Brain Fingerprinting:An Overview

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***Abstract*—any crime is bound to leave evidence, be it physical or mental. While physical evidences can be tampered with, a mental image is always permanent or in other words the brain is left with a print. This can be analyzed using encephalography and understanding of the reactions of brain to stimuli pertaining to the crime, in a suspect. The reason of this document is to describe the boundaries of the science of Brain Fingerprinting as a forensic tool and its applications.**

Keywords—Brain fingerprinting, EEG- encephalography, P300-MERMER, forensic science.

I. INTRODUCTION

Brain Fingerprinting was developed and patented in 1995 by Dr. Lawrence A. Farwell, chairman of the Brain Wave Institute in Fairfield, Iowa, and former Harvard University research associate. Brain fingerprinting is based on the theory that throughout any action, the brain plans, records, and executes all of the actions. Such details, all concealed within the brain, can now be revealed through brain fingerprinting. This technique measures how brain waves respond to specific words or pictures flashed across a screen. Pictures, both relevant and irrelevant to the actions, are shown. The relevant images should trigger memories of subject.

Basic fundamental of this technique is whether an individual recognizes specific information related to an event or activity by measuring electrical brain wave responses to words, phrases or pictures presented on computer screen. The technique can be applied only in situations where investigators have a sufficient amount of specific information about an event or activity that would be known only to the perpetrator and Investigator. In this respect, Brain Fingerprinting is considered a type of Guilty Knowledge Test

II. ARRANGEMENT OF SYSTEM

The entire Brain Fingerprinting System is under computer control, including presentation of the stimuli and recording of electrical brain activity, as well as a mathematical data analysis algorithm that compares the responses to the three types of stimuli and produces a determination of "information present" ("guilty") or "information absent" ("innocent"), and a statistical confidence level for this determination. At no time during the testing and data analysis do any biases and interpretations of a system expert affect the stimulus presentation or brain responses.

The devices used in brain fingerprinting Equipment required:

1. Personal computer
2. A data acquisition board
3. A graphics card for driving two monitors from one PC
4. A four-channel EEG amplifier system.
5. Software developed for data acquisition and analysis.

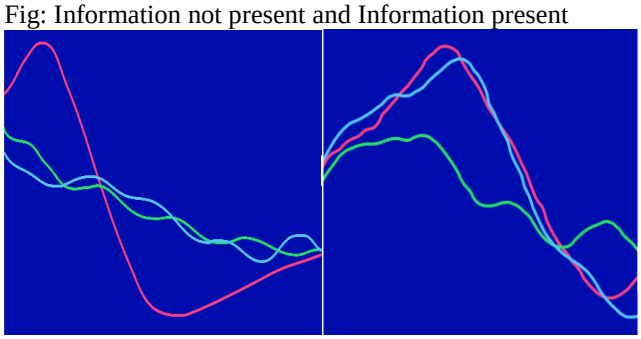
III. WORKING OF BRAIN FINGERPRINTING

Brain Fingerprinting detects information stored in the individual brain. Sensors on a headband, list the subject's EEG, or brain signal reaction to the processor images. The EEG is feed all the way through an amp and into a processor that uses proprietary software to display and interpret the brain effect. A specific, electrical brain sign reaction, known as a P300, is emitted by the intelligence within a division of a succeeding when a personality recognize and process an inward incentive that is important or notable. When an immaterial spur is seen, it is seen as being not important and not notable and a P300 is not emitted. In his research on the

P300 response, Dr. Farwell exposed that the P300 was one portion of a bigger theory reaction that he named a MERMER (memory and encoding related multifaceted electroencephalo-graphic response).MERMER comprises a P300 reaction, happening 300 to 800ms after the spur, and supplementary patterns happening more than 800ms behind the spur, given that even supplementary exact domino effect using "Many-sided electroencephalographic reaction study (MERS)", shows that a specific many-sided electroencephalographic response (MER), known as a memory and programming related many-sided electroencephalographic reaction (MERMER), is elicited when a person recognizes and processes a spur that is predominantly essential to him/her.

The MERMER includes: the P300, an electrically positive component maximal at the parietal scalp location, longer latency, electrically pessimistic subcomponent famous at the frontal scalp site, and Physic changes in the rate of recurrence and arrangement of the gesture. Three types of stimuli are presented in EEG: Target, Irrelevant, Probes.

Fig: Information not present and Information present



A. Using brain waves to detect guilty Working:

A Suspect is tested by looking at three kinds of information represented by Different colored lines:
--Red: information the suspect is expected to know.
--Green: information not known to suspect.
--Blue: information that only perpetrator would know.

B. Information not present:

Because the blue and green lines closely correlate, suspect does not have critical knowledge of the crime.

C. Information Present:

Because the blue and red lines closely correlate and suspect has critical knowledge of the crime.

IV. COMPARISON WITH OTHER FORENSIC TOOLS

The inevitable resort to any crime investigation is DNA. But what if the suspect never leaves one? That's where the science of brain fingerprinting finds its place.

Sometimes ballistic reports and other bite marks and other secondary evidences can become distorted over time but not a brains' image print. This solves a major time dependent issues regarding crime evidences.

Although hair matching proved convincingly efficient, scientists still claim to find that a single hair strand can be matched to 80 other persons provided you find the exact human premise.

Toxicology tests can prove to be unreliable sometimes on continuous testing with various other chemicals for its reaction to other chemical stimuli. Once tampered, it proves to be comparatively useless.

V. APPLICATIONS AND LIMITATIONS

Applications:-

1. To Counter National Threats:

In any crime or terrorist act, the brain of the perpetrator is always there - planning, executing, and recording the crime. There may or may not be other kinds of evidence. Brain fingerprinting technology can identify the perpetrators and planners of terrorist acts by detecting the record stored in the brain. In addition, it could be used to identify trained terrorists.

2. Criminal justice:

It has been proved to be true in 99.9% of cases in which it has been applied. So, it can be used to do criminal justice. Several instances have proven to do justice more than mere contemplating on barely available evidence like half-prints, etc.,

3. Medical Field:

In case of Alzheimer's patients can be tested for relation with any entity be it a person or a location as to whether they have a distinct recollection of the event or at least a faint memory of it.

4. Advertising:

It can be used to know the "pulse of people" by examining the information in brains of people in response to the advertisements being used for publicity. Though it's a long shot it will be a reality in the near future.

Limitations:-

1. Costly

It uses high end technology involving EEG sensors, diffusion tensor images and other positron emission tomography techniques. The equipment involved to make it feasible would definitely be very costly.

2. Scope is limited

Not many cases can afford the use of this technique. Only the critically hyped or in other cases the financially affordable innocent can attempt to use brain fingerprinting. Thus its' scope is very limited.

3. Availability

The availability of the equipment is not available everywhere.

4. Complex situations

The technique can only detect information from their memory that would place both at the scene of the crime and it cannot determine what their roles were, thereby creating a distinct possibility of an innocent eye-witness becoming a suspect of the crime and giving a dubious opportunity to the real culprit to create a situation of doubt.

VI. CONCLUSION

Brain fingerprinting is a proven powerful tool in forensic analysis in spite of the aforementioned cons. However given the rising stats in the crime sector we can't afford to simply rule out high rate of success that is inevitably visible from the many real-time applications in criminal proceeding, for instance. Brain fingerprinting in spite of its limitations is a definitive tool in revolutionizing the way criminal cases can be solved and also extending to medical and cases of national security. Thus, brain fingerprinting is a promise to a future void of tampered evidences or as a definite shot at humanitarian peace.

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