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BIOMETRIC IDENTIFICATION SYSTEM USING EEG SIGNALS: A REVIEW

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ABSTRACT

An overview of current developments in high accuracy EEG biometric user identification is given in this review paper. In addition to highlighting the most recent findings and advancements in this area, the article addresses the prospective of EEG biometrics for trustworthy and secure user identification. The paper also looks at the drawbacks and restrictions of EEG biometrics and considers possible future paths for study and advancement. This paper's overall goal is to give readers a thorough overview of the state of high precision user identification with EEG biometrics today and to provide guidance for future developments in this field.

Analyses of brain waves obtained using a consumer-grade EEG equipment explore the device's potential for user authentication and identification. The P300 element of event-related potential (ERP) information gathered from 14-channel-related EEGs on 25 patients is statistically significant, to start. Next, alternative combination of a method for reducing dimensionality and a classification algorithm are used, and their user identification performance is compared using a range of machine learning techniques.

Keywords- EEG biometrics, User identification, High accuracy, Brainwave authentication, Biometric security, Electroencephalography User authentication, Biometric recognition, Neurotechnology, Biometric identification.

I. INTRODUCTION

Over the past ten years, researchers have focused a lot of emphasis on biometric identification and authentication—the recognizing of individuals depending on their distinct physiological or behavioral features. Brain signaling is one of the most potent candidates among the currently available biometric features because of its extremely distinctive nature, that making it hard to copy or steal. Recent research has shown that electroencephalography (EEG), a widely used noninvasive technique for recording brain activity, is an effective method for developing biometric systems because of its affordability, portability, and ease of use when compared with other non-invasive brain signal acquisition designs. An subject whose eyes can be opened or closed and who can experience active reaction states is seen to provide EEG signals during a peaceful rest state. These signals have been reported to be robust carriers of unique personality traits.

II. METHODOLOGY

1.Eeg-Mi Methodology With A Highly Recognizable Accuracy:

In the security domain, series of data-based feature extraction techniques like AR and PSD have lately been used to create personal identity models instead of CSP. However, due to its high identification of users and accuracy, our investigation showed that the EEG-MI methodology is appropriate for biometric authentication systems [5]. This methodology was applied with the CSP feature collection technique and the SVM classifier based on the EEG-MI datasets. Similar to this, T. N. Alotaiby et al. demonstrated that the CSP–SVM combo offers a highly identifiable user correctness (95.15%) , despite the fact that our results indicated an accuracy that was 3.82% greater than theirs. Additionally, our results consistently demonstrate great accuracy in ensuring personal identity for each of the 54 participants.

2.Difficulty Classifying The One User From The Non-Users:

In the sphere of security, we employed the CSP–SVM methodology, which denotes one approach to distinguish a single user from a group of users using EEG-MI signals. Because most research focuses on recognizing other biological cues, including the iris and fingerprint instead of brain waves, our proposed model is uncommon. Identifying the brain signals collected during cognitive activities and non-tasks as done by a user was another

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area of emphasis for many researchers[7] . Furthermore, earlier research has yielded comparatively poor efficiency: Andreas M. Ray previously reported that a mean accuracy for classification of 75.30% was reached using 27 healthy volunteers. Using a total of 18 individuals, a recent study found that the average classification accuracy was 71.20%.

3.Proposed Methodology For Estimating the Number Of Users:

To make up for CSP's limitations—small datasets make it less accurate—we calculated the bare minimum of users needed to guarantee the trustworthiness of utilizing of the categorization findings. Using the tiny dataset IVa, we were able to verify that a data size equal to five persons is a feasible data size for guaranteeing the proper dependability. The dependable HTER findings obtained by utilizing the CSP–SVM combo are shown in Figure 8. Since the number of users affects the data size, it is acceptable to estimate the minimal number of users in terms of information security. Numerous studies have already documented that conclusions from too-small data sets are not very accurate .

III. MODELING AND ANALYSIS

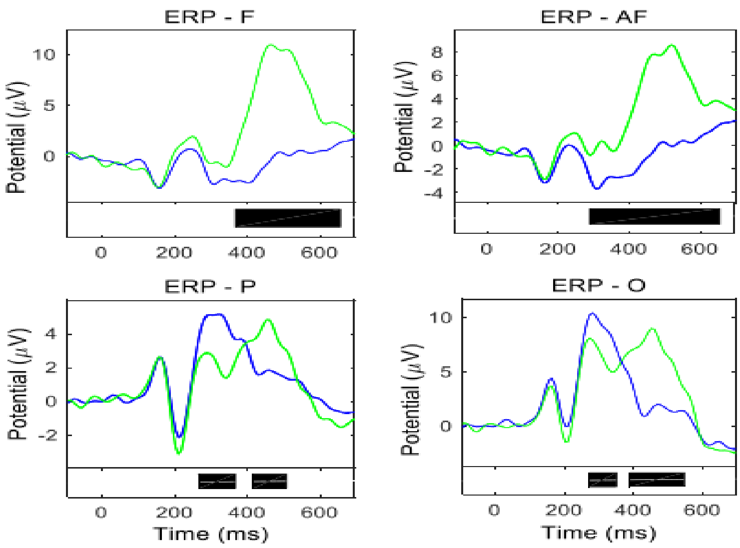

Fig 1: Grand average ERP from frontal (F), pre-frontal (AF), occipital (O), and parietal (P) lobes (green: target card, blue: non-target card).

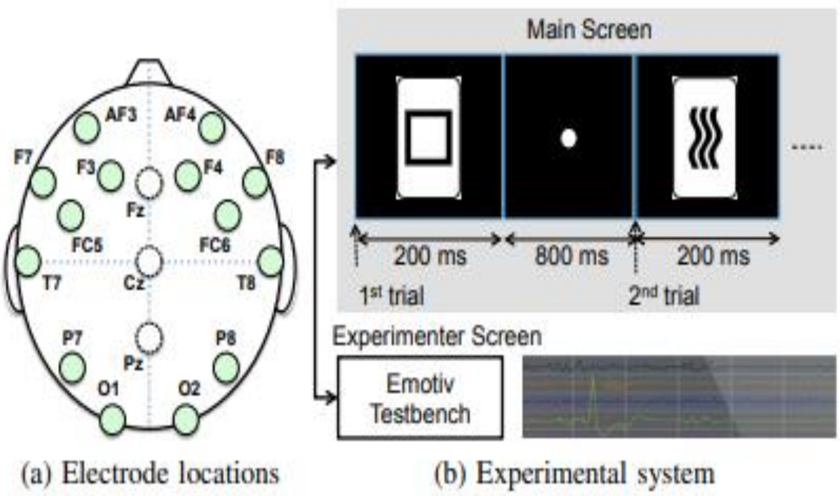

Fig. 2: Experiment protocol with Zener cards [18] displayed on the main screen. The real-time EEG data are captured and monitored on the experimenter's screen using the Emotiv Testbench software

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IV. RESULTS AND DISCUSSION

Literature Survey:

1. EEG based Brain-Computer Interface:

This essay examines a wide range of Brain-Computer Interfaces literature in order to provide readers with a concise overview of the area. lack a great deal of expertise conducting BCI research. We discovered that the four basic components of a BCI system are feedback, application interface, signal processing, and signal acquisition. There are several different implementation strategies for each module, each having advantages and disadvantages. Considering its commercial application for everyday life and research, as well as its ease of access, the adoption of EEG appears most realistic. Most of the time, the selection of different signal processing & classification techniques depends on the application. However, the many approaches that were examined can be divided into four groups: deep learning, matrix & tensor classifiers, adaptive classifiers, and transfer learning techniques [8].The use of BCI extends beyond its use as a communication aid for individuals with severe disabilities. The benefits of this field are also being utilized by a number of other industries, including entertainment, automation, security, and education. However, there are still certain problems with the BCI that need to be resolved. We are at the early stages of a moderately major revolution that will transform BCIs from a tool that is limited to specific applications to one that is widely used. Lastly, we hope that this poll helped the readers gain a brief understanding of BCIs—their concept, potential, and limitations.

2. Multimodal EEG and Keystroke Dynamics Based Biometric System Using Machine Learning Algorithms:

In this study, we present a multi-modal system for user authentication and identification that combined keyboard dynamics with EEG data. Our multimodal system has been integrated into the popular password/PIN-based authentication system. This eliminates the need for end users to adjust to a new authentication procedure, hence decreasing their annoyance. The password will be used for permission, and the pattern of behavior can be utilized to identify the user using a confidence level using the attributes that were gathered from the input data. Using the pre-processed data, we applied a range of machine learning computational methods and chose a model based on accuracy along with additional performance indicators. To further enhance the multimodal system's recognition performance, we trained unique, customized models for every user [9].

Users were categorized as authentic or fraudulent using the customized models. Additionally, we created a quick binary template matching technique for authentication and identity. To the best of our understanding, it's the first time that keystroke dynamics and EEG biometrics have been combined into an integrated system for authorization and identification. With the help of the hard-to-copy EEG signal & Keystroke Dynamics, which accurately records the user's typing rhythm and behavior, this solution offers further security levels. We have talked about a number of our system's shortcomings despite its advantages, and we will address these in our upcoming research. Additionally, we think that this demonstration will stimulate more research into these multifunctional systems, which can subsequently be used to various industries.

3. Individual Identification Using Cognitive Electroencephalographic Neurodynamics:

The suggested neurodynamic connectivity-based user identification system investigates how it might develop into a powerful future tool for unique identification. The current top-down SSVEP paradigm utilizes a highly compressed stimulus presentation, in contrast to most earlier investigations in SSVEP-based neurological technology, which invariably need large ocular motions.[1] Consequently, our new paradigm for EEG-based forensics & security offers an identification method that does not require gaze change. Theoretically, this unique strategy could leverage top-down cognitive traits assessed by individual neurodynamic causative connectivity—a technique that could eventually be valuable for security and forensics procedures. According to this study, individual top-down EEG signals offer strong and promising identifiable features that facilitate useful and adaptable user recognition applications. [10]. Methodology for User Biometric Identification Using EEG-Based Motor Image Signals.This survey investigates the EEG-MI approach to user identification.

According to this study, human top-down EEG signals offer strong and promising identification features that can be used for a variety of useful and adaptable user-recognition applications [10].

4. User Biometric Identification Methodology via EEG-Based Motor Imagery Signals:

In order to increase the reliability of users by ensuring that one user can be reliably identified from other non-users, the study investigates the EEG-MI method for user identification. We compared optimal classifiers with four different

feature extraction techniques. Among all combination methods, the CSP–SVM technique yielded the greatest identification result, with a detection rate of 98.97%. Additionally, the GNB classifier yielded the largest identification difference (47.23%) between CSP, which had its greatest accuracy (97.47%), with AR, which had the lowest accuracy (50.24%). Although CSP offers excellent performance, its sensitivity to data amount is quite significant. Consequently, we are able to ascertain the quantity of the dataset required to ensure CSP performance, even at moderate data scales [11].This work contributed to the development of the best user identification method for the EEG-MI methodology by significantly improving user identification accuracy.

Challenges And Ethics:

1. Methodological Challenges:

A full and thorough comprehension of how the brain functions and influences certain behaviors and decision making processes is still lacking in current neuromarketing research. Currently, brain activity at the human neuron level cannot be recorded using the popular neuromarketing methods of EEG, MEG, and fMRI. Thus, to fully comprehend these intricate relationships, advancements in data collection and processing techniques are needed. Sustained progress in these areas will contribute to the creation of goods and services that unquestionably satisfy customers' needs, both implicitly and explicitly.[3] Furthermore, real-time simulation of the dynamics produced by physiologically plausible synthetic neural assemblies can be achieved through the use of field programmable gate arrays (FPGA) and brain-inspired computing .

There have been reports of neuromarketing systems based on EEG. The main obstacle to employing EEG in this kind of research is noise interference. Unwanted electrical devices are included in the EEG brain activation .It is difficult to eliminate the large amplitude of background electrical brain activity brought on by irrelevant marketing stimuli. It is not a simple or practical undertaking to conduct a large number of tests per condition in order to accurately measure the real ERPs [4].. In order to eliminate the undesirable signals, preprocessing methods like filtration and regression are suggested in the literature. Environmental noise, experimental error, and physiological changes in the body, such as changes in muscle, heart rate, and eye movement, can all be sources of artifacts.

2. Ethical Challenges:

There are moral questions raised by the ongoing research and development of techniques that can track and eventually modify human decision-making. The main ethical worry is that neuromarketing shouldn't interfere with consumers' ability to make free decisions. According to Consumer Alert's (2003) description. Advances in the neuromarketing domain may impact customers and ultimately result in the elimination of their free will.

The capacity to influence or forecast customer decision, predict choices made by customers, transparency, quality certification, and privacy are examples of potential risks.[6] Customers' choices and decision-making are influenced by their interest in commercials and their emotional and physical attachment to the products. Customers experience consoling sentiments from advertisements, which foster empathy and a sense of affiliation.

On the other hand, cautious and moral research in the area might actually serve to lower the likelihood of such issues, Standard guidelines are required should be put into practice with the intention of using neuromarketing solely to improve the purchasing experience for customers rather than turning them into robots who make decisions for them.

Despite these difficulties, neuromarketing is still a developing area, largely because of the possible financial benefit. Therefore, in order to guarantee that customers and society as a whole gain from and are shielded from further advancements, it is imperative that we continue to have an open dialogue and promote scientific understanding grounded in the fundamentals of neuroscience and psychology. [8]

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V. CONCLUSION

According to the studied literature, EEG biometrics have great promise as a dependable and highly accurate technique of user identification. The difficulties and constraints that come with EEG technology have been addressed by researchers through the development of numerous strategies and tactics, which has improved the technology's security and accuracy. EEG biometrics has several potential uses in fields like consumer electronics, healthcare, and security systems. Recent advancements in neurotechnology have also helped to improve EEG biometrics for user identification.

EEG is a promising biometric identification method that can help stop identity theft and unlawful access because of its superior accuracy and security features. Furthermore, because EEG biometrics can enhance safety and user authentication procedures, it has important ramifications for many different companies and sectors.

Overall, because of its great precision and dependability, EEG biometrics has the ability to completely change biometric security in the future. Significant improvements in user identification & security protocols may result from the ongoing development and implementation of EEG biometrics into numerous sectors.

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