is a gap between what biometrics professionals know and what biometrics projects are possible.

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