A New Wave in Biometric System:Systematic Study

Saumya Rajvanshi*, Shiv Chauhan, Savneet Kaur
Department of Computer Science and Engineering
Chandigarh Engineering College, Landran, India
Email Id: - saumya.4826@cgc.edu.in

Abstract: **Biometric system is a technique used to identify a person using its personal identification methods. The main concept of biometric systems is to provide confidentiality and security to the user. A number of biometric systems are introduced but some systems are widely used and are famous because of their usage and security they provide. Physiological and Behavioral biometrics are the two types of biometric systems. Biometric systems include physiological biometrics like face recognition, fingerprint recognition, iris recognition and behavioral biometrics like signature recognition and voice recognition. All these recognition systems are discussed in this research paper. Biometric systems work on three levels: Enrollment, Verification, and Identification. Enrollment is the process in which patterns are captured from the user and stored in the database. Verification means to confirm that the sample entered by the user belongs to him or not. When the user wants to access the data then the user must use his/her biometrics so that the system checks that the person who wants to access the data is the real owner of the data or not. This process is identification. All three levels are the working levels of the Biometric System. In earlier years, biometrics were used only at ground levels to provide basic security to data but now the tables have turned. It is playing a major role in providing security to our data. Biometrics are not only used in day-to-day life in phone unlocking, phone assistants, attendance systems but also used at advanced levels like in airports, border security, cloud computing etc. In this research paper, we will discuss the future scope of biometric systems and how it could even change the future.**

Indexed Terms: **Biometrics, Recognition, Security, Identification, Authentication**

I. INTRODUCTION

Biometric is a Greek word that is the combination of bios i.e., "life" and metron i.e., "measure". A biometric system is a system in which any part of the body can be recognized by its biometric data, and that data is stored in the database and recognized based on matrices. It is a unique identification method that nobody can copy.

This technology is basically used for the recognition of people to access their data and to provide security to the data. Earlier, some patterns or identity proofs were used to secure the data. But due to the advancement of technology, some hackers took advantage and used technology in the wrong way to steal other's confidential data.

Moreover, any person can easily claim that he/she has forgotten the password or has lost his/her identity proof.

To overcome this, a new method of recognition, i.e., biometrics, has been introduced to provide more security to confidential data. As biometrics are inherited and cannot be shared or stolen, it is one of the best methods to provide security for data. For instance, our fingerprints can be used as an identification method because they are unique and cannot be manipulated or copied down in any way by anyone. In the same way, our eyeballs, our face, our signature or tone of speaking can also be used as identification methods.

As technology develops, biometric systems are introduced to society. Earlier, in India, this method was used only in the visa application process, but now it is almost applicable everywhere. It could be said that every application process has one biometric process.

Not only do our smartphones have biometric identification, but many cards issued by the government, like the Aadhar Card, Pan Card, and even defense cards, also have biometrics in their backend. This system has become so advanced that many museums, industries, and research labs are using it as their security system. Not only that, but the system has also been used in schools and colleges for attendance purposes.

The biometric system has several advantages that have made it more important. Speaking of its first advantage, it is reliable and convenient. At ground level, we are using biometrics in our daily life, even if we are unlocking our phone or are in our office. At its advanced level, it is used in research labs or in our defense system to secure confidential data.
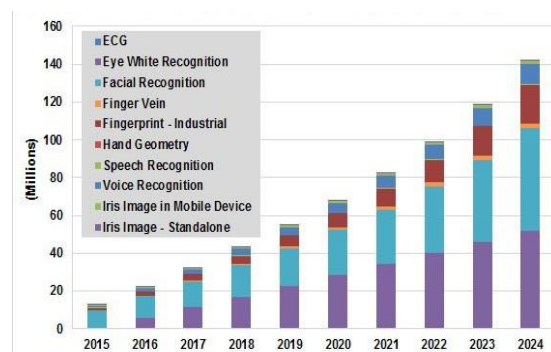

Fig.1 Increase in Biometrics from 2015-2024

It denies imposters access to our data, whether it is personal or professional. If we are using a password to secure a set of data, then it can be cracked by hackers or some illegal agencies who use the data against us. But if we are using biometric recognition instead, then there are fewer chances for the loss of data because biometrics works on the concept of matrices where the passwords are stored in

the form of patterns rather than any number, text, or special symbol.

Also, the biometric system plays a major role in keeping track of employees in a workplace. They are not able to change their arrival time and cannot mark others' attendance. In such a way, this system helps in maintaining discipline in the workspace.

1.1 DIFFERENT TYPES OF BIOMETRICSYSTEM:

A biometric system mainly has two types:
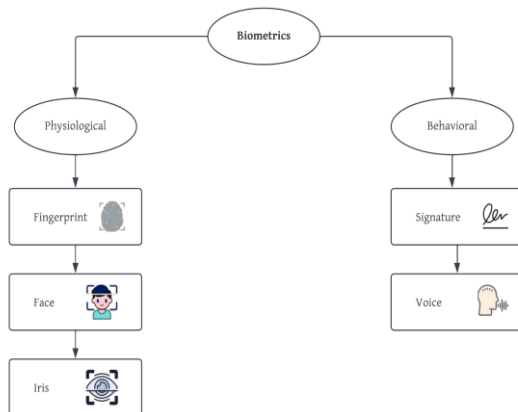- Physiological biometric systems
- Behavioral biometric systems [4]

Fig.2 Types of Biometrics

Physiological *Biometric System*: The physiological biometric system is the system that includes the physical behaviors of the human body. Face recognition, fingerprint recognition, and iris recognition are examples of physiological biometric systems.

In this type of recognition, any part of our body is used as a recognition pattern, which is used as the base or master pattern. For instance, the phone unlocking system has saved our master fingerprint or face pattern, which it uses afterwards to unlock the phone.

It includes the following methods:

Fingerprint *Recognition*: This is the oldest as well as the most trustworthy method that has been used in the industry for a very long time. This method was discovered by Sir Francis Galton in 1888 [7].

Everyone has a unique fingerprint pattern called minutiae, which can't be copied in any way. Keeping in mind that this method was discoveredto check whether the two fingerprints were fromthe same person or not,

The lines on the fingers are called minutiae, and the patterns of minutiae are unique for everyone. Both our hands have different fingerprints i.e., no two fingers have the same set of patterns. Also, no other person in this world has the same set of minutiae [7]. Thus, it is one of the secure recognition methods.

There are many fingerprint patterns like double loops, radial loops, arches, and accidental patterns. Biometric systems are implemented according to these patterns. Every pattern is scanned and stored in a database, and then whenever a person tries to unlock the password, he/she scans their fingerprint.

Then it is checked whether the pattern that the user is scanning now and the saved pattern of the user match or not. If there is a match, then the user is directed to their data.

Fingerprint recognition method has now become a daily practice in the life of humans. And there is nodoubt that this is a futuristic thing. It is used in:

- Smart phone Unlocking.
- Aadhar Verification or Identification.
- UPI Authentication.
- Bank Servers.
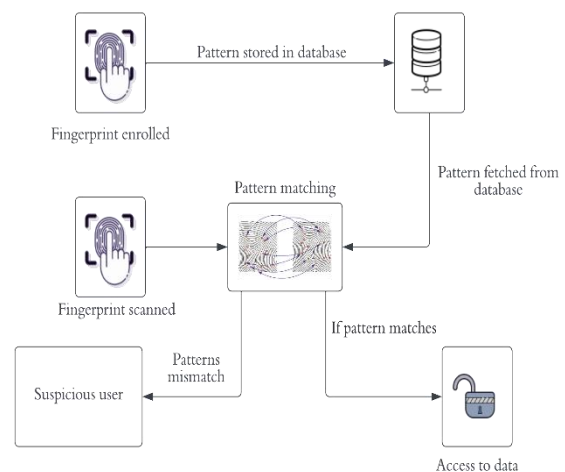- Office/Private Space Unlocking.

Fig.3 Fingerprint Recognition System

Face Recognition: This is the mathematical representation of a person's face. Woodrow Wilson Bledsoe, an American mathematician, and a great computer scientist, made a great contribution in the field of pattern recognition (commonly known as face recognition). And now it is spread all over the world. Almost every mobile camera has the facilityof face recognition. Face Recognition works on the concepts of deep learning where the images are converted into numerical expressions and then these expressions are processed by applying Artificial intelligence and deep learning algorithms which convert it into useful data

Face Recognition has become so advanced that it helps in:
- Fraud Reduction
- Convenience
- Security
- Automation
- Access Control

Instead, we have a very great future with face recognition as:
- There could be 3D recognition, as we currently have 2D sensor recognition, which is less advanced than 3D recognition.
- It could be a real-time personalized experience. Think of when you go to the market and, based on your facial expression, the AI robots or machines show ads and show products.

For instance, it could be an automated experience where, for instance, you are scrolling on Facebook or Instagram and the application shows you different things of your choice and which you like based on the recognition of your face.
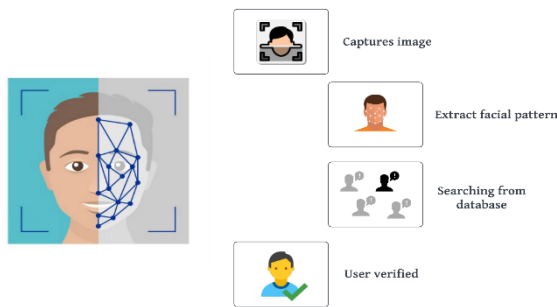

Fig.4 Face Recognition System

Iris Recognition: Iris recognition is one of the most precise among all other types of biometrics. Any other biometrics can be copied or can be erased but this will stay forever with us and cannotbe copied. So, it is the most secure authentication method. This method is based on the concept of deep learning. Firstly, our eyeballs or iris is scannedby the scanner and the picture of the iris is divided into small blocks which then are converted to binary codes and matched with the pattern of codesalready stored in the database [8].

Iris Recognition is such a futuristic concept that itcan be used in many ways:
➢ Iris scanners can be installed at theentrance of any personal property.
➢ It can be used as a security system in museums or at places which require high security.
➢ Can be used in military offices to restrict entrance of unauthorized persons.

Behavioral Biometric System: This system is based on human behavior. Basically, it works on the concept of human behavior like how a person speak, in which tone he is speaking, his typing speed and his signature. This system regulates the pitch of voice, keystrokes, and the way in which a person sign. This system includes signature recognition, voice recognition and many more.

Advancement from Physical to Digital signature:
As the time has changed, now there are very few places where these physical signatures are used. Instead, these are replaced by the Digital Signatures which are done by some software's. These are more reliable than the old traditional ones.Thus, now a lot of certificates and other documents are Digitally Signed and are trustworthy. It also reduces paper wastage and time consumption.

Signature Recognition: SignatureRecognition is also an old method of biometric recognition. Earlier when people were not so educated, at that time they used to sign by just imprinting their thumb impression on the piece of paper but then it changed into signature. This method is not the most secure one as one can copy it and can misuse it too. Thereare very few places where this type of recognition is done. For instance, in banks we sign on the documents,

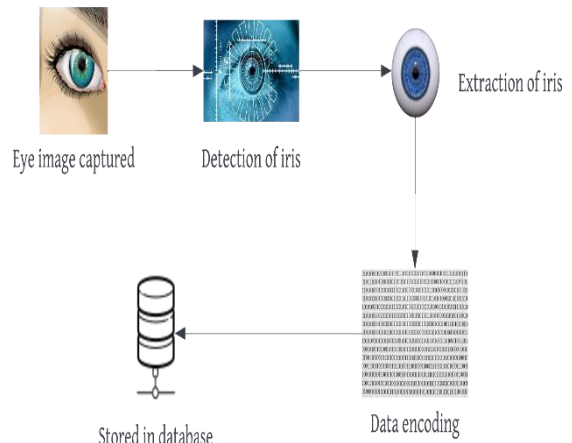checks, and at other places. This is also done on wills, property papers, exams, etc.

Fig. 5 Iris Recognition System

Voice Recognition: Voice Recognition is an AI Based identification method used at many places. This is an advanced method used in many places, for instance, we have voice assistants like Siri, Google Assistant, Bibxy which recognize our voice when we ask them to do something by giving some voice commands. In voice recognition, firstly our voice is saved in the database and transformed into many commands which can be asked by us at various stages in our life with the help of AI. After this, when any voice command is given, the voice is compared with the voice already saved in the database and if it matched, it would give the desired output. It gives lots of benefits like:
➢ It has improved the customer's experience.
➢ It takes very less time.
➢ It can be used widely and remotely.

These biometrics systems are quite popular as they are growing widely in the IT market as well as among different people in the world. These biometrics popularity is illustrated in below table:

TABLE 1: POPULARITY INDEX

RANK	BIOMETRICS	POPULARITY
1	Fingerprint	53%
2	Signature	41%
3	Iris	33%
4	Face	30%
5	Voice	27%

Largest number of popularity as it is the oldest recognition method followed by signature and other methods in the market.

II. PHASE OF BIOMETRIC SYSTEM:

To use a biometric system there are 3 methods that are mandatory to follow: enrollment, verification, and authentication. In other words, we can say that the user

must submit its pattern so that it can be stored in a database and can be used as future reference and then the user verifies their pattern. After this, whenever a user is using its biometrics then its pattern must be matched with the pattern that is stored by itself in the database.
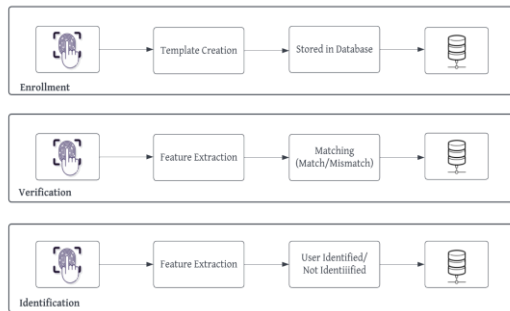
Fig. 6 Different phases of Biometric system

➢ Enrollment**:** It is the process that is responsible for registering individuals to the biometric system. The user's biometric samples like fingerprint, face or signature etc. are captured by a biometric scanner. The quality of the provided samples should be clear to ensure the reliability of the samples. The samples are stored in the form of some matrices like in number, alphabets, and special characters. The biometric samples are stored in the database with its demographic information like user's name, gender, height etc. [8].

➢ *Verification:* This process is responsible to ensure that the user's claim to his identity is true. It is a "one-to-one comparison. The user provides a pin or username as an identifier of the sample. It is checked that the sample provided by the user is right or not by comparing the data entered by the user in this process and the sample template provided during the enrollment process. The verification process produces a match/mismatch decision. Match decision is declared when the data entered by the user and the data stored in the database matches. Mismatch decision is produced when the data entered by the user and the data in the database do not match due to wrong username, or pin or wrong sample etc. [8].

➢ *Identification:* This process is "one to N" comparison. In other words, in this process when the user tries to unlock/get the secured data with his provided biometrics then the pattern or matrix of numbers provided by the user biometrics matched with the user's original patterns stored in the database [3]. If the user is identified, then he can access their data and if the user is not identified then it can lead to disapproval of the access and there could be a chance that any hacker or imposter is trying to hack some data.

III. APPLICATIONS:

Biometrics has a lot of scope and is widely used at various places for security purposes. When we talk about biometrics, the word itself gives satisfaction that our work

is secure enough. It has a lot of advanced applications which are there and are used at different departments. A few of them are listed indetail:

➢ *Judicial Documents***:** Biometrics in official judicial documents were there from quite a long time and still it is there, and we trust it with our full respect. Fingerprint and Signature Recognition are used in these documents. It helps the officials to recognize the exact person when in need. It helps in improving the safety of public documents.

➢ *Airports and Borders***:** Biometrics technology is used in borders and airports for the smooth travel of the passengers. It includes the safety and health of the travelling person. If a person is travelling to another country, then taking biometrics will authorize the government to say that the person belongs to their country and travelling to the country. It will help them to act if they get in trouble while travelling. Similarly, during airport flight, it gives passengers a smooth travelling experience.

➢ *Security***:** It is wrong to doubt the security that biometrics give to us. It gives an extra layer of security to the old security systems like in our phone we have biometrics with the old PIN.

Whether it is door lock or any phone lock, we all have a secured system with biometrics. Large industries where data is everything to them used to install the high security biometric locks which helps them to allow only the trustworthy persons to enter the particular area.

➢ *Access Entry***:** Nowadays biometrics are commonly used in large MNCs as an entry identity. Earlier the entry of the employees was accessed either by Keys, Id-cards or by any kind of smart card. Those traditional methods were not so secured as these keys or cards can easily be stolen or can be replicated easily. So, replacing these with biometrics is the best option chosen by the MNCs

➢ Fig. 7 Biometrics helping in attendance

➢ *Attendance***:** Taking a record of one's attendance is a *difficult* task when you have a count of approximately thousands of individuals at one place. Biometrics has made it easy and convenient for both, the attendance taker and for whose attendance is being taken. It also resolves the problem of "Buddy Punching" [5] which means clock in or clock out for any other person with his name. Simply, it is like a proxy in college. i.e., the

fake attendance in the lectures for completing attendance criteria. Fingerprint and face recognition methods are used for taking attendance [6].

➢ **Criminal Identification:** Most importantly biometrics are also a great source for criminal identification. The only way to identify the accurate criminal is to match his biometrics with the biometrics in the database of the government criminal records. The huge database is known as "Automated Fingerprint Identification System". Lots of criminals are being identified by this process of biometrics identification and matching [6].

➢ *Cloud computation*: Cloud computing is very famous for its convenience, mass storage and security. In this, new user's biometrics are quickly added to the database and sent to the cloud to reduce complexity and cost. It is helpful in various ways. Like it can be used in Elections to match voter's identity by its biometrics. Also, banks can use this system to prevent frauds and delicacy errors.

➢ All these applications usually grow and become more advanced as time passes. There must be some more applications of biometrics systems which may not be identified till now but surely be there in future years.

IV. CONCLUSION:

Biometrics totally depends on person to person as it is a personal identification method which can't be copied in any way. Biometrics helps in many ways like securing personal data, professional life, or financial data of users. All biometrics i.e., psychological, or behavioral performs different tasks at different places. They are used everywhere like in schools, offices, big MNCs, etc.

Even we use it daily on our smartphones. Who could imagine that one day all our expenses will be done by just using biometrics in our phones with the help of either Apple pay, or Samsung pay? Even this is not enough, a lot of research is going to make biometrics experience user friendly and to provide best ever technology with the help of it. The biometrics technology will go until that level which you can imagine or maybe what you can't.

V. FUTURE SCOPE:

The Biometric System has become so advanced and is used at almost all places that it seems crystal clear that it has a bright future with lots of advancement in the technology and use case. We have created a few points which give an idea of how a biometric system creates a great future scope.

Global Payments: Biometrics is heading towards a seamless payment experience. We can see lots of platforms where we can easily proceed our payments with the help of biometrics. Few of these are Apple Pay, Android Pay and Samsung Pay [3].

It gives an advantage that users do not have to remember the PIN or any kind of Password to do any kind of transaction. He just needs to be physically present

to use his biometrics whether it is Fingerprint or anything else [7].

➢ *Immigration Services*: Shifting from one place to another is a very hectic experience for all. What if it becomes a bit easy in any way? It is possible in the future just because of the biometric system. Face recognition and fingerprint recognition can be used for passenger boarding and baggage check-in. It will be more interesting when our Physical passport will be replaced by the biometrics passport which provides reliable personal identification and makes the passenger experience more convenient [4].

➢ *Multi-factor Authentication*: This is the most secure method which uses smart cards, PIN or Password and Biometrics to reduce password hacking. If the hacker wants to hack, then he must collect all the data and make fake biometrics which is very difficult [4].

➢ *Checkout free Shipping*: This is a truly new method which nobody even imagined but if not, how can it be. Major companies which are product-based companies like amazon need more and more products on their site. And when the shoppers collect the goods from their warehouses the AI cameras just detect the person through Face Recognition and the payment is done automatically. No need to wait even a second for scanning the QR code or to pay, it is just done automatically [2].

➢ *Automation in Cars*: Today, facial and voice recognition are used in smartphones in the form of lenses and assistants. In upcoming years, these features will be used in cars as replacement of physical or touch buttons. As touch screens and buttons are included in the cars, in the same way voice and facial recognition systems will be installed for automation. While driving a car, if a person receives any call, he just has to use voice recognition, and can answer it with his voice only. This will also reduce the chances of road accidents. This feature will totally change our life.

➢ *Gender Recognition*: It is a big problem to recognize a person's gender with our eyes. Thus, to provide help to the security forces and the government many researchers are working on this technology where we can recognize the gender of the person by just with the help of iris recognition or facial expression recognition which is possible with AI and ML [2].

Food Management: Food management is very important in today's world, and it can be done with the help of face recognition methods.

For instance, some big companies like Microsoft, Google offer food to their employees which they can access easily but they can ensure that no wastage is done by installing Computer Vision Cameras in the campus so that these cameras can detect the person who is doing food wastage with the help of ML [1].

These are futuristic things which will change the whole world and will increase the productivity of every person. There is no doubt that more such biometric use will be discovered and soon we'll be using it in our day-to-day life.

REFERENCES:

[1] P. Divya Bharathi, V. Pranav Raj, P. Suresh Kumar, S. Venkata Narayana Reddy, "Food Management based on Face Recognition", *International Journal of Innovative Science and Research Technology*, Volume 7, Issue 5, Page 1502-1505, May 2022.

[2] Ms M. R. Rajput, G. S. Sable, "Gender Prediction Based on Iris Recognition", *International Journal of Innovations in Engineering Research and Technology*, Volume 6, Issue 11, Page 13-19, November 2019.

[3] Souhail Guennouni, Anass Mansouri, Ali Ahaitouf, "*Biometric systems and their applications*", March 1st, 2019.

[4] Sunil Swamilingappa Harakannanavar, Prashanth Chikkanayakanahalli Renukamurthy,Kori Basava Raja, "*Comprehensive Study of Biometric Authentication Systems, Challenges and Future Trends",* Volume 10, Issue 4, Pages 3958-3968, January 2019.

[5] Alex Nasonov, "What's the future for biometrics in global payments?", *Biometric Technology Today,* Volume 2017, Issue 8, Pages 5-7, September 2017.

[6] R. Das, *"The* application *of biometric technology"* (accessed on October 20, 2016)

[7] Anil K. Jain, Arun A. Ross, Karthik Nandakumar, "*Introduction to biometrics", First Edition, New York,* Springer, 3 November 2011.

[8] Davide Maltoni, Dario Maio, Anil K. Jain, Salil Prabhakar "*Handbook of fingerprint recognition",* Second Edition, Springer, Verlag, London, 2009.