A
Project Report
on

To explore the effect of OM mantra meditation on brain using classifiers.

Submitted to

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Submitted in partial fulfilment of
the requirements for the Degree of
Bachelor of Engineering in
Electronics and Telecommunication Engineering

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Certificate

This is to certify that the project report entitled **"To explore the effect of OM mantra meditation on brain using classifiers"** is hereby approved as a creditable study carried out and presented by

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in a manner satisfactory to warrant of its acceptance as a pre-requisite in a partial fulfillment of the requirements for the degree of Bachelor of Engineering in Electronics & Telecommunication Engineering of Sant Gadge Baba Amravati University, Amravati during the Session 2022-23.

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Chapter 1

Introduction

Meditation is one of the aspects of yoga that can be stated as consciously and voluntarily guiding self attention for relaxation or for seeking oneself or for personal improvement. Meditation can be categorized into two types: the first type involves focusing attention on a particular object and second being a mental or loud repetition of a chant called mantra meditation. Varieties of mantras can be chosen for meditation. Mantra repetition is a simple method to implement in order to attain meditation. The appearance of the Om syllable in Upanishads, Bhagvat Gita, and Vedas make it holy and sacred, thus making it the highest sacred symbol in Hinduism. Om, considered as the name of God, is a sacred syllable in Hinduism from which all other sound came into existence.

OM can be represented in many ways. It is having its own importance because it is on type of mantra which is the gift given by God shiva to us. Chanting OM is very beneficial to our body it gives relief to our body. According to Hindu philosophy, the letter A represents creation (Brahma), U represents balancing (Vishnu), and M represents existence (Shiva). While pronouncing A-U-M, length of letter 'M' should be large. During chanting OM feel some vibration in our body due to a concentration. Some Advantages of OM are as follows: -

- It helps in cleansing the mind.
- Controlling the emotions.
- Improves the concentration, memory and understanding capacity.
- Relaxes Physically, Mentally, emotionally.
- Charges the surrounding atmosphere

1.1 Brain imaging Techniques

Magnetoencephalography is a neuroimaging technique used to measure the magnetic fields generated by electrical activity in the brain. It provides a non-invasive way to study the dynamic functioning of the brain with high temporal resolution. MEG is based on the principle of electromagnetic induction. When neurons in the brain become active, they generate small electrical currents. These currents, in turn,

produce tiny magnetic fields. MEG measures these magnetic fields using an array of superconducting sensors.

Positron Emission Tomography is a nuclear medicine imaging technique that provides information about the metabolic and biochemical processes in the body. It involves the injection or ingestion of a radioactive tracer, which emits positrons (positively charged particles). PET scans detect these positrons and create detailed three-dimensional images of the activity within the body.

Functional magnetic resonance imaging (fMRI) is a non-invasive neuroimaging technique that measures changes in blood oxygenation and flow in the brain. It provides a way to observe brain activity and create detailed maps of brain function. fMRI is based on the principle that neural activity in the brain is associated with changes in blood oxygenation levels. When a specific region of the brain becomes active, there is an increase in blood flow to that area. This change in blood flow is detected by fMRI, allowing researchers to infer brain activity.

Functional Near-infrared spectroscopy (fNIRS) is a non-invasive neuroimaging technique that measures changes in blood oxygenation in the brain. It provides information about brain activity and is often used as an alternative or complementary method to functional magnetic resonance imaging (fMRI).

Electroencephalography (EEG) is a non-invasive neurophysiological technique that measures the electrical activity of the brain. It involves placing electrodes on the scalp to record the electrical signals generated by the firing of neurons in the brain. EEG provides valuable information about brain function and is widely used in both research and clinical settings.

EEG is a versatile and widely used technique for studying brain function and activity. Its non-invasive nature, high temporal resolution, and ability to capture neural dynamics make it valuable for investigating cognitive processes, diagnosing neurological disorders, and monitoring brain health.by the firing of neurons within the brain.

Chapter 2

Literature Survey

2.1 EEG Spectral Analysis on OM Mantra Meditation[1]

Om mantra meditation is easy to practice. “OM” Mantra is the highest sacred symbol in Hinduism. The present study investigated the temporal dynamics of oscillatory changes after OM mantra meditation. Twenty-three naive meditators were asked to perform loud OM chanting for 30 min and the EEG were subsequently recorded with closed eyes before and after it. To obtain new insights into the nature of the EEG after OM chanting, EEG signals were analyzed using spectral domain analysis. Statistical analysis was performed using repeated measures of analysis of variance. It did not reveal any specific band involvement into OM mantra meditation. But significantly increase in theta power was found after meditation when averaged across all brain regions. This is the main effect of OM mantra meditation. However, the theta power showed higher theta amplitude after condition at all regions in comparison to the before condition of meditation. Finding was similar to other studies documenting reduction in cortical arousal during a state of relaxation. The study argues for the potential role of loud ‘OM’ chanting in offering relaxation. It provides a new perspective of meditation to the naive meditators. This information may help to demystify meditation and encourage. Those considering this as beneficial practice.

2.2 Higuchi Fractal Dimension Analysis of EEG Signal before and after OM Chanting to Observe Overall Effect on Brain

The OM chanting is one type of the meditation. In the present paper, the author tried to observe its effect on the brain. To obtain insight of the brain, the author recorded EEG signal before and after OM chanting for 10 subjects. Author used a technique of the complexity measure based on fractal analysis to compare the EEG signal before and after OM chanting. Time domain fractal dimension was calculated using Higuchi algorithm. (HFD). Paper presents the results based on average HFD all over the electrodes for each subject before and after OM chanting.

2.3 Higuchi fractal dimension: An efficient approach to detection of brain entrainment to theta binaural beats

Binaural beats (BBs) are two pure tones with a small frequency difference (i.e., beat) separately presented to each ear. They cause the beat perception in the brain. BBs are used in both clinical and basic science applications. Studies in BB literature have mainly focused on linear analysis of the brain signals. Even though these approaches have produced promising findings, there may still be some facets left to be considered, which cannot be studied by linear measures. BBs entrain the brain and generate synchronous responses. Previous studies have proved that increasing brain synchronicity reduced its complexity measured by fractal dimension (FD). In this study, Higuchi fractal dimension (HFD) was used to test whether: 1) BB stimulation decreases the electroencephalogram (EEG) complexity, and 2) HFD is a reliable alternative to its common linear counterpart (i.e., relative power of the band in which the beat frequency lies) in terms of the brain entrainment detection. Results revealed that 3-min BB stimulation significantly decreased the HFD in temporal and parietal lobes, which was about half the time required to probe any changes in EEG power. Moreover, there was significant negative correlation between the relative power and HFD in these regions. In comparison to the relative power, HFD produced mostly higher classification accuracies and areas under empirical receiver operating characteristic (ROC) curve in these lobes. Our findings suggest that HFD can be a reliable replacement for relative power in terms of entrainment detection and response classification.

2.4 Explore the effect of Om mantra meditation on brain with wavelet analysis

This study uses a discrete wavelet transform based feature extraction method to examine the effect of Om meditation on the brain. With twenty-three healthy engineering college students between the age group of twenty to twenty-two chosen as subjects for the study, EEG signals were obtained before performing Om
Meditation as well as after performing Om meditation. EEG signals were classified into Gamma, Beta, Alpha, Theta and Delta bands by using detailed coefficients and approximate coefficient obtained by five level wavelet transform. Feature such as relative power using the Welch method was extracted from each band and was analyzed using two way repeated analysis of variance. Findings reveal increased theta

power and higher theta amplitude in after condition at all regions in comparison to the before the condition of meditation but results were not significant. No significant results were found in any other band. As described in other studies, increased theta power is a sign of relaxation. Results revealed through the study were promising results for single day testing and immediate effect of Om meditation. The study emphasizes the importance of Om meditation which could work wonders for people under stress if adopted as a daily routine. As Om meditation is simple and easy to practice, it could open a new horizon for naïve meditators.

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2.5 SVM classification of EEG signal to analyze the effect of OM Mantra meditation on the brain

Meditation can significantly contribute to improving physical and mental health in modern stressful life. “OM” mantra is very easy to practice for meditation .This study is undertaken to classify the EEG band to observe abrupt changes in band as an effect of Om mantra meditation. Twenty-three naive meditators were experimented to chant OM mantra for 30 min and EEG signal recorded before and after meditation. The stationary wavelet transform is used to exact five bands from the EEG. The different statistical features were calculated. SVM classifier with Radial Basis Kernel is employed to classify the band. Results show the significant changes in the delta band which represent the brain in deep sleep. Thus OM meditation gives the experience of deep sleep. Thus study can be helpful to given direction towards the meditation.

Up till now there is only one work on SVM classifier to explore effect of om mantra meditation on brain has been done.

Chapter 3

Problem Statement

There is need to investigate the effect of om mantra mediation on brain with different classifiers.

Chapter 4

Project objective

.To analyze the positive effect of om mantra meditation on brain by using om mantra meditation with two different classifier SVM and Random Forest.

Chapter 5

Materials and methods

5.1 Subjects:

A total of 23 naive meditators with a mean age of 20.99 years, between the age group of 18–22 years were assessed. Subjects chosen had no meditation training referred to as naïve meditators. They were chosen from a Shri Sant Gajanan Maharaj College of engineering randomly. Subjects were informed to practice Om mantra meditation and that their brain activity would be recorded before and after OM chanting. Nonsmokers, not frequent drinkers and right-handed subjects with sound mind state were chosen with the explicit consent of each subject. This study is presented and applied to the concerned ethical committee of Government Medical College, Akola, Maharashtra, India.

5.2 Design of study:

The study was conducted in two sessions with repeated measures: the first session involves EEG assessments before Om meditation and the second involves EEG assessments after Om meditation. Subjects were asked to perform OM chanting for a duration of 30 minutes.

Rest **OM Chanting** **Rest**

Fig 5.1: Experimental Setup

The experimental setup for the study is “Rest ->OM chanting ->Rest” as shown in the figure below . The recording was done in a peaceful and quiet place in order to help the subject to concentrate more effectively. The subject was asked to relax by laying down on a cot with closed eyes. In this relaxing mode, EEG was recorded termed as “EEG before meditation”. After recording EEG data, the subject was instructed to sit

in an erect position and perform Om chanting for about 30 minutes. During the Om chanting subject was asked to breathe smoothly. During meditation, subjects were asked to inhale for a longer time and exhale with chanting Om. The room of the recording was kept dark for better concentration. Following meditation, the subject was again asked to relax by laying down on a cot with eyes closed. And, again EEG was recorded for more than two minutes which is termed as "EEG after meditation". The subject provided with their detailed experience after experiment

5.3 EEG recording before and after Om mantra meditation:

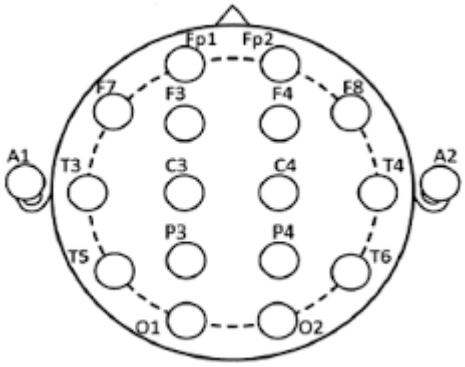


Fig 5.2: Electrodes placement

In an electrically shield room of Bilala Hospital, Akola, EEG recording was performed under the guidance of Dr. Saurabh Bilala. EEG signals were recorded using monopolar montages, according to international standard 10-20 from 16 channels using the RMS India system with a 256 Hz sampling frequency. The electrodes and their placement are as shown in fig. 2. The electrodes in the left hemisphere were referred to the left earlobe (A1) with the ground at the forehead [9]. Electrodes placed on the right hemisphere are numbered evenly, whereas those on the left hemisphere are numbered oddly. Electrodes used are prefrontal electrodes Fp (1,2), frontal electrodes F(7,3,4,8), temporal electrodes T(3,4,5,6) Central C(3,4), Parietal P(3,4), Occipital O(1,2) and reference earlobe A(1,2).

5.4 Subjects and data acquisition:

EEG signal have been recorded from 23 naive meditator (F=14, M=20.99, SD=0.99, 18-22 years). All subjects where new meditators and all the selected subjects were a non smoker, not habitual to drinking. Subjects were chosen from the college of engineering so that they can present valuable knowledge for meditation practice. The data has been obtained while, the subject asked to take a rest just lying

down with closed eyes and at this moment the EEG data were recorded for 2 min. this new data is an EEG signal of before OM chanting. In a second moment, the subject asked to relax and chant i.e. OM mantra for 30 with closed eyes and in correct posture of meditation. After chanting mantra respective subject asked to get relax while lying down with closed eyes and then EEG data were recorded for more than 2 min. This recorded data is an EEG signal of after OM meditation. The signal were acquire with a sampling rate of 256 Hz with Sixteen channel EEG activities were recorded using monopolar montages, according to international standard 10-20 from 16 channels using the RMS India system.

5.5 System description and preprocessing:

Below fig n shows a block diagram with the different steps followed in this study. Initially, EEG signals from each channel for each of the subjects were segmented. These segments were then decomposed into five constituent bands using stationary wavelet transform. Ten statistical parameters were calculated for the band derived from the segments. These parameters were averaged over all the segments. Furthermore, the SVM classifier is applied to discriminate each post EEG band from pre EEG band.

Chapter 6

Om Signal

For thousands of years, Indian rishis, munis, and sages have been meditating on OM. In Samadhi, they felt very subtle Universal Vibrations - anahata nada and they associated this with OM. Hindus, Jains, Buddhists, and Sikhs all revere and recite OM. This is the only mantra which can be called a Universal Mantra. It is made up of letters A, U, M, or O, M (A+U-O). Islam reveres a form of Aum called "Amin." Christians say "amen." Jews use "shalom."

The Vedas, Puranas, Upanishads, Smrutis, Tantras, Yoga Darshana, Brahmana's, and the Bhagavad Gita all point to the great strength that aum-pranava has, and all give special Techniques for meditation on OM. From Brahma Himself, to Manu the first man and lawgiver, too many rishis throughout the ages all have done japa of Aum. Even Shri Rama and Shri Krishna used to chant the gayatri and Om mantras [3]. Meditating on Aum, Brahma reached brahmatva (the essence of Brahma), Vishnu reached vishnutva (the essence of Vishnu), and Shiva reached shivatva (the essence of Shiva).

According to Hindu philosophy (see Mandukya Upanishad), the letter A represents creation, when all existence issued forth from Brahma's golden nucleus; the letter U refers to Vishnu the God of the middle who preserves this world by balancing Brahma on a lotus above himself, and the letter M symbolizes the final part of the cycle of existence, when Vishnu falls asleep and Shiva has to breathe in so that all existing things have to disintegrate and are reduced to their essence to him. More broadly, OM is said to be the primordial sound that was present at the creation of the universe. is said to be the original sound that contains all other sounds, all words, all languages and all mantras.

When you look at OM, your brain waves calm down from beta levels to alpha level and eventually further down to gamma and delta levels. When you hear OM, the same thing happens. Chanting OM allows the mind to become blissful and quiet so that very few new thoughts originate in your mind. OM is the sound of kundalini Shakti moving through the body, the sound of the purification of the nervous system. OM is the sound of Mother Nature in us. It is the supreme mantra, an ultimate mantra. Nothing can replace this mantra; nothing is greater than OM.

It is very easy to pronounce OM. OM is very delicate, extremely sweet, and easily attainable. Omkar is medicine for the soul. [1] It gives us salvation (nirvana, moksha). It is also known as pranava, omkar, or udgitha ('worthy of singing in higher notes").

- ‘A’ represents Rigveda, water, earth, rajas, Brahma the Creator, and the past.
- ‘U’ represents Yajurveda, space, air, sattva, Vishnu the Preserver, and the present.
- ‘M’ represents Saavedra, fire, tames, Mahesha the Destroyer, and the future

AUM-OM is Brahma, Vishnu, and Mahesha all in one. It is a single syllable mantra. It is made up of akar, ukar, makar, ardhamatra, bindu (dot), nada (sound), kala (crescent), and Shakti (energy). Many mantras start with Aum, and many end with Aum. OM which has all the religious symbols, as in the panchshila or unity Aum.

Fig. Om Mantra

The entire psychological pressure and worldly thoughts are taken away by the chanting of Om mantra. [4] Elimination of disruption and introduction of new dynamism in the body are given by the OM chanting The consciousness could be promoted through the repetition of Om mantra. [3]

Chanting meditation means keeping a not-moving mind and perceiving the sound of your own OM. Perceiving your voice means perceiving your true self or nature. Then you and the sound are never separate, which means the you and the whole universe are never separate. [8] Thus to perceive our true nature is to perceive universal substance. With regular chanting our sence of being cantered gets stronger and stronger. However, when we do chanting meditation correctly, perceiving the sound of own voice, we learn that chanting meditation is not for our personal pleasure, to give us good feeling, but to make our direction clear [2]

6.1 OM SIGNIFICANCE

OM is considered to be the 'primordial sound". Even before the material creation came into existence there was only the natural humming energy which resembled the sound of OM.

- A tamas (darkness, inertia, Ignorance)
- U-rajas (passion, activity, dynamism)
- M-Sattva (purity, truth, light)

The basic mantra is OM or 'Aum', which in Hinduism is known as the 'pranava mantra' the source of all mantras. If there is no religious preference then the sound vibration 'OM' is a universally recognized mantra. It is the representation of the Supreme Being. The past, present and the future are all included in this one sound. Meditation on this sacred syllable is said to satisfy every need and leads to liberation..

6.2 Origin of 'OM:-

There are many theories regarding the origin of syllable OM. Max Muller proposed that it might have been derived from an ancient word "Avam" which was used in prehistoric time in the sense of "that" to refer to distant objects. The word is also linked to the sound of breath and a subtle and high potency universal vibration which can be heard internally in the subtle plane as a deep sound (pranavanada) by the adepts all the time. The chandogya Upanishads narrates how the syllable OM issued forth from Brahma as he brooded upon the worlds he created in the initial stages of creation. From his brooding first emerged the threefold knowledge (trayi vidya) and then the syllables bhur, bhuvah and suvah. When he brooded upon them, the syllable OM issue forth from them. Thus symbolically, OM represents the entire creation manifested in three planes, namely the earth, the mid region and the heaven.

6.3 Historical Development:

Initially in the early Vedic period, because of sanctity associated with it, the word was kept as secret and never uttered in public. It was used in private conversations and passed on from teacher to disciple or father to son directly in

Secrecy. It was also not used in rituals. Because it was not permitted to use the word directly, some early Upanishads referred to it indirectly as udgita (upsound) or

panama (calling out), alluding to its significance in regulated breathing and religious chanting respectively. In the Bhagavad-Gita Lord Krishna declares that of the utterances He is mono syllable OM

6.4 Meaning of 'OM:

OM consists basically of 3 sounds AUM where

- A-represents Consciousness.
- U-represents Dream State.
- M-represents Deep sleep state.

The silence between 2 successive OM represents 4 state Turiya' a state of self-recognition. The fourfold nature of AUM is also represented truthfully in the symbol of AUM, which consists of four curves and one circle. The four curves represent four states of consciousness and the circle represents the self. The lower curve represents the waking state, the middle curve the dream state, the upper curve the deep sleep state, the semicircle detached from these three represent the transcendental state while the circle above all is the witnessing self or the supreme self. Symbolism of AUM is depicted in the diagram below.

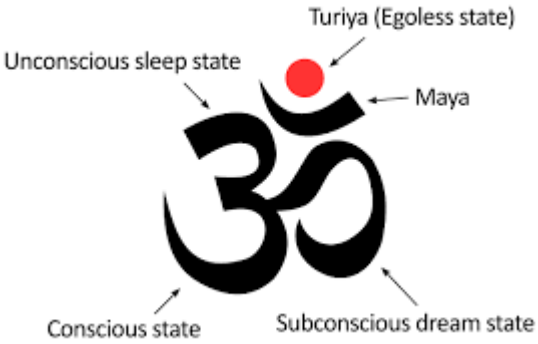


Fig 6.1. OM Symbol

6.5 How to chant 'OM'

- As Patanjali states in sutra 1.28, OM should be chanted keeping its meaning and significance in mind. Since OM is the representative sound and symbol for Ishvara, it is important to keep the essence of Ishvara (sutra 1.24) in mind while chanting OM. The technique for chanting OM is given below:

- Sit in a comfortable cross-legged seated posture with the spine upright, head, neck and spine in a vertical (if comfortable) alignment. Close the eyes and take a deep inhalation. While exhaling start uttering the OM sound. Begin by feeling the vibration of the "O" sound building up in the navel area and traveling upward. As you continue the chant, feel the vibration moving upward toward the base of the throat. When the vibration reaches the throat arca, convert the sound to a deep humming sound of "M". Continue to feel the vibration moving upward until it reaches the crown of the head (called Sahasrara Chakra). You may repeat this process two or more times. At the end of the final chant, continue to sit still and feel the vibration of the OM sound permeating the whole body - every single cell of the body.

6.6 Benefits of OM chanting:

- The chanting of OM drives away all worldly thoughts and removes distraction and infuses new vigour in the body.
- When we feel depressed, chanting OM fill us with new vigour and strength. The chanting of OM is a powerful tonic. When we chant OM, we feel we are the pure, all pervading light and consciousness.
- Those who chant OM will have a powerful, sweet voice. Whenever we take a stroll, we can chant OM. The rhythmic pronunciation of OM makes the mind serene and pointed, and infuses the spiritual qualifications which ensure self realization.
- Those who do meditation of OM daily will get tremendous power. They will havelustre in their eyes and faces

Chapter 7

Electroencephalogram (EEG)

The existence of electrical current in the brain was discovered in 1875 by an English physician Richard Caton. The EEG was first measured in humans by Hans Berger 1929. Electroencephalographic measurements are commonly used in medical and research areas. The EEG signal is used to diagnosis various brain disorder. [5] Electroencephalography is a medical imaging technique that reads scalp electrical activity generated by brain structure.

The bioelectrical potential generated by neural network of brain called EEG signal. Electroencephalography is defined as electrical activity of an alternating type recorded from the scalp surface after being picked up by metal electrodes and conductive media.

The EEG measured directly from the cortical surface is called Electroencephalogram while when using depth probes it is called electro-gram. In this report, we will refer only to EEG measured from the head surface. Thus Electroencephalographic reading is a completely non-invasive procedure that can be applied repeatedly to patient, normal adults and children with virtually no risk or limitation. When brain cells (neurons) are activated, local current flows are produced. [12]

Only large populations of active neurons can generate electrical activity recordable on head surface. Between electrode and neuronal layers current penetrates through skin, skull and several other layers. Weak electrical signals detected by the scalp electrodes are massively amplified, and then displayed on paper or stored to computer memory. Due to capability to reflect both the normal and abnormal electrical activity of the brain, EEG has been found to be a very powerful tool in the field of neurology and clinical neurophysiology.

7.1 Classification: -

EEG waveforms are generally classified according to their frequency, amplitude, and shapes, as well as the sites on the scalp at which they are recorded. The most familiar classification uses EEG waveform frequency (e.g. alpha, beta, theta and delta). [12]

Brain waves have been categorized into four basic groups:

7.1.1 Alpha (8-13 Hz)

7.1.2 Beta (>13 Hz)

7.1.2 Theta (4-8 Hz)

7.1.2 Delta (0.5-4Hz)

7.1.1 ALPHA WAVES: -

Alpha waves generally are seen in all age groups but are most common in adults. They occur rhythmically on both sides of the head but are often slightly higher in amplitude on the no dominant sides, especially in right-handed individuals. A normal alpha variant is noted when a harmonic of alpha frequency occurs in the posterior head regions. They tend to be present posterior more than interiorly and are especially prominent with closed eyes and with relaxation. Alpha activity disappears normally with attention (e.g. mental arithmetic, stress, and opening eyes). In most instances; it is regarded as a normal waveform.

Fig 7.1.1: - Alpha Wave

7.1.2 BETA WAVES: -

Beta waves are observed in all age groups. They tend to be small in amplitude and usually are symmetric and more evident interiorly. Beta waves are high-frequency, low-amplitude brain waves that are commonly observed in an awaken state. They are involved in conscious thought and logical thinking, and tend to have a stimulating effect.

Fig 7.1.2: - Beta wave

7.1.3 Theta Wave: -

Theta waves normally are seen in sleep at any age. In awake adults, these waves are abnormal if they occur in access. Theta and delta waves are known collectively as slow waves these slow waves have a frequency of 3 Hz or less.

Fig 7.1.3: - Theta Wave

7.1.4 Delta Wave: -

They normally are seen in deep sleep in adults as well as in infants and children. Delta waves are abnormal in the awake adults, Often, they have the largest amplitude of all waves.

Fig 7.1.4: - Delta Wave

7.2 STRENGTH OF EEG: -

- Is a measure of brain function: supplement neuroimaging studies.
- Provides direct rather than indirect evidence of epileptic abnormality.
- May be the only test that shows abnormalities in epileptic patients.

7.3 APPLICATION OF EEG: -

EEG provides less spatial resolution compared to MRI and PET.EEG can determine the relative strengths and positions of electrical activity in different brain regions. [13] Some clinical applications of the EEG in humans and animals are used to:

- Monitor alterness, coma and brain death.
- Locate areas of damage following head injury, strokes, tumor, etc.
- Monitor cognitive engagement (alpha rhythms)
- Monitor human and animal brain development.

7.4 ADVANTAGES OF EEG: -

- Provides some spatial or localization information.
- Low cost.
- Low morbidity
- Readily repeatable
- Portable
- The greatest advantage of EEG is speed.

7.5 METHODS OF EEG RECORDING:-

Measurements of physiological signals differ depending on the environment in which the measurements are performed. The environment includes all the conditions that influence the measurements such as temperature,illumination subject(the human body that is measured),equipment and so on [13] According to these conditions we can divide the examination environment into two groups, namely:

- Clinical Environmental
- Non-Clinical Environmental

7.6 Clinical Environment:-

Conditions in a clinical environment are strictly limited. The aim is to acquire considerable quality and content of physiological signals from the measurements.

7.7 Non-Clinical Environment

Conditions in non-clinical environment are less limited. There is a balancebetween the quality of physiological signals and the freedom of conditions Figure below is given as an example of equipments used to measure EEG signals in both clinical and non-clinical environment. The left photo is taken in a clinical environment. It shows an EEG measurement by a cap 32 electrode (sensors) on it. There is an extra electrode on the face of the subject. The extra electrode records the electrooculography (EOG). The right photo shows a non-clinical environment in which an EEG measurement is made by a headphone with only 2 electrodes on it. In this thesis, a non-clinical environment is also called a lifestyle measurement because it can easily be performed by non-specialized in daily life.

7.8 ELECTRODES

The electrodes are simply small metallic disc devices that provide the conduction of potential electro cortical by wires towards the amplification device and a recording machine. They can be made of gold, silver, tin or copper and are glued to the scalp using a special conductive paste.

To help in placement of the electrodes there are a special flexible head cover called electrode cap. A disadvantage which has characterized these caps is indicated to be the fact that the electrode positions are fixed, and are not individually adjustable for the requirements peculiar to each individual electrographic analysis and patient**.**With the right size and requirement of the electrode cap the time of placement and consequently the comfort for the patient are improved. [5]

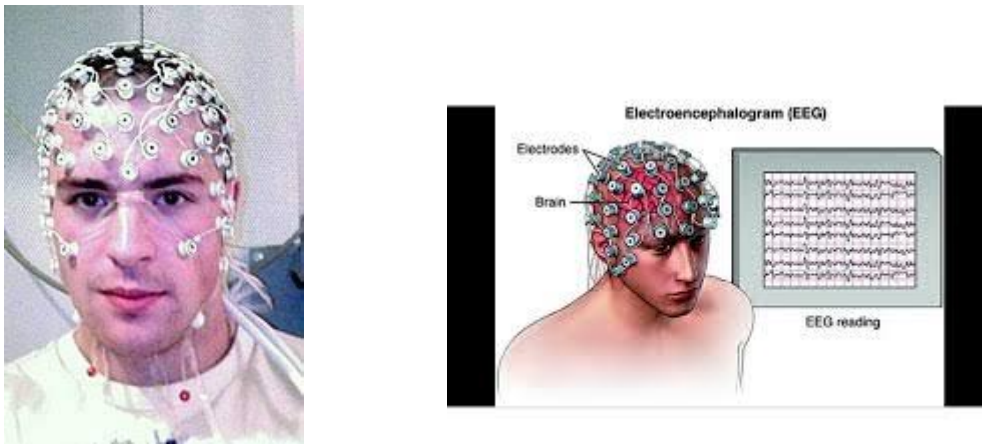


Fig 7.2 Placement of Electrodes

7.9 PLACEMENT OF ELECTRODES:-

The placement of the electrodes is commonly standardized to be able to perform an analysis of the given information in any laboratories. The most typical model is called "10-20 International system of Electrode placement". In this system 21 electrodes are located on the surface of the scalp. The "10 "and "20" refer to the fact that the actual distances between adjacent electrodes are either 10% or 20% of the total front-back or right-left distance of the skull. Often the earlobe electrodes called Al & A2, connected respectively to the left and right earlobes, are used as the reference electrodes [12]. In addition to the 21 electrodes of the International 10-20 system, intermediate 10% electrode positions are I also used. The locations and nomenclature of these electrodes are standardized by the American Electroencephalographic Society. In recommendation, four electrodes have different names compared to the 10-20 system; these are T7, T8, P7, and P8. These electrodes are down grey in the iError! No se encounter Origen de la referencia.

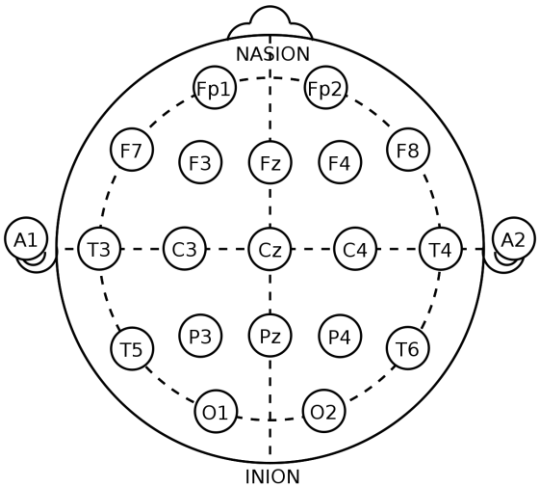


Fig: 7.3 Points of Electrode

7.8.1 TYPES OF ELECTRODES

- Disposable(get-less, and pre-gelled types)
- Reusable disc electrodes (gold, silver, stainless steel or tin)
- Headbands and electrode caps
- Saline-based electrodes
- Needle electrodes

7.9 DATABASE

Recording of EEG signals before and after OM chanting served as a of the project. The recordings were made in a quiet room at 256 Hz sam using EEG. The data of all the 10 subjects were taken. All the subjects did recording in the afternoon time before lunch and in the Shavasan position a chanting is in sitting position. Recording is done for about 3 min but the da of 30 sec only.

Chapter 8

FEATURE OF EEG

The Extracted feature from the signal are below: -

8.1 Skewness

8.2 Variance

8.3 Kurtosis

8.4 Shannon Entropy

8.1 Skewness: -

Skewness is a measure of symmetry, or more precisely, the lack of symmetry. A distribution, or data set, is symmetric if it looks the same to the left and right of the center point. The skewness is defined for a signal as where μ and σ are the mean and standard deviation

$$\operatorname{skew}(X) = \mathbb{E}\left[\left(\frac{X-\mu}{\sigma}\right)^3\right]$$

Where,

σ are the mean and standard deviation respectively

E denotes statistical expectation.

If the distribution is more to the right of the mean point the skewness is negative and vice versa. Consider the two distributions in the figure just below. Within each graph, the values on the right side of the distribution taper differently from the values on the left side. These tape-ring sides are called tails, and they provide a visual means to determine which of the two kinds of skewness a distribution has:

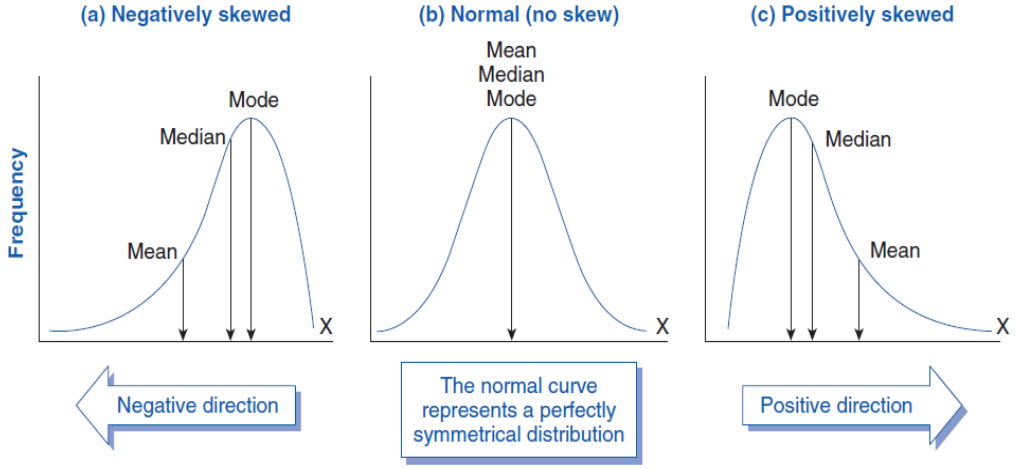
8.1.1 Negative Skew: -

The left tail is longer, the mass of the distribution is concentrated on the right of the figure The distribution is said to be left- skewed, left-tailed, or skewed to the left, despite the fact that the curve itself appears to be skewed or leaning to the right, left instead refers to the left tail being drawn out and, often, the mean being

skewed to the left of a typical center of the data. A left-skewed distribution usually appears as a right- leaning curve

8.1.2 Positive Skew: -

The right tail is longer; the mass of the distribution is concentrated on the left of the figure. The distribution is said to be right- skewed, right-tailed, or skewed to the right, despite the fact that the curve itself appears to be skewed or leaning to the left; right instead refers to the right tail being drawn out and, often, the mean being skewed to the right of a typical center of the data. A right-skewed distribution usually appears as a left-leaning curve.



fig

Fig 8.1 Skewed Curves

Skewness has benefits in many areas. Many models assume normal distribution; i.e., data are symmetric about the mean. The normal distribution has a skewness of zero. But in reality, data points may not be perfectly symmetric. So, an understanding of the skewness of the dataset indicates whether deviations from the mean are going to be positive or negative.

8.2 Variance: -

Variance measures how far a set of (random) numbers are spread out from their average value (mean) Variance has a central role in statistics, where some ideas that use it include descriptive statistics, statistical inference. Variance is an important tool in the sciences, where statistical analysis of data is common. It gives added weight to numbers far from the mean (outliers), since squaring these numbers can skew interpretation of dad. Variance of zero indicates that all the values are identical; all

variances that are non-zero will be positive numbers. A large variance indicates that numbers in set are far from the mean and each other, while small variance indicates the opposite Simply variance is the square of the standard deviation.

Formula for Population Variance: -

The variance of a population for grouped data is:

$$\sigma^2 = \sum f\,(m - \bar{x})^2 / n$$

Formula for Sample Variance: -

The variance of a sample for grouped data is:

$$s^2 = \sum f\,(m - \bar{x})^2 / n - 1$$

Where,

f = frequency of the class

m = midpoint of the class

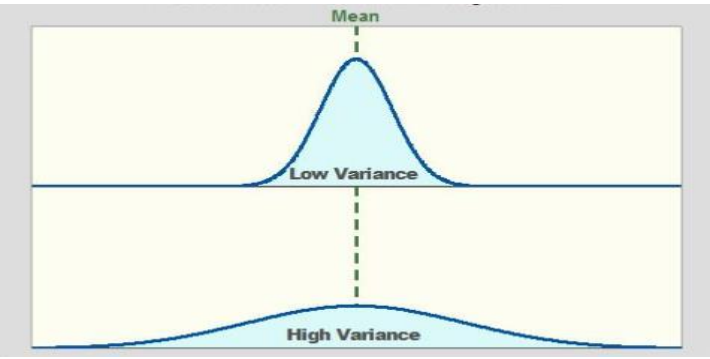


Fig 8.2: Variance Distribution

8.3 Kurtosis: -

Kurtosis is a statistical measure used to describe the degree to which scores cluster in the tails or the peak of a frequency distribution. The peak is the tallest part of the distribution, and the tails are the ends of the distribution.

There are Three types of Kurtosis

8.3.1 Mesokurtic

8.3.2 Leptokurtic

8.3.3 Platykurtic

8.3.1 Mesokurtic: Distributions that are moderate in breadth and curves with a medium peaked height.

8.3.2 Leptokurtic: More values in the distribution tails and more values close to the **mean (i.e., sharply peaked with heavy tails)**

8.3.3 Platykurtic: Fewer values in the tails and fewer values close to the mean (i.e., the curve has a flat peak and has more dispersed scores with lighter tails).

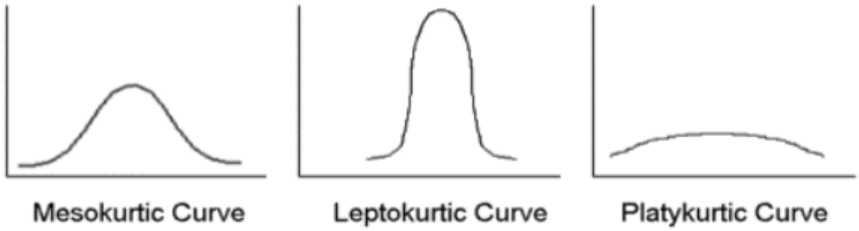


Fig 8.3: - Kurtosis

8.4 Shannon Entropy: -

Shannon entropy, named after the American mathematician and electrical engineer Claude Shannon, is a measure of the uncertainty or information content in a random variable or a probability distribution. It provides a quantification of the average amount of information needed to describe an event drawn from the distribution.

The Shannon entropy of a discrete random variable X with probability mass function P(X) is given by the formula:

$H(X) = -\Sigma[P(x) * \log_2(P(x))]$,

Where,

- H = Shannon Entropy
- P_i = fraction of population composed of a single species i
- ln = natural log
- S = how many species encountered
- Σ = summation of species 1 to S

where the sum is taken over all possible values of X. In this equation, P(x) represents the probability of the random variable X taking the value x.

The entropy H(X) is measured in bits if the logarithm is taken to base 2, or in nats if the natural logarithm (base e) is used. It represents the minimum average number of bits or nats needed to encode the outcomes of X.

The Shannon entropy is maximum when the distribution is uniformly distributed, meaning that all possible outcomes are equally likely. In this case, the entropy attains its maximum value, indicating the highest degree of uncertainty. On the other hand, the entropy is minimum (zero) when the distribution is deterministic, and only one outcome is possible with certainty.

Shannon entropy has various applications in information theory, data compression, cryptography, and machine learning. It serves as a fundamental concept for understanding and quantifying the information content of data and random processes.

Chapter 9

Support vector machine

Support vector machine is a machine learning method that is widely used for data analysing and pattern recognizing. The algorithm was invented by Vladimir Vapid and the current standard incarnation was proposed by Corinne Cortes and Vladimir Vapid.

Support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyse data used for classification. Given a set of training examples, each marked for belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on.

More formally, a support vector machine constructs a hyper plane or set of hyper planes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks. Intuitively, a good separation is achieved by the hyper plane that has the largest distance to the nearest training-data point of any class (so-called functional margin), since in general the larger the margin the lower the generalization error of the classifier.

Any hyper plane can be written as the set of points satisfying w.x+b=0
Where w is the (not necessarily normalized) normal vector to the hyper plane. The Parameter b determines the offset of the hyper plane from the origin along the normal vector w.

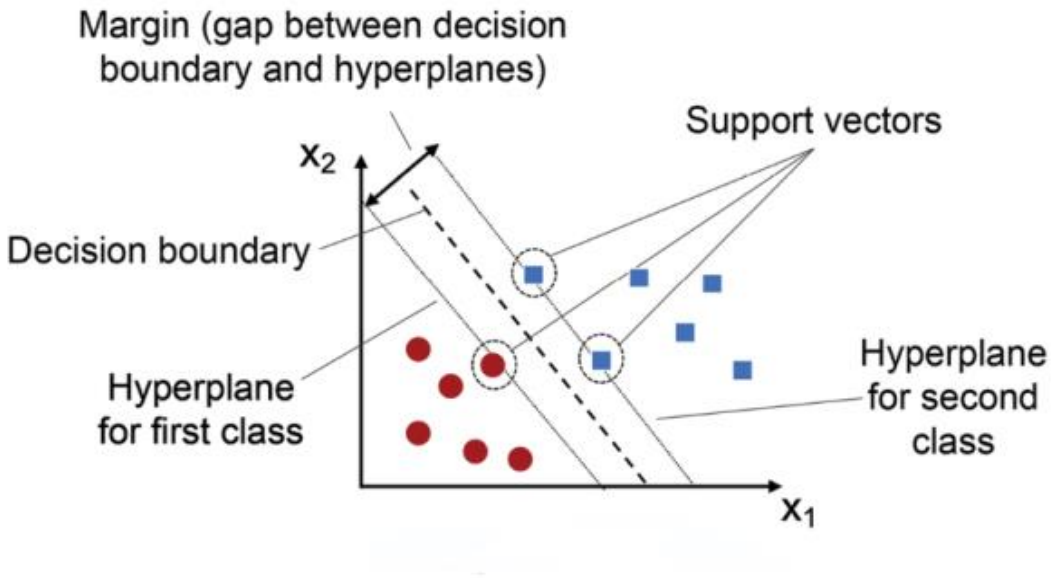


Fig9.1: SVM.

9.1 Training data selection

According to the architecture of the support vector machine, only the training data near the boundaries are necessary. In addition, because the training time becomes longer as the number of training data increases, the training time is shortened if the data far from the boundary are deleted. Therefore, if we can delete unnecessary data from the training data efficiently prior to training, we can speed up training. The selection optimum values of the parameters for SVM are an important step in SVM design. When applied to a large data set, however, it requires a long time for training so the model selection task and its performance can be degraded a long time To reduce the time for model selection, in this page we propose a training data selection method then apply the model selection on reduced training set.

9.2 Build a simple support vector machine using Neuro-solution

1. Open Neuro-solution software and click on Neuro-solution for Excel.
2. Open the Excel sheet→create→ Tag data→ Column as Input and Column as Output.
3. Click on preprocessing → To randomize the data
4. Go-to rows by percentage

Training-80%

Cross validation= 0

Testing-20%

5. Create network →→Create custom network-SVM.

6. Save the network in Neuro-Solution .

7. Go-to Excel toolbar →→Train network

8. Click Excel toolbar →Test network

9. Result

9.3 Advantages of SVM

- Training is relatively easy
- No local optimal, unlike in neural networks
- It scales relatively well to high dimensional data
- Trade off between classifier complexity and error can be controlled explicitly
- Non-traditional data like strings and trees can be used as input to SVM, instead of feature

Chapter 10

Random Forest

Random forests or random decision forests is an ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees at training time. For classification tasks, the output of the random forest is the class selected by most trees. For regression tasks, the mean or average prediction of the individual trees is returned. Random decision forests correct for decision trees' habit of overfitting to their training set. Random forests generally outperform decision trees, but their accuracy is lower than gradient boosted trees.[citation needed] However, data characteristics can affect their performance.

The first algorithm for random decision forests was created in 1995 by Tin Kam Ho using the random subspace method, which, in Ho's formulation, is a way to implement the "stochastic discrimination" approach to classification proposed by Eugene Kleinberg.

An extension of the algorithm was developed by Leo Bierman and Adele Cutler, who registered "Random Forests" as a trademark in 2006 (as of 2019, owned by Minitab, Inc.). The extension combines Bierman's "bagging" idea and random selection of features, introduced first by Ho and later independently by Amit and Gaman in order to construct a collection of decision trees with controlled variance.

Random forests are frequently used as black box models in businesses, as they generate reasonable predictions across a wide range of data while requiring little configuration

The below diagram explains the working of the Random Forest algorithm:

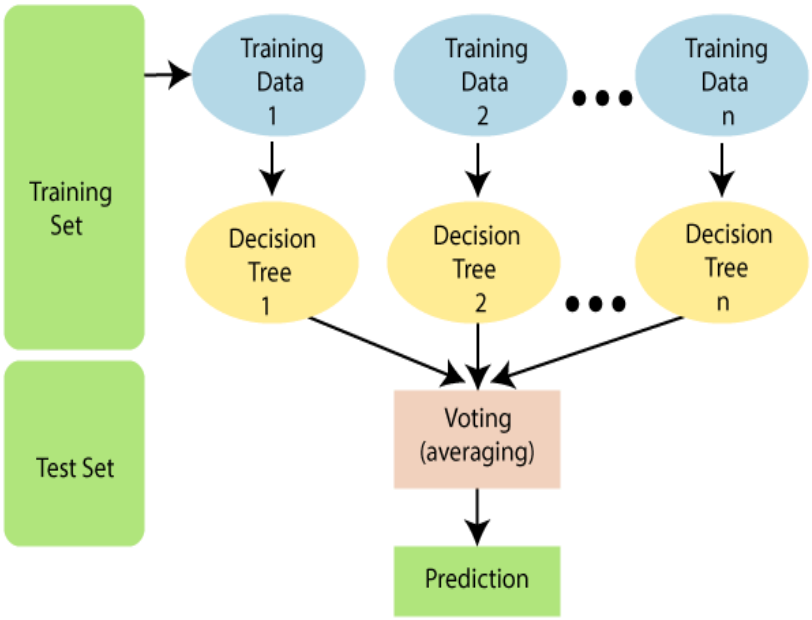


Fig 10.1 working of the Random Forest algorithm

Random Forest works in two-phase first is to create the random forest by combining N decision tree, and second is to make predictions for each tree created in the first phase.

The Working process can be explained in the below steps and diagram:

Step-1: Select random K data points from the training set.

Step-2: Build the decision trees associated with the selected data points (Subsets).

Step-3: Choose the number N for decision trees that you want to build.

Step-4: Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes.

Chapter 11

RESULTS

Four features from EEG data of before and after meditation were calculated. In fig.1,fig.2.fig.3 and fig.4 the blue lines and orange line represent the mean value of before and after meditation of kurtosis, skewness, Shannon entropy and variance. As we can observed from the following figure there is some changes in data after calculating the features of before and after meditation

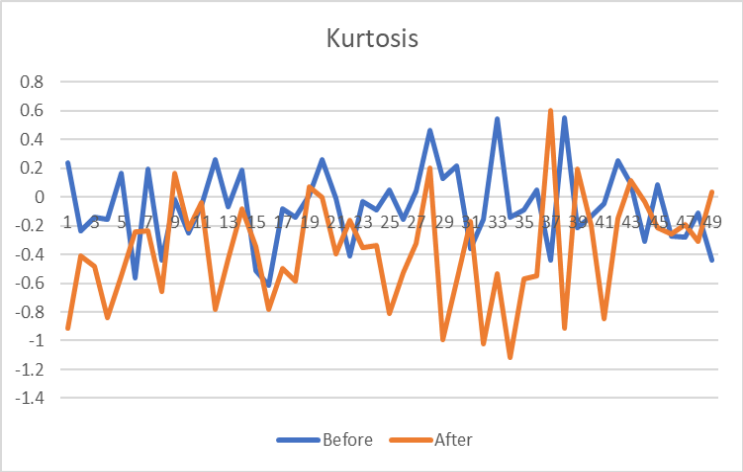


Fig.11.1 Mean of data of kurtosisbefore and after OM meditation

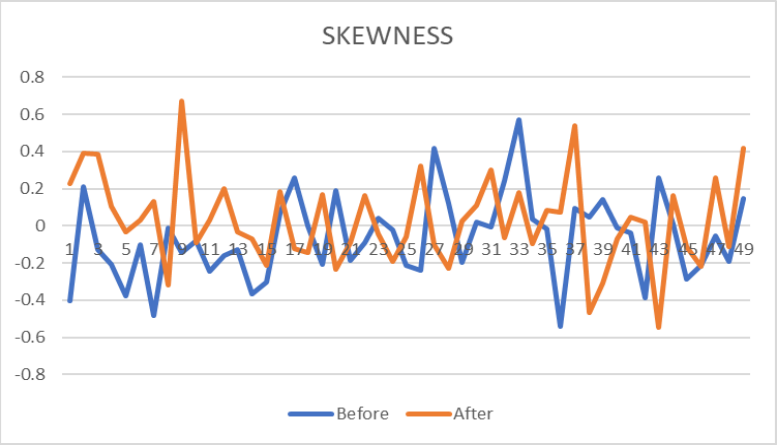


Fig.11.2 Mean of data of skewness before and after OM meditation

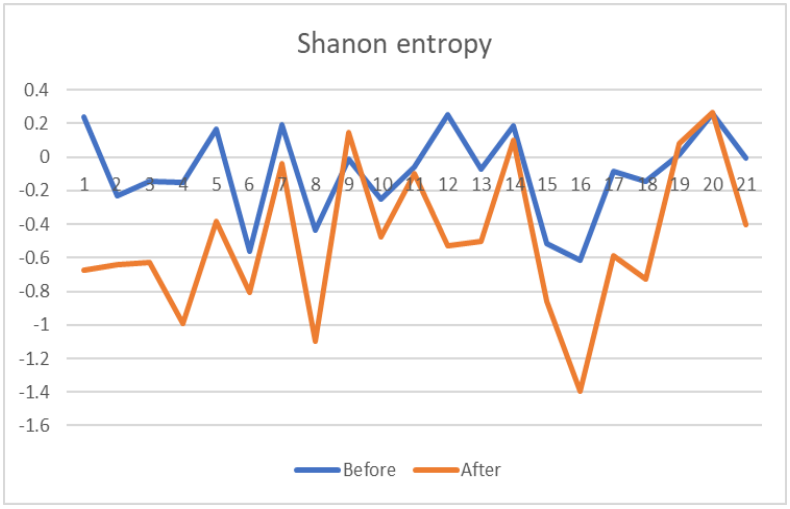


Fig.11.3 Mean of data of Shannon entropy before and after OM meditation

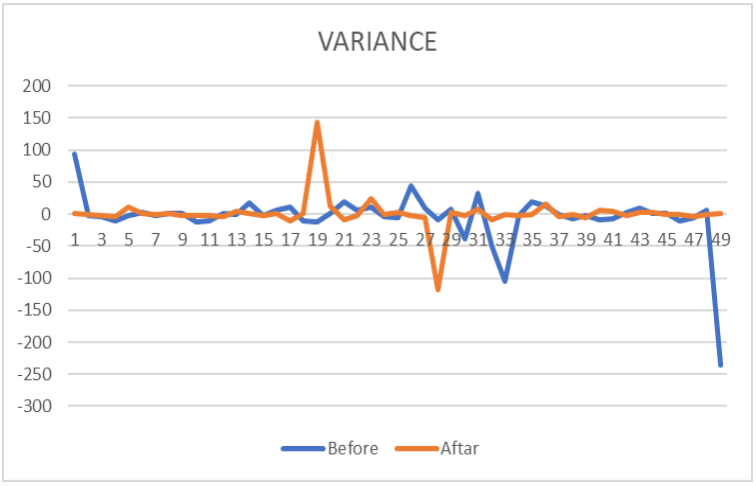


Fig.11.4 Mean of data of Variance before and after OM meditation

The main aim of this work is to design the classifier to classify the two different classes i.e., before and after EEG signal to explore the effect of OM mediation on brain. For this purpose, the extracted features used as an input for the training purpose to the SVM classifier. we get the 52% accuracy form the SVM. As we get less accuracy from SVM For more accuracy we try another classifier which is random forest classifier. And after give the same data to the Random Forest we get the accuracy 75%. As we can observe from following figure we get the better results from The Random Forest than the SVM.

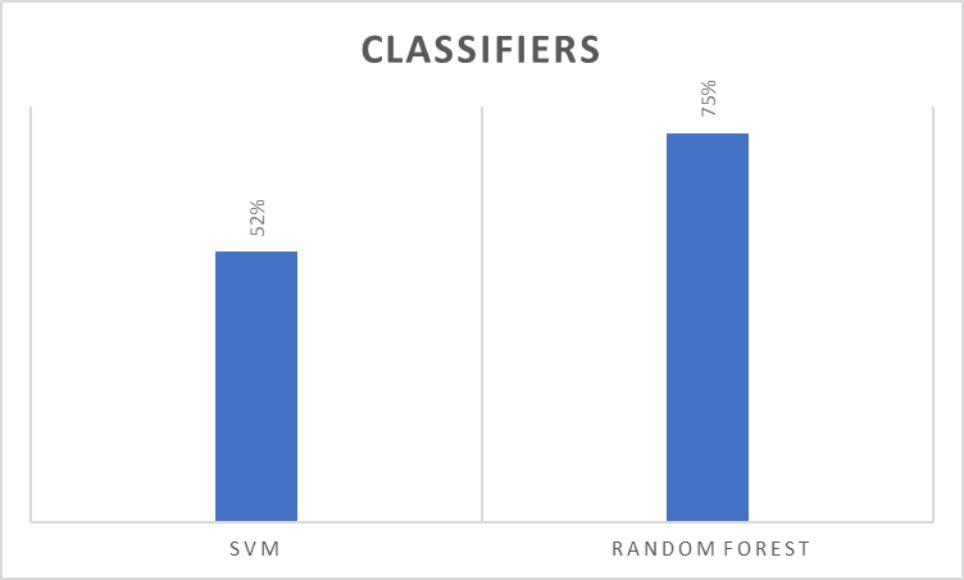


Fig. 11.5: SVM VS RANDOM FOREST

Chapter 12

Conclusion

This work provides an effective way to detect the abrupt changes in two classes i.e., Before and after OM meditation on brain with a system designed using features with less computation time and complexity. This work mainly focused on the method having high computational accuracy with less complexity and less computational time with the SVM classifier. As we conclude from output of two classifier there is some changes in data between before and after meditation. This study can also be helpful to give new direction towards the meditation.

Chapter 13

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