iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42979

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Unique Brain Wave Pattern Detection Using Brain Electrical Oscillation Signature Profiling (BEOSP)

Ashish L[1], Dilna A[2]
[1]*Assistant Professor, Nehru College of Engineering and Research Centre*
[2]*Department of MCA, Nehru College of Engineering and Research Center*

Abstract: ***When a person experiences a familiar stimulus, the brain emits a unique brain wave pattern, which is known as brain fingerprinting. The use of functional magnetic resonance imaging in lie detection stems from studies that reveal that people who are asked to lie have distinct patterns of brain activity than people who are telling the truth. The use of such evidence in courts is examined in detail. The author concludes that neither approach has adequate evidence of accuracy in identifying fraud to be used in court at this time. A new lie detector has been developed in the field of criminology in the United States of America. This is referred to as "brain fingerprinting." This innovation is said to be the greatest lie detector on the market right now. When a person experiences a familiar stimulus, the brain emits a unique brain wave pattern, which is known as brain fingerprinting. In order to identify lies, functional magnetic resonance imaging is used. This innovation is believed to be the finest lie detector accessible to date, detecting even slick crooks who easily pass the polygraph exam (the traditional lie detector test). The new technology uses brain waves to determine whether or not the person being tested remembers the finer details of the incident. According to scientists who are very pleased about the new kid on the block, even if the person voluntarily suppresses the vital knowledge, the brain wave will undoubtedly catch him.***

Keywords: ***Brain finger printing, sources of EEG, EEG Vs FMRI & PET, Four phases of brain fingerprinting, Applications***

I. INTRODUCTION

Brain fingerprinting is a contentious proposed research tool that analyses recognition of known stimuli by analysing electrical brain wave responses to words, phrases, or pictures on a computer screen. Lawrence Farwell is the inventor of brain fingerprinting. The hypothesis holds that a suspect's reaction to specifics of an event or activity will reveal whether or not the suspect was aware of the event or activity beforehand. To determine familiarity, this test employs Farwell's MERMER ("Memory and Encoding Related Multifaceted Electroencephalographic Response") response. Dr. Lawrence A. Farwell invented, developed, proven, and patented the technique of Farwell Brain Fingerprinting, a new computer-based technology that uses brain-wave responses to crime-relevant words or pictures presented on a computer screen to accurately and scientifically identify the perpetrator of a crime. In over 120 tests, Farwell Brain Fingerprinting has proven to be 100 percent accurate, including testing on FBI agents, tests for a US intelligence organisation, tests for the US Navy, and tests on real-life circumstances such as actual crimes. By detecting electrical brain wave responses to words, phrases, or pictures presented on a computer screen, Brain Fingerprinting can establish whether an individual recognises specific information associated to an event or action. Only in cases when investigators have a substantial amount of particular knowledge about an incident or behaviour that is known only to the culprit and the investigator can the technique be used. In this way, Brain Fingerprinting can be compared to a Guilty Knowledge Test, in which the "guilty" party is supposed to react strongly to the important information of the activity. Brain Fingerprinting, on the other hand, uses a fitted headband with unique sensors to assess electrical brain activity. Brain fingerprinting is said to be more accurate in detecting "guilty" information than traditional polygraph methods, but this is vigorously contested by specialised researchers**.** The person being evaluated wears a headband with electronic sensors that detect electroencephalography at multiple points on the scalp. The tester is presented with a number of irrelevant stimuli, words, and pictures, as well as a series of relevant stimuli, words, and pictures, in order to calibrate the brain fingerprinting system. The tester can assess if the measured brain responses to test stimuli, or probes, are more similar to the relevant or irrelevant responses by observing the test subject's brain response to these two types of stimuli.

The technique uses the well known fact that an electrical signal known as P300 is emitted from an individual's brain approximately 300 milliseconds after it is confronted with a stimulus of special significance, e.g. a rare vs. a common stimulus or a stimulus the proband is asked to count. The novel interpretation in brain fingerprinting is to look for P300 as response to stimuli related to the crime in question e.g., a murder weapon or a victim's face.

Because it is based on EEG signals, the system does not require the tester to issue verbal responses to questions or stimuli. Brain fingerprinting uses cognitive brain responses, brain finger printing does not depend on the emotions of the subject, nor is it affected by emotional responses. Brain fingerprinting is fundamentally different from the polygraph (lie-detector), which measures emotion-based physiological signals such as heart rate, sweating, and blood pressure. Also, unlike polygraph testing, it does not attempt to determine whether or not the subject is lying or telling the truth.

II. LITERATURE SURVEY

J.Peter Rosenfeld researched on " 'Brain fingerprinting': A Critical analysis"[1].After the study he concluded that One could accept that the technique is confidential and patented (indeed, there are multiple patents on P300-based detection of secret information, the earliest of which predate Farwell's), and that BF has received substantial media coverage, as mentioned above. However, there is serious doubt regarding the US government's ability to meet 34ROSENFELDurgent needs. This can be validated by reading "Federal Agency Views on the Potential Application of' Brain Fingerprinting,'" a report from the US General Accounting Office to Senator Charles E. Grassley (U.S. General Accounting Office 2001).

"Officials representing the CIA, DOD, Secret Service, and FBI do not foresee deploying the Brain Fingerprinting technology for their operations," according to the study. Officials from the CIA concluded that Brain Fingerprinting was only useful for CIA operations. Overall, DOD officials stated that Brain Fingerprinting is only partially applicable to DOD's mission. According to FBI authorities, the creator "had not supplied adequate material to support the veracity or underlying scientific basis of his assertions... the technique had limited relevance and utility to the FBI." These highlights are expanded upon in the full report, which is available on the Internet. In light of all of the preceding information, the last statement from the BF Web page just mentioned, "The technology is fully established and available for deployment in the field," is likely best charitably seen as florid advertising copy. This raises a broad question regarding this review.

When writing a technology review, one usually refers to peer-reviewed scientific publications rather than Internet marketing material. However, in the instance of BF, there is little option because, as previously said, there has only been one substantial publication based on his work.

Dhiraj Ahuja and Bharat Singh on journal named "Brain fingerprinting",2012[2] discussed and concluded that the discovery that the brain generates a unique brain wave pattern when a person experiences a familiar stimulus is the basis for brain finger printing. The use of functional magnetic resonance imaging in lie detection stems from studies that reveal that people who are asked to lie have distinct patterns of brain activity than people who are telling the truth. The use of such evidence in courts is examined in detail. In the realm of criminology, the United States of America has created a novel lie detector known as "brain finger printing." This innovation is believed to be the best lie detector currently available, capable of detecting even slick crooks who easily pass a polygraph test (the traditional lie detector test).

A research paper on' BRAIN FINGERPRINTING TECHNOLOGY: A UNIQUE TECHNIQUE THAT DETECT THE CULPRIT' by Bibin Abraham Zachariah, Dr. S.L. Vaya, Bijin Thomas Zachariah presented and concluded that Electroencephalography is used in brain fingerprinting to determine the presence or absence of information in a subject's brain based on electrical events in the brain. Brain Fingerprinting technology, as a novel forensic psychology interrogative and investigative tool, is poised to have a significant impact on the presentation and conclusion of chosen judicial cases in the near future. As the number of terrible crimes and terrorist operations increases, countries throughout the world are trying to implement alternative technologies to help combat these crimes. When physical evidence, witnesses, and other forms of information are inaccessible to investigating agencies in a case, this technology can help gain a lead and point them in the correct path, especially in blind murder cases. The technology of brain fingerprinting has undergone certain changes.

ASHWINI V. SHARMA , Dr. GANESH S. SABLE on a journal named 'Brain Fingerprinting' ,[3]and concluded that When a person experiences a familiar stimulus, the brain emits a unique brain wave pattern, which is known as brain fingerprinting. The use of functional magnetic resonance imaging in lie detection stems from studies that reveal that people who are asked to lie have distinct patterns of brain activity than people who are telling the truth.

The use of such evidence in courts is examined in detail. The author concludes that neither approach has adequate evidence of accuracy in identifying fraud to be used in court at this time. To determine familiarity, this test employs Farwell's MERMER ("Memory and Encoding Related Multifaceted Electroencephalographic Response") response. Lie detection is one of the applications. Lawrence A. Smith, M.D.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

III. METHODOLOGY

A. Electroencephalography

Electroencephalography (EEG) is a method of recording the electrical activity of the brain using electrodes implanted on the head.The electrical activity of the brain can be described on very small to relatively large sizes, just as the activity of individual transistors in a computer can be comprehended on various levels, from the activity of individual transistors to the function of applications. Action potentials in a single axon or currents within a single dendrite of a single neuron are on one end, and activity recorded by the EEG, which aggregates the electric voltage fields from millions of neurons, is on the other. The so-called scalp EEG is gathered from tens to hundreds of electrodes placed at various points on the head's surface.

B. Sources of EEG activity

Scalp EEG activity oscillates at several frequencies with varied typical spatial distributions linked with different states of brain functioning such as waking and sleeping. Synchronized activity throughout a network of neurons is represented by these oscillations. Some of the neural networks that underpin these oscillations are well characterised (for example, the thalamocortical resonance that underpins sleep spindles), but many others are not (example, the system that generates the posterior basic rhythm).

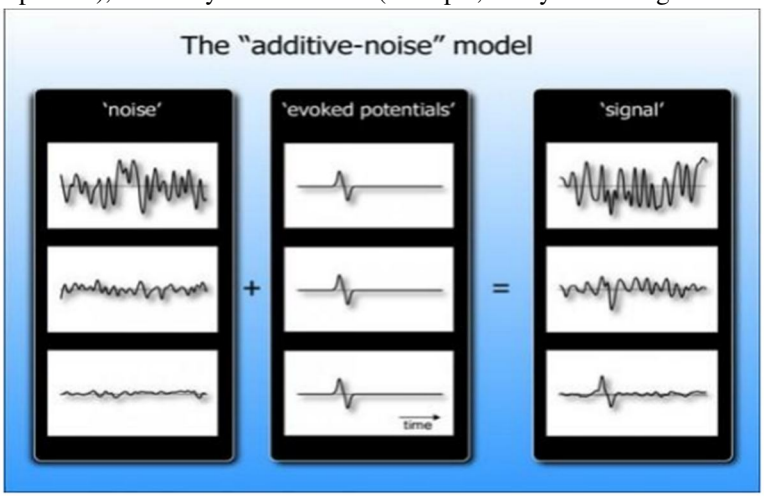


Figure 1. Noise module

As a method for investigating brain activity, EEG has various advantages. For example, its time resolution is extremely high (on the level of a single Brain Fingerprinting Division of Computer Engineering, SOE 8 millisecond). PET and FMRI, for example, have a time resolution of seconds to minutes when looking at brain activity .Other technologies, such as SPECT, FMRI, and PET, assess changes in blood flow or metabolic activity, which are indirect markers of brain electrical activity. EEG and FMRI can be used together to record high-temporal and high-spatial-resolution data at the same time; however, because the data produced from each occurs over a separate time course, the data sets do not always represent the same brain activity. Combining these two modalities has technological challenges, such as currents being created in moving EEG electrode wires due to the MRI's magnetic field.Data from these complementary high-time-resolution techniques can be merged by recording EEG at the same time as MEG.Magneto-encephalography (MEG) is an imaging technology that uses extremely sensitive equipment like superconducting quantum interference devices to assess the magnetic fields created by electrical activity in the brain (SQUIDs).

C. Method

Scalp EEG is a type of EEG recording in which electrodes are placed on the scalp. A Brain Fingerprinting Division of Computer Engineering, SOE 9 common system reference electrode is attached to the other input of each differential amplifier, and each electrode is connected to one of the differential amplifier's inputs. The voltage between the active electrode and the reference is amplified (usually 1,000–100,000 times, or 60–100 dB of voltage gain) by these amplifiers. When measured from the scalp [2], a normal adult human EEG signal has an amplitude of about 10–100 V, and when measured from subdural electrodes, it has an amplitude of about 10–20 mV. After passing through an anti-aliasing filter, the amplified signal is digitised in digital EEG systems using an analog-to-digital converter.

D. Role in Criminal Proceedings

Investigation, interview, scientific testing, and adjudication are the four stages of using Brain Fingerprinting in a criminal case. Only the third of these four phases is scientific in nature.

A skilled investigator does the first phase, an interviewer who may or may not be an investigator or a scientist conducts the second phase, a scientist conducts the third phase, and a judge and jury conduct the fourth phase. This is comparable to how other sciences are used in forensics.

If a person is discovered dead of unexplained circumstances, for example, an investigation is conducted to see if foul play was involved. If there is a suspect, the suspect is questioned to see what role, if any, he claims to have played in the incident. If it is determined that the person was poisoned with ricin or cadmium, two rare and strong poisons, scientific tests to detect these specific compounds in the body might be undertaken.

It doesn't tell us when to look for toxins, where to seek for them, or which ones to look for. Investigation will be required to provide the necessary advise on these issues. The science of forensic toxicology also cannot determine whether a suspect is guilty or innocent of a crime. The determination of guilt or innocence is a legal, not a scientific, matter, and it is made by a judge and jury, not a scientist or a machine.

1) *Phase 1: Investigation:* The investigation of the crime is the first step in using Brain Fingerprinting testing in a criminal case. An investigation must be conducted before a Brain Fingerprinting test can be performed to discover information that can be used in the exam. Brain Fingerprinting is a technique that accurately determines whether or not specific information is stored in a person's brain. It detects whether or not specific information is present in the brain. We must first decide what facts to test for before we can execute this scientific experiment. This investigation takes place before and informs the scientific portion of the Brain Fingerprinting exam. The purpose of investigation is to locate precise facts that will aid in a Brain Fingerprinting exam.
2) *Phase 2: Interview of Subject:* It can be highly useful to collect the suspect's version of the situation after evidence has been gathered through inquiry and before the Brain Fingerprinting test is undertaken to establish if the evidence can be linked to the suspect. For example, if an investigation reveals that specific fingerprints were found at the scene of a murder, a suspect can be questioned to see if his prints were there for a legal cause. If the suspect claims he was never there at the crime site, a match between his fingerprints and those found there would be extremely incriminating. If the suspect claims that he was at the location for a justifiable cause right before the crime, fingerprints must be interpreted differently, especially if there is supporting evidence of the suspect's presence at the place before the crime. The suspect's interview may aid in determining which scientific tests to do and how to conduct them. A suspect may claim, for example, that he entered and then exited the room where a murder was committed a short time before the crime, and that he never saw or handled the murder weapon. A finding that the suspect's fingerprints matched those on the doorknob would be of little value in this case, but a finding that his fingerprints matched those on the murder weapon would be incriminating. An interview with the suspect is conducted prior to the Brain Fingerprinting test. The suspect is questioned about whether he has any valid cause to know any of the information contained in the possible probing stimulus. This data is presented without specifying which stimuli are probes and which are not. "The media reports, which you no likely have seen, suggest that the victim was struck with a blunt object," the suspect would be asked.
3) *Phase 3: Scientific Testing with Brain Fingerprinting:* The Brain Fingerprinting test is where science has a role in the procedure. Brain fingerprinting is a scientific method of determining whether or not specific information is stored in a person's brain. Brain fingerprinting is a scientifically validated process. The probe stimuli, which are formulated based on the investigation and interview, are the input for this scientific technique. This scientific approach results in a determination of "information present" or "information absent" for those precise probe stimuli, as well as a statistical confidence level for that judgement. This assessment is done using a scientific algorithm rather than the scientist's subjective judgement.The following is all that Brain Fingerprinting informs us: "These specific details concerning this crime are (or are not) stored in this person's brain." A judge and jury decide whether someone is guilty or innocent based on this and all other available evidence.
4) *Phase 4: Adjudication of Guilt or Innocence:* The assessment of guilt or innocence is the ultimate step in the use of Brain Fingerprinting in court processes. This is completely unrelated to science. The judge and jury have sole authority over the determination of guilt or innocence. It is not the responsibility of the investigator, scientist, or computer. The issue of guilt or innocence has always been and will always be a legal one, not a scientific one. Science gives evidence, but it is up to a judge and jury to weigh the evidence and reach a decision.

E. Role in Legal Proceedings

The scope of the science of Brain Fingerprinting – and all other disciplines – is limited in legal processes. The purpose of Brain Fingerprinting is to take the results of investigations and interviews to determine what information is relevant, to make a scientific determination about the presence or absence of that information in a specific brain, and to provide evidence to the judge and jury to help them decide whether a suspect is guilty or innocent. The science of Brain Fingerprinting, like other forensic disciplines, does not tell us when to run a test, who to test, or what to test for. The investigator determines this based on his ability and judgement, which is then assessed by the judge and jury. Recall the case of the potential poisoned murder described earlier. All forensic toxicology informs us is whether or not a particular cadaver contains ricin or cadmium. In this scenario, science does not urge us to hunt for these specific poisons. The investigator determines this based on his skill and judgement. Similarly, the science of Brain Fingerprinting does not specify what data to look for. Again, the investigator gathers this material based on his ability and judgement. Brain fingerprinting determines whether or not this specific information is stored in the brain of a certain person. Science cannot tell us whether a single suspect is guilty in the poisoning case stated above. The judge and jury make this decision based on their human judgement and common sense. The same may be said about Brain Fingerprinting, as well as any other scientific process.Again, the science of Brain Fingerprinting cannot tell us whether or not a suspect is guilty. Only a judge and jury have the authority to determine guilt or innocence, and they do it based on their human judgement, taking into account all scientific and other evidence.

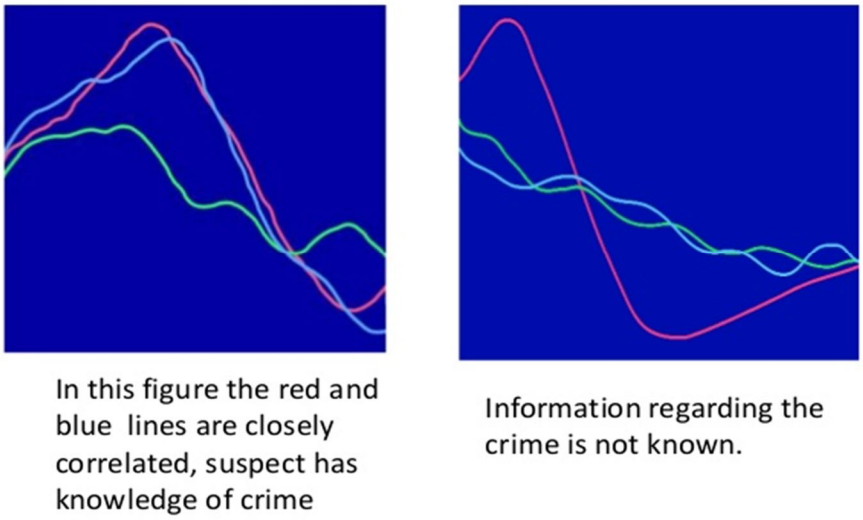


Figure 2.Result of crime in wave form

Science isn't a replacement for careful and successful study. To establish when to test, whom to test, and what to test, science relies on investigation, which is outside the realm of science. The evidence gathered by science and inquiry must finally be reviewed and analysed by human beings who serve as judge and jury, using their human judgement and common sense to reach a decision on the accused's guilt or innocence.

The judge and jury must be provided with all available evidence to aid them in reaching their verdict, which is basic to our legal system and crucial to the cause of justice. Brain fingerprinting gives strong scientific evidence that the judge and jury must examine alongside other available evidence. Denying a judge and jury the opportunity to hear and evaluate the evidence provided by the science of Brain Fingerprinting, along with all other available evidence, would, in our opinion, be a serious miscarriage of justice. Such a denial would likewise be an egregious human rights violation if a suspect presented Brain Fingerprinting evidence supporting a claim of innocence.Brain Fingerprinting is not a substitute for the thorough deliberations \of a judge and jury. However, by presenting reliable, scientific facts relevant to the issues at hand, it can play a critical role in guiding these discussions.

IV. RESULT ANALYSIS

There are two possible outcomes:

1) "information present" — the specifics of the crime are stored in the suspect's brain.

2) or "information missing"– the suspect's brain does not have the details of the crime.

Experiment: The only way to figure out who has knowledge and is involved in any criminal cases actions is to look at their brain signals. The digital electroencephalography technology can be used to obtain the brain signal.

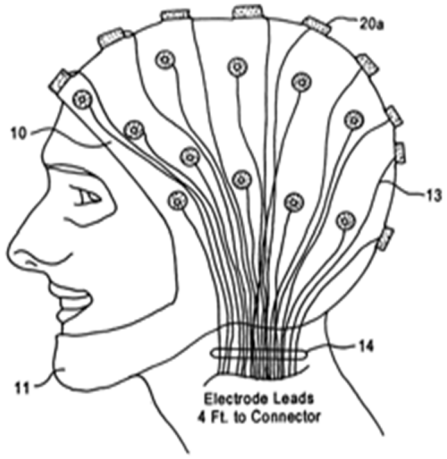


Figure 3. electrodes connected on the scalp.

There are four different types of waves in the brain

a) *Alpha Wave:* The first wave is a green-colored wave. It has a frequency of 9–13 Hz and is strongest over the occipital (back of the head) and frontal cortex during waking.

b) *Beta Wave:* This is a wave that is blue in colour. It operates in the 15-30 Hz range. Beta activity is described as "rapid."

c) *Theta Wave:* Theta wave is a wave that is reddish in colour. It is classified as "slow" activity since its frequency ranges from 4 to 7.5 Hz. It is extremely crucial during infancy and childhood.

d) *Delta Wave:* This is a gray-colored wave called a delta wave. It occurs in deep sleep and reflects the unconscious mind at a frequency of 1 to 3 Hz (typically 0.1-3.5 Hz). The lowest frequency EEG rhythms are delta waves.

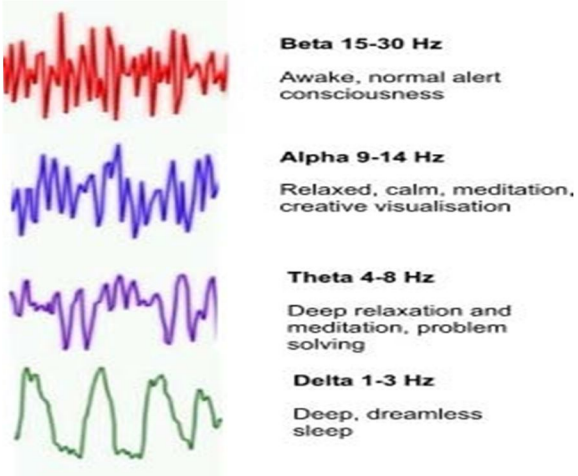


Figure 4: different types of brain waves.

However, with brain fingerprinting, a suspect is evaluated, and we can detect wrongly accused people by looking at only three types of brain signals.

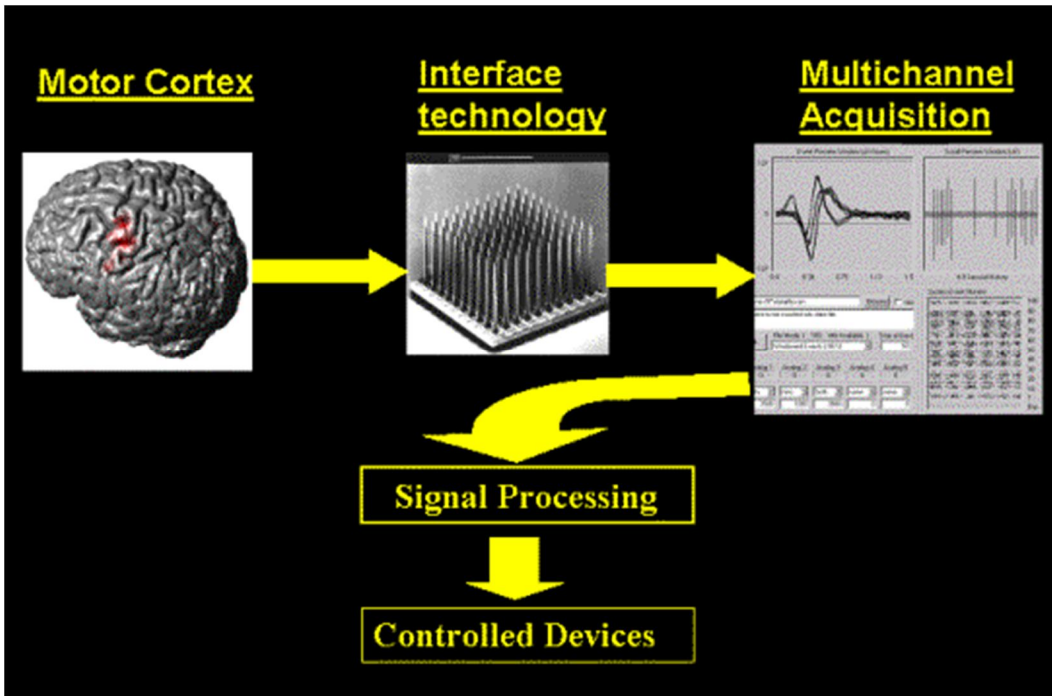


Figure 5:brain waves generated during test

A. Output

The EEG electrodes are attached to the brain's scalp and map the brain waves. When someone lacks information, the brain–signal network collapses.

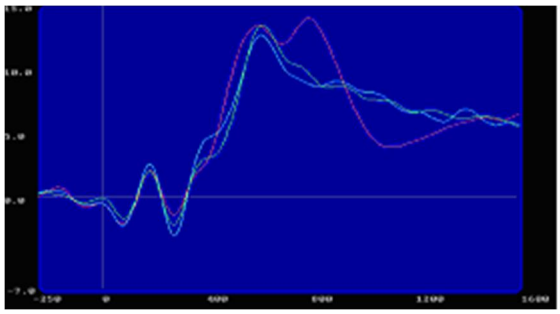


Figure 6: information absent.

When a person receives information, the brain waves will appear as shown.

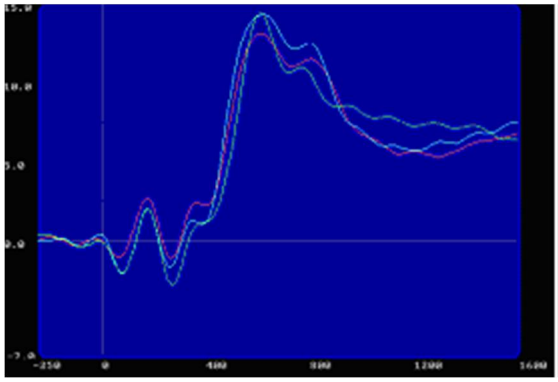


Figure 7: information present.

V. LIMITATIONS

The following are some examples of the technique's limitations (in crime scenarios):

1) Brain fingerprinting measures information-processing brain responses that disclose the subject's stored information. It has no way of knowing how that information got there. This fact has ramifications for the technique's application and timing. When a suspect claims not to have been at the crime site and has no legitimate reason to know the facts of the crime, but detectives have information that hasn't been made public, brain fingerprinting can objectively assess whether or not the subject knows such information. Brain fingerprinting could be useful evidence in this situation.The test, on the other hand, cannot be used if the suspect knows everything the investigators know about the crime for whatever valid reason. There are various scenarios in which this could be the case. If a suspect admits to being at the crime scene but claims to be a witness rather than a perpetrator, the fact that he knows information about the crime is irrelevant. There would be no point in administering the test because the "information present" response would simply demonstrate that the suspect understood the specifics of the crime — knowledge that he already admits he got at the crime site, whether as a witness or as a perpetrator.

2) Another situation in which brain fingerprinting isn't appropriate is when a suspect and an alleged victim – say, of a sexual assault – agree on the contents of what was said and done but dispute on the parties' intent. Only information, not intent, is detected by brain fingerprinting. The fact that the suspect is aware of the undisputed facts of the situation does not indicate which party's version of events is correct.

3) There is no available information with which to design probe stimuli in a case where the suspect knows all that the investigators know since he has been exposed to all available material in a previous trial. Even though the suspect knows numerous specifics about the crime, it is occasionally possible to uncover crucial information that the perpetrator must have come across during the course of the crime but that the suspect claims not to know and would not know if he were innocent. Terry Harrington was one of those people. Dr. Farwell was able to uncover key details about the case by reviewing reports, interviewing witnesses, and visiting the crime scene and nearby locations.

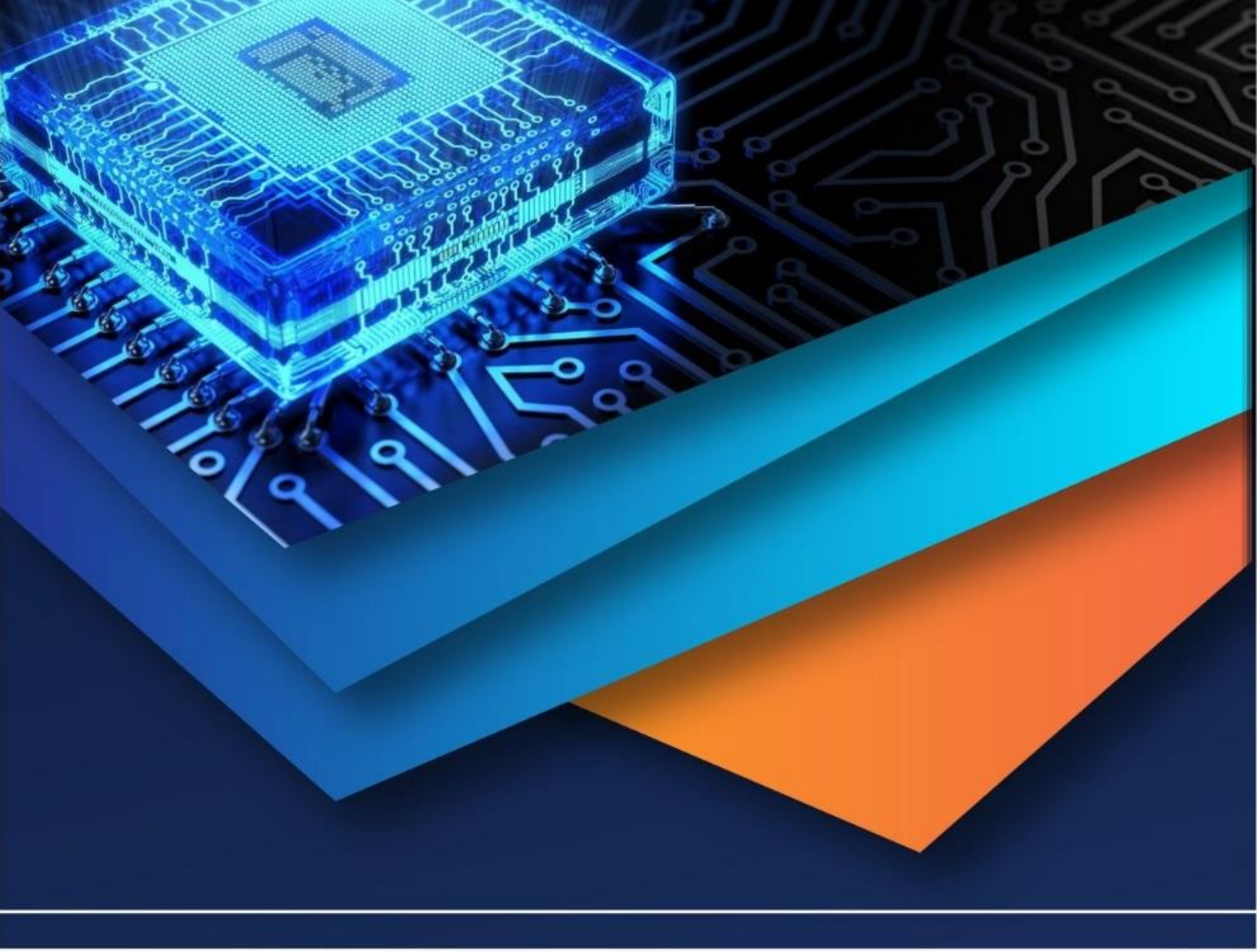
4) A scientist must obviously avoid adding information that has been made public while designing a brain fingerprinting test. Detecting that a suspect is aware of information gleaned from a newspaper would be useless in a criminal inquiry, and normal brain fingerprinting processes exclude all such information from the test's structure. News accounts providing many information about a crime, on the other hand, do not obstruct the creation of a brain fingerprinting test; they just limit the material that may be tested.

VI. CONCLUSION

Brain Fingerprinting is a ground-breaking new scientific tool for solving crimes, identifying offenders, and exonerating innocent persons, with a track record of 100% accuracy in research with US government agencies, actual criminal cases, and other uses. Governments, law enforcement agencies, corporations, investigators, crime victims, and wrongfully accused, innocent suspects all benefit from the technology.

REFERENCES

[1] J.Peter Rosenfeld researched on " 'Brain fingerprinting':A Critical analysis",2005.
[2] Dhiraj Ahuja and Bharat Singh on journal named "Brain fingerprinting",2012.
[3] ASHWINI V. SHARMA , Dr. GANESH S. SABLE on a journal named 'Brain Fingerprinting', ISSN: 0975 – 6779| NOV 12 TO OCT 13 | VOLUME – 02, ISSUE – 02
[4] LA Farwell, E Donchin P300 is a brain detector that can detect dishonesty. 24:434 in Psychophysiology, 1986.
[5] LA Farwell, E Donchin Interrogative polygraphy ("lie detection") with event-related brain potentials will reveal the truth. 531-541 in Psychophysiology, 1991.
[6] Inventor LA Farwell. Multifaceted electroencephalographic response analysis method and apparatus (MERA). Patent number 5,363,858 was issued on November 15, 1994.
[7] Farwell, Los Angeles Brain-wave detection of professional information is one of two novel variations on the truth detector. Psychophysiology 29(4A):S3 (1992).
[8] Inventor, Farwell LA. Truth detecting method and device. Patent number 5,406,956 was issued on April 18, 1995.
[9] Picton TW. Human event-related potentials in electroencephalography and clinical neurophysiology. Amsterdam



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY