A Review of Brain Fingerprinting Process

Nikita Sharma[1]
Computer Science Department, Amity University, Address,
Gurugram, Haryana, India
Niku.sharma8@gmail.com
Srashti Verma[2]
Computer Science Department, Amity University, Address,
Gurugram, Haryana, India
srashtiverm@gmail.com
Pooja Batra Nagpal[3]
Computer Science Department, Amity University, Address,
Gurugram, Haryana, India
poojabatra9@gmail.com

Abstract

Brain fingerprinting is a new scientific technology introduced by Dr. Lawrence Farwell. Brain Fingerprinting uses electroencephalography (EEG) to determine whether in the person's brain the specific information is present or not. This technology involves working on P300 MERMER (Memory and Encoding Related Multifaceted Electroencephalographic Response). Using this technology a subject's brain response and their electrical brainwave are recorded and measured. When the human brain recognizes important information it triggers a special electrical signal called MERMER. A terrorist or other dangerous person can be identified by measuring person's "brain print" whether they are familiar with a given phrase, sound, or photo. Specific pattern is revealed in EEG when brain process event related information. Brain fingerprinting does not require verbal response to question or stimuli from the subject. Brain fingerprinting doesn't detect lie, anxiety, or feeling. Brain fingerprinting computes whether information is present or not.

Keywords: Electroencephalography; P300-MERMER ,Brain Fingerprinting

1. Introduction

Brain fingerprinting technology is based on the fact that certain activities are generated by our brain, as all of our activities are being stored in brain, brain stimulus reacts acc. to those different activities. Brain generates certain brain wave pattern when it encounters a familiar stimulus and all these patterns using some technology helps in detection. When a person is happy, a different stimuli will react, when sad or nervous a different stimuli will react which helps in detection of situation. The person is being encountered with some situation and if that situation is familiar then a brain wave pattern will be generated comparatively with non-lying condition and thus helping in lie detection.

Brain fingerprinting technology was developed in UNITED STATES OF AMERICA and is capable of detecting smart criminals who can pass polygraph test (popular lie detection test) quite easily. Even if the subject intentionally tries to hide the information, the waves generated by brain are capable to identify it because it is not like POLYGRAPH which is based on emotions. According to (Farwel,2012)Brain processing for any info reveals a specific pattern in EEG. It uses P300 brain response to detect info stored in brain. P300 Mermer provides greater accuracy and statistical confidence. As electrical p300 signals are being emitted by each individual's brain hence in forensics, stimuli detection like murders face or victim p300 is used. Brain is central to all human acts, if evidence of some event is not present since brain is always present, documenting, recording events and we can use it for obtaining info. As per (Kumar Ravi,2012)It is being detected scientifically because it tells us difference between perpetrators and falsely accused (innocent), as perpetrator is having analysis of crime scene within his brain and crimeless don't. When the crime occurs the whole story is being stored in perpetrators brain and later on it is being retrieved from his brain for investigation.

2. Related work and methodology

POLYGRAPH test or lie detection test sometimes used in police investigations is used to check whether a person is lying or not while answering the questions. It is also used while executing for a work, person will have to sustain this test like applying for some govt. job with FBI or CIA require polygraph test. As per (L.A. Farwell,2012) When an individual takes Polygraph test, he is being attached with 4-6 sensors. These sensors produce different signals and are recorded on moving paper i.e. graph. Usually the sensor records-

- Person's respiratory activities
- Person's cardiovascular activities
- Person's beat
- Person's perspiration
- Also muscle movement

Analyst asks some specific questions for establishing norms for one's signals. After then major test begins and valid question related to crime are being asked and accordingly graph is created. Both during and after the test graph are being checked and judged for significant changes of signs on any questions. The person is lying or not is decided on the basis of significant change in graph.

When a perfect analyst detects, it can detect liar with high accuracy as different people reacts differently while lying and they will be having different graphs at that stage. A polygraph test is not exact and can be proved wrong. Then comes a technology called Brain Fingerprinting by Lawrence Farewell and this technology is not based on emotions just like polygraph rather it checks information stored in one's brain and matches it with evidences and then gives us result.

3. Operation of Technique

It determines whether a specific info is present in someone's brain or not. The subject wears an electronic sensors special headband to measure electroencephalography from several locations on scalp. According to this technology, the subject needs to face irrelevant and relevant stimuli, words & pictures. Now brain will give response to these different types of stimuli allowing analyst to identify whether the results (probes), are similar to relevant or irrelevant responses.

Due to activation of some special stimulus because of some special activity being done, brain emits certain electrical signal approx 300ms known as P300. This technology uses these responses of crime related stimuli for eg. Murderer weaponry or a criminal's face. Brain Fingerprinting is based on EEG hence there is no requirement for oral answers to questions or stimuli by testee. It uses cerebral brain response and never depends on feelings or emotional results. It is quite separate from Polygraph as polygraph checks one's emotions or corporal (physiological) signals such as sweating, someone's changed heart rate and blood pressure. Dissimilar to polygraph it never tells us that testee is not telling truth and is lying fairly it channel brain reply to applicable phrases or images to sense either the related info. is present in its brain or not.

4. Phases of FARWELL Brain Fingerprinting-

In Brain Fingerprinting proof is recognized and gathered from the misdeed scene and conserved appropriately. It is being checked for detection. According to (Farwell et al, 1988) Brain Fingerprinting works on fact that info. collected from both the places i.e. from the crime scene as well as from one's brain must be same, it must be informational evidence rather than physical evidence.

1. Brain fingerprinting fault sight data compilation;
2. Brain fingerprinting brain proof gathering;
3. Brain fingerprinting computer data study;
4. Brain fingerprinting technical outcome.

During 1st phase-

In this, Farewell Brain Fingerprinting an analyst checks a offence picture and collects evidences and information from there. Vital fear to all these phases of law enforcement govt., private investigations and intellect operations are detection of concealed info. In forensic science a new paradigm is being presented which detects info. directly on basis of electrophysiology manifestations of info.

During 2nd phase-

In this phase experts conduct brain evidence collection for determining whether the proof from crime picture matches with the brain of suspect or not. Brain Fingerprinting utilizes MERA (Multifaceted Electroencephalographic Response Analysis) to detect stored info. A MERMER is obtained when testee identifies and computes an incoming stimulus which is significant, if some irrelevant stimulus is seen it is not not-worthy and MERMER is absent.

During 3rd phase-

In this phase, the Bain Fingerprinting system makes mathematical determination for the info. is present in brain or not and then frames a statistic for same.

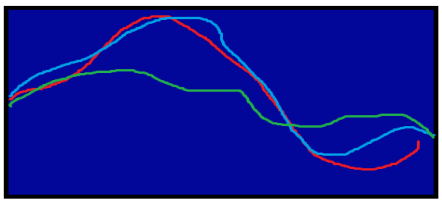

Fig 1. Mathematical wave form of brain

During 4th phase-

- The statistics framed there constitutes the technical product of Farewell Brain Fingerprinting: either "information is present"- if the information of sin is present in brain of test, or "information is absent"- if the information of sin is not present in brain of test

5. Calculative Analysis

Brain Fingerprinting incorporates the following protocols. According to (Farewell,2001)Subject is presented with words and pictures on a computer screen as stimuli. There are three types of stimuli

- Irrelevant stimuli: it contains information not appropriate to the crime and subject. It consists of incorrect but possible crime features. It is insignificant in context. so, it does not elicit a P300-MERMER.
- Target stimuli:. All the relevant information related to crime which the subject knows. Whether he is involved in the crime or not. Target does not elicit a P300-MERMER
- Probes stimuli: It contains information relevant to the crime. Details only the person present at the crime scene knows. Probe elicits a P300-MERMER. Innocent subject has no knowledge about it. so, probe does not elicit P300-MERMER

List of targets is given to the subject, then he is asked to press a when target appear on the screen and press different button for other stimuli. EEG sensors are placed in a specially designed headband which measures the brain response. A computer based program is used to determine the existence or non-existence of information.
Three colours represent three types of stimuli:

- Red: It represents Target stimuli.
- Green: It represents irrelevant stimuli.
- Blue: It represents Probe stimuli.

If the suspect has the knowledge of crime, then red and blue lines are closely correlated due to the elicitation of P300-MERMER otherwise green and blue lines are correlated due to the absence of P300.

6. LIMITATIONS

- Brain fingerprinting detects brains responses & provides us info stored in the brain of subject but it doesn't tell us how the info is stored in brain i.e. either it is witness or perpetrator.
- In case of general screening brain fingerprinting is not relevant or appropriate, if the investigators are not having any idea about crime the individual have committed.
- It can be used to detect a person as FBI agent or AlQaeda-trained terrorist or a member of any illegal organisation or terrorist cell because of his/her knowledge about the same.
- It detects info. present in brain not detect lies. During the test neither questions are asked nor it tells the truth, all what we get is info stored in brain.
- Subject's memory is the base of brain fingerprinting. As all the witness testimony depends on subject's memory.

Compared to the judgment of judge and jury, brain fingerprinting is not as much effective. It can't take place of investigation done by investigator.

7. Admissibility of brain fingerprinting-

Some relevant features of brain fingerprinting when its admissibility is being tested in court are-

- It is being tested scientifically and thoroughly.
- Its theory and application are been subjected to peer review and publication.
- Error rate are quite low.
- In relevant scientific community this theory gained acceptance.
- It is non-testimonial and non-invasive.
- As evidence of murder conviction of Terry Harrington brain fingerprinting has been ruled admissible.

8. CONCLUSION

Brain fingerprinting is a new advanced technology in the field of criminology. It helps in detecting the perpetrator among the innocent people. It has high degree of accuracy. It can be used for Counter terrorism (determine those who are involved in illegal activities and those who are not), Criminal justice (perpetrator has a record of the illegal event stored in his brain and the innocent subject does not), Medical, Additional applications.

References

[1] Farwel LA,Donchin E .(2012) " The brain detector.P300 in the detection of deception. Psychophysiology"

[2] Kumar Ravi (2012) " Brain Fingerprinting", Compusoft- An International Journal of Advanced Computer Technology,Vol 1,Issue 2

[3] Farwell LA.(2012) Brain fingerprinting: a comprehensive tutorial review of detection of concealed information with event-related brain potentials. Cognitive Neurodynamics.;6(2):115-154. doi:10.1007/s11571-012-9192-2.

[4] Farwell LA, Donchin E.(1988) Event-related brain potentials in interrogative polygraphy: analysis using bootstrapping. Psychophysiology. 25(4):445.

[5] Faewell LA, Smith SS (2001) Using brain MERMER testing to detect concealed knowledge despite efforts to conceal. J Forensic Sci 46(1):135–143.