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EEG Based Brain Fingerprinting Using MERMER Technology

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Abstract: The criminals to be detected by usage of DNA testing has preferred before, but now due to technological innovation, a new technique called Brain fingerprinting technology has developed. Brain fingerprinting technology is the computer based technology, used to find trespasser's crime accurately by using brain wave responses of the criminal. In any crime, there should be evidence; the evidence can be analyzed by using Electroencephalography (EEG). Forensic science gives information about the specific crime to judges and juries who handle this case. When a person commits the crime that we suspects, then unique brain wave pattern of that person is displayed on the screen. By using magnetic response imaging, it can also detect whether the person is induced by other to lie, in that case, it shows different wave pattern. In criminology field, lie detector is developed in USA. Brain fingerprinting technology is one of the best lie detector studies. It provides 100% accuracy among 120 tests.

Key words: Brain Fingerprinting · EEG · MERMER technology · RSA algorithm.

INTRODUCTION

Brain fingerprinting technology was developed in 1995. It is a brain computer interaction. Brain fingerprinting technology was introduced by Dr. Lawrence A. Farwell. It is a newly developed forensic science technique, which is fully based on action of brain through electrical signals. It is used to detect whether particular information about crime is stored in subject's brain [1]. Recording and analysis of neurological (brain) responses to pictures, that are visible on computer screen of a suspect person to resolve whether the person is telling the truth or not. Farwell's Brain fingerprinting origin used brain response known as p300. Later he developed MERMER ("Memory and Encoding Related Multifaceted Electroencephalographic Response") technique. MERMER technique includes p300 and additional features [2]. This technique is an electrical signal, which is the part of the brain wave response. If the brain detects any information about crime, there is a change in brain wave signals. MERMER technique provides more accuracy than p300 alone. This test can be done as little as 10 minutes. When research is done individually, William Laono and few others followed similar scientific protocol, which gave same high level of accuracy. This technique is applied only in case of investigators have sufficient amount of information about that crime that would be known only by criminal and investigators. It is referred as *'guilty knowledge test'*.

This guilty knowledge test depends on emotions based on physiological signals such as blood pressure, heart beat rate and palm sweating.

Fig. 1: Signals from various measures induced on stimuli

Techniques: Brain fingerprinting technology uses a MERMER technology. A person is tested under this technique wears a special headband with more number of electronic sensors (electrodes) produces waveforms on the EEG.

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Generally, electrodes are placed of two different types.

- Invasive (electrodes are attached directly to the brain tissue).
- Non-invasive (electrodes are placed directly on the scalp).

The person who is tested is given a set of irrelevant stimuli, words and pictures or relevant stimuli, words and pictures. Different types of stimuli used in this technique are irrelevant, target, probe. It uses an electrical signal known as p300, which is present in each person's brain. It produces special stimuli for every 300 milliseconds once the criminal is found [3]. The interpretation checks for the response of the p300 for the questions related to crime. It displays the weapons on the screen, which was used by the criminal. By the usage of EEG signals, it does not depend upon verbal responses to stimuli. Brain fingerprinting technology does not depend upon emotional responses of subject. The EEG consists of four waves, namely alpha waves, beta waves, delta waves and theta waves [4].

Delta Waves: Delta waves are obtained during deep sleep, extremely deep meditation. Its frequency ranges from 0.5 to 4Hz.

Fig. 2: Observation of person by using EEG

Theta Waves: Theta waves occur during emotional stress, disappointment, day dreaming, drowsiness, etc. Its frequency range is from 4 to 8 Hz [5].

Alpha Waves: Alpha waves normally occurs in relaxed conditions such as deep relaxation, imagination, intuitive thinking. Its frequency ranges from 8 to 12Hz.

Beta Waves: Beta waves occur only when the person is in active state. Its frequency ranges from 12Hz and above.

Brain of the perpetrator is always under four phases.

- Brain fingerprinting crime scene evidence collection.
- Brain fingerprinting brain evidence collection.
- Brain fingerprinting computer evidence analysis.
- Brain fingerprinting scientific result.

Brain Fingerprinting Crime Scene Evidence Collection (1st Phase): It explains that the investigators visits the crime spot and collect the information regarding to crime. It is needed to provide words related to crime for further investigation. Compared with many scientific tests, Brain fingerprinting technology gives very useful evidences for judges to provide judgment [6].

Brain Fingerprinting Brain Evidence Collection (2nd Phase): After submission of evidence for investigation, it is useful to determine whether the evidence is match with suspects. It involves EEG sensors. It is the analysis for the competition between the crime place information and the proof from suspect's brain. The investigators first checks with the information said by the subject, if it doesn't match, then he goes for fingerprint matching. If the subject is present in the crime place for some other reason and if the fingerprint doesn't match, then they will investigate for a genuine reason.

Brain Fingerprinting Computer Evidence Analysis (3rd Phase): It is the scheme and test of brain waves that includes the use of complex mathematics for getting the outcome that reveals whether the suspect is a culprit or not. From the previous steps, the input is obtained in the form of probes. The output is to establish whether the information is present or absent for these probe stimuli with a combination of algebraic assurance.

Brain Fingerprinting Scientific Analysis (4th Phase): The result is obtained in two methods:

- Information is present.
- Information is absent.

Depending on the screen, design of brain waves will conclude whether information is present or not. This result depends on scientific testing only. This technique works simultaneously excluding the evidence got from the

crime place and from the suspect is informational evidence rather than physical evidence [7].

The graph shows whether information is obtained on the screen or not and that specific information depends upon three different colored lines [8, 9].

RED: The suspect only expected to know the information about the crime.

GREEN: The suspect is unaware of the information about the crime.

BLUE: The suspect only knows the information about the crime.

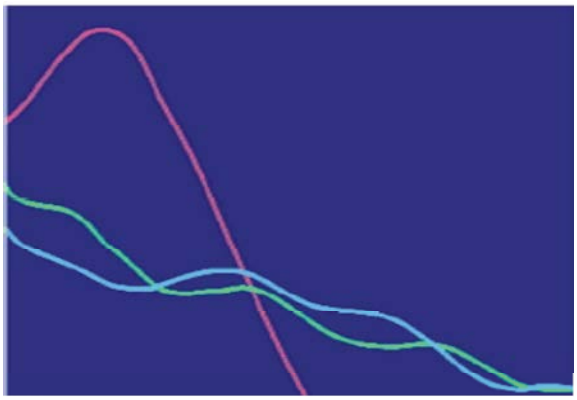

Fig. 3: Information Absent

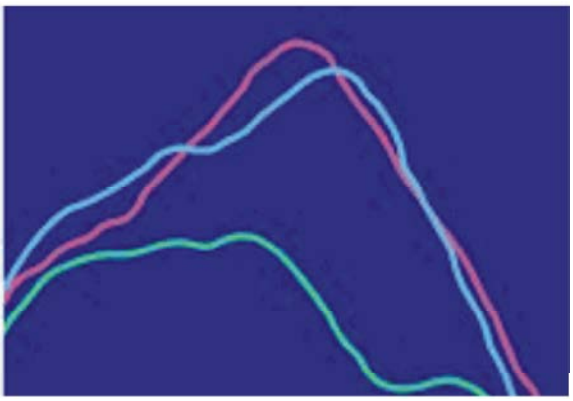

Fig. 4: Information present

Proposed Method: In this proposed method, headband with silver chloride electrodes is used which helps to reduce the time required for the observation. Silver chloride electrodes were fabricated from solid materials. By the usage of silver chloride electrodes, number of electrodes required for EEG can be minimized. This in turn helps to reduce the cost required for this technology. The principle of silver chloride electrodes is the process of conversion of ion current of human tissue to electron current to be delivered through lead wire to the EEG instrument. This helps in minimizing the timing range. It helps to determine the role-layed by the suspect at the crime scene, even if the suspect lies.

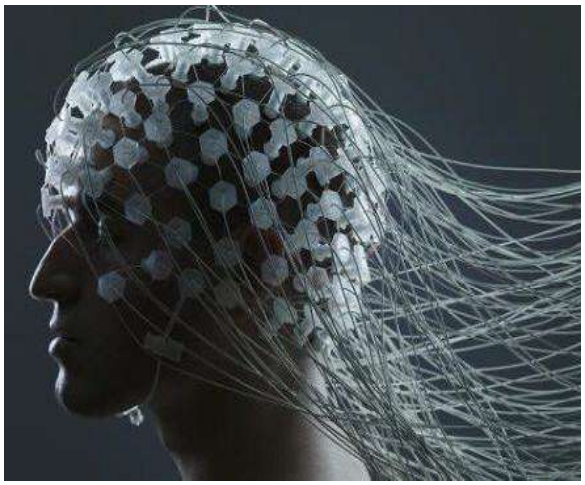

Fig 5

Fig. 6: A numerous electrodes used in fig 5, can be reduced to less number of electrodes which is shown in fig 6, due to silver chloride electrodes.

The person is guilty and not guilty according to following rules:

Not Guilty: From the graph, not guilty occurs when blue and green lines closely correlate.

Guilty: From the graph, guilty occurs when blue and red lines correlate.

We can obtain 'a', when 'c' terms and we product 'b'. This algorithm helps to record each actions of brain and thus it works effectively.

RSA Algorithm: The RSA (Rivest-Shamir-Adleman) algorithm is the essential cryptosystem.
This works based on few steps as follows.

- If a= bc,

Where,
b, c = large prime digits.

We can obtain 'a', when we product 'b' and 'c' terms. This algorithm helps to record every actions of brain and thus it works effectively.

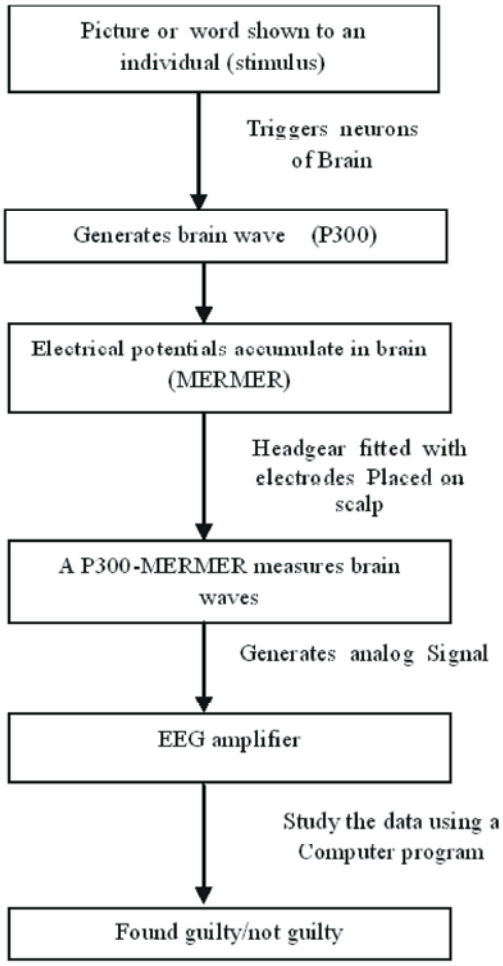

Fig. 7: Flow diagram for experimental design

Applications

Medical Applications: It helps to detect the symptoms of Alzheimer's disease, depression and neurological disorders. It also helps to identify the person is affected by medications. It helps to improve the health care and quality of life for many numbers of people. It uses MERMER technology, which was analyzed by researchers and thus provides more sensitive measurement than P300 alone.

Counter Terrorism: It is the best method to identify terrorist participated in terrorist activity either directly or indirectly. It helps to identify who plays a leadership role in the terrorist organization. It also helps to detect the sleeper cells those were not active even for many years. In this technique, rebel knows the organization, training and plans of the terrorist act whereas an innocent person is unaware of the plan.

Advertising Applications: In this application, Brain fingerprinting laboratories will produce important advances in determining the operation and media effectiveness. This technology helps to determine whether the information is present in the memory of the particular person regarding the product idea. This technique adds an intact novel aspect to the methods of advertisement dimensions. The implications for this application are very stirring.

Insurance Industry Applications: This technology helps to reduce the insurance fraud by determining if the individual has committed any criminal act. It can also help to identify specific knowledge, involved in computer crimes where there is no witness or physical indication related to crime is just took from the individuals brain. It also detects real life events.

Criminal Justice: Brain fingerprinting technology identifies whether the information is present or absent and the information includes terrorist's acts and its associations. It determines a trained terrorist who has the ability to commit terrorist acts in future. This technique is used in 60 to 70 percent of major crimes. There is no scientific technology for high accuracy determination of suspect of the crime, until the innovation of Brain fingerprinting technology.

Advantages:

- Identify the criminals quickly and effectively.
- It gives 100% accuracy.
- It helps to detect terrorist and their group members.
- Cost fabrication for this technology is less.
- Human rights oriented.
- Reduce evasion of justice.
- Helps to determine the role played by the individual in crime place.
- Number of electrodes is reduced.

RESULT

MERMER brain reaction can be identified by different methods using different data features.No methods can imprison data in a similar form.The successful method provided a visual portrayal of the brain response differences, which involves plotting the average response to probe, goal and immaterial stimuli as voltage over time at exact scalp mark. Figures 8 and 9 represents the average brain responses to probe, goal and immaterial stimuli for two of the subjects.Figure 8 represents statistics for a subject who knows all the information regarding the investigated result. Figure 9 represents statistics for a subject who has no information regarding the investigated event.

These figures plot the voltage over time at the parietal (Pz) scalp location. In these figures, the MERMER appear as a positive voltage peak in the region of 500 ms followed by a negative voltage deflection maximal at approximately 1200-1500 ms.(the latency of the deflections vary according to the velocity of the subjects brain indulgence). The brain responses of the two subjects whose data are accessible here are their personality groups, knowledgeable and not knowledgeable. It can be clearly seen in figures, for the well-informed subject (figure 8), the MERMER brings out the response to both target and probes and for the subject who was not well-informed (figure 9), the MERMER brings out only the reaction to target.

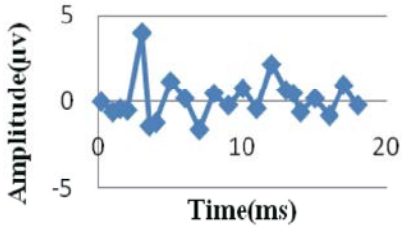

Fig. 8: Information present brain response

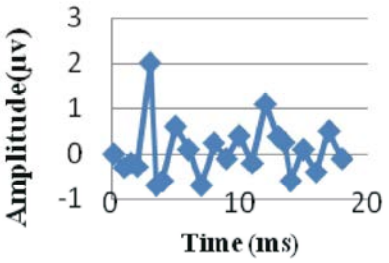

Fig. 9: Information absence brain response

CONCLUSION

Brain fingerprinting technology is the most useful method in forensic science to detect the criminals effectively, agencies, investigators, etc. It provides high rate of success. It fulfills the critical needs of government, law enforcement especially in the field of criminal cases. If research study determines that brain MERMER testing is reliable enough, that could be introduced as evidence in court and it may be the foremost investigative means for the future.

REFERENCES

1. www.ijarcsse.com
2. www.scribd.com
3. Farwell, L.A. and E. Donchin, 1986. The brain detector: P300 in the detection of dishonesty. Psychophysiology, 24: 434
4. Farwell, L.A., 1995. inventor. Method and apparatus for truth detection. US patent 5,406,956.
5. Dalbey, B., 1999. Brain Fingerprinting Testing Traps Serial Killer in Missouri. The Fairfield, IA,
6. www.d.umn.edu/~rlloyd/MySite/Mind../Brain%20Fingerprinting.ppt
7. www.brainwavescience.com
8. Dinesh Chandra Jain and V.P. Pawar, 2011. The Brain Fingerprinting through Digital Electroencephalography Signal Technique. IJCSE, Volume 3 March 2011.
9. http://en.wikipedia.org/wiki/Brain _fingerprinting