

## Human Authentication from Brain EEG Signals using Machine Learning

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### Abstract

Biometric systems are much better as compared to traditional authentication methods like access cards, ID cards, passwords, etc. Traditional methods were possession based or knowledge based methods, whereas biometrics are inherent features. In high security areas like military setups, data centers, nuclear reactors, R&D facilities, etc., implementing multi-modal biometrics or multi-factor authentication with biometrics provides even greater security. Electroencephalogram (EEG) based human authentication is increasingly becoming popular in biometric systems. The reasons that EEG based biometric system are better than other biometric systems are:

1. Highly secured (cannot be falsified)
2. Checks if the person is alive or not.

**Key Words:** EEG, Biometrics, Entropy, Wavelet, SVM, ECOC, WPS, FIR, Security.

## 1 INTRODUCTION

The present day biometrics is being easily fooled. In locations where high security access is a must, traditional biometric systems fail to provide a robust solution. EEG based biometrics, prove to be a solution to these problems. EEG signals emitted from a live functioning brain are found to be unique to every human being. These EEG signals can thus be used to form a biometric system which overcomes the shortcomings of traditional day methodologies. This fool-proof system, provide a secure and fast person identification basis. With the help of optimized machine learning models, EEG signals have proven to be a viable alternative to the loopholes of present biometric systems. Increase in use of biometric recognition systems across all industries and sectors in variety of applications has paved the way to a huge commercial market for devices and solutions. Modern biometric systems have ability to connect to information systems and the network. Currently, low-cost EEG devices are increasing in the marketplace. EEG analysis has a lot of applications but it is still in research.

## 2 RELATED WORK

A lot of research is going on to come up with a viable biometric system, based on EEG waves. Many EEG based biometrics system are coming up which use the various types of methodologies and machine learning model. EEG based biometrics system are attempting to accurately identify a person with accuracies nearing perfection. Robust methods are attempted to identify human while being in different emotional states. The process of collection and processing of the EEG waves is also a field of ongoing research where contactless options such as wearable brain caps which come under the BSN (Body Sensor Networks) technology is being considered. Attempts are being made towards providing highly reliable and secure systems for accurate biometrics.

The health care systems which are crucial as far as the security is concerned experiences multifarious problems. The professionals in the health care department have to spend a lot of time on identification, record-keeping and the retrieval of patient records.

Current health care systems which use the traditional patient

tagging methods is full of faults which include mixing of records, medical charts are confused and wrong medication is given to the patients. Thus error in the identification can lead to the loss of life, keeping this process free from flaws becomes crucial. A lot of research is going on regarding the use of biometrics to secure the data and to prevent the mistakes which may have fatal consequences. Once the identity of the patient is established with the use of biometrics patient records can be fetched immediately, there is no need to carry ID or papers for the future visits to the hospital. This proves beneficial to the in patients and out patients equally. In the hospitals there are certain areas where only the doctors and the staff can enter. Biometrics have proven to be helpful here in providing a centralized hospital-wide access control to deter unauthorized access.

Thus biometric authentication to login to the PCs, servers and other devices can protect the patients records, stop the hackers/fraudsters and also help to stay complaint with the government regulation [5].

Today due to the advancements in the biometric technology which is equipped with the computer intelligence techniques, the manual identification approaches which used personal probabilities in the forensic sciences are being replaced. This is a fundamental shift in the criminal detection. Due to the traditional methods of crime scene investigation the forensic sciences are facing number of challenges which include,

1. Insufficient available evidences
2. Concealment of the identity
3. Time consuming
4. Paucity of standardization

Hence biometrics is a strong alternative for the crime detection. It provides an automated method to establish the identity of the person based on his/her physical and behavioral characteristics. It contributes to the crime detection by associating the traces to the persons stored in the database, ranking the identity of persons and selecting the subdivision of persons from which the traces may originate.

The accuracy showed by the system is over 70% which concludes that is an efficacious way to collect the evidence the serial crime investigations [3].

### 3 PROPOSED METHOD

In the proposed system, the raw EEG signal passes through FIR Bandpass filter so that the noise is removed. Then, this noise-reduced signal is divided into five different segments. Different multiscale methods, such as Multiscale Wavelet Packet Decomposition and Multiscale Shape Description are used for feature extraction from the EEG signal. In Multiscale Wavelet Packet Decomposition, the EEG segments are then decomposed into different levels using Wavelet Packet Decomposition. The sub-bands correspond to delta, theta, alpha, beta and gamma frequency bands of the brain signals. These are used for feature extraction. In Multiscale Shape Description, extraction of multiple binary patterns is done at each sample point of EEG signal. From the five segments, three are used to train Error Correcting Output Code Support Vector Machine classifier, whereas the other two segments are used to test on the learned model.

1. Signal Acquisition
2. Preprocessing
3. Feature Extraction

The feature extraction methodologies are applied as following:

- (1) Multiscale Shape Descriptor
- (2) Multiscale Wavelet Packet Statistics
- (3) Multiscale Wavelet Packet Energy Statistics
- (4) Alpha-Beta Statistics

4. Classification :

Matching of input EEG vector and EEG vector stored in the database, as a process is known as classification. The two popular classifiers used are Artificial Neural Networks and Support Vector Machine. Error Correcting Output Code is used to solve the multiclass problem in the SVM [2].

## 4 ANALYSIS

Table 1 COMPARISON OF DIFFERENT BIOMERTRIC SYSTEMS.

Biometric Type	Accuracy	Cost	Size of Template	Long Term Stability	Security Level
Facial Recognition	Low	High	Large	Low	Low
Iris Scan	High	High	Small	Medium	Medium
Fingerprint Recognition	Medium	Low	Small	Low	Low
Finger vein Recognition	High	Medium	Medium	High	High
Retina Scan	Low	Medium	Small	Low	Low
EEG Recognition	High	High	Medium	High	High

## 5 APPLICATIONS

### A. Usability Testing:

User Experience is one of the very important things to consider while making a product. EEG waves of the tester can be used to identify the frustration points with an aim to improve the user experience of the product. The tester will wear the EEG recording device and then use the product to be tested. A recording of the EEG waves and the product is taken. A collection of such recordings will help us make decision about how to improve the user experience [7].

### B. Driver attention system:

The drivers attentiveness is of utmost priority while driving on the road. EEG waves can be used to detect the points of inattentiveness of the driver. The EEG data of a driver can be collected from various sources such as head rest of the car seat or helmet of a bike rider. The analysis of this data can be used to alarm the driver about moments of drowsiness, inattentiveness, etc [4].

### C. Lie Detection:

Detecting lies has always been crucial in identifying frauds and investigating suspects. EEG waves reflect what subconscious mind thinks and it is very difficult to manipulate it. Thus, a lie detection system could be created which uses EEG waves [1].

#### **D. Brain computer interface(BCI):**

Scientists have developed the BCI system that studies the blood oxygen levels and electrical activity of the brain and enables the communication by deciphering the thoughts of the patients who are totally paralyzed and are unable to talk. This for instance can help the paralyzed patients to steer the wheelchairs or move the cursor on the screen [8].

## **6 CONCLUSION**

The main objective of the paper is to compare the biometric authentication using EEG with the other biometric systems based on various parameters. It also includes the principle of operation of the proposed EEG based human identification model, its application area, instruments required, advantages. Summarizing from the study of various research papers, journals, international conferences it is found that development in direction of an innovative and cost-effective human identification system has to be done. EEG based system is a fool proof authentication system with high reliability and can be used in the area of great security interests.

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