

ANALYSIS OF EEG SIGNALS TO ASSESS PSYCHOMOTOR DOMAINS BASED ON BLOOM'S TAXONOMY METHOD

Submitted in partial fulfillment of the requirements for the award of

Master of Technology degree in Medical Instrumentation

by

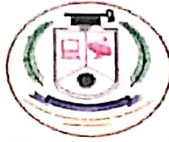
JINU JACOB.Y (42440003)



**DEPARTMENT OF BIOMEDICAL ENGINEERING
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade "A++" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNA- 600 119

APRIL - 2024



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A++" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

DEPARTMENT OF BIOMEDICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **JINU JACOB.Y** (42440003) who carried out the project entitled "**Analysis of EEG Signals to Assess Psychomotor Domains based on Bloom's Taxonomy Method**" under my supervision from June 2023 to April 2024.

Dr. P. GRACE KANMANI PRINCE, M.E., Ph.D.,

Internal Guide

Dr. T. SUDHAKAR, M.Sc., Ph.D.,

Head of the Department

Head of the Department
Department of Biomedical Engineering
Sathyabama Institute of Science & Technology
(Deemed to be University)
Category I University by UGC
Jepplaar Nagar, Rajiv Gandhi Salai,
Chennai - 600 119

Submitted for Viva-voce Examination held on 20-04-2024.

Internal Examiner

External Examiner

20/4/24

DECLARATION

I, JINU JACOB.Y (42440003) hereby declare that the Project Report entitled "Analysis of EEG Signals to Assess Psychomotor Domains based on Bloom's Taxonomy Method" done by me under the guidance of Dr.P.Grace Kanmani Prince, ME., Ph.D., Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

DATE: 22-04-2024

PLACE: CHENNAI



SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge our sincere thanks to the **BOARD OF MANAGEMENT OF SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. Sudhakar, M.Sc., Ph.D.**, Head of the Department, Department of Biomedical Engineering for providing us with necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. P. Grace Kanmani Prince ME., Ph.D.**, for her valuable guidance, suggestions, and constant encouragement that paved the way for the successful completion of my project work.

I wish to express my thanks to all **Teaching and Non-teaching staff members** of the Department of Biomedical Engineering who were helpful in many ways for the completion of the project.

I would like to express my thanks to our parents for their unwavering support of me during these years.

ABSTRACT

An Electroencephalogram is a test that measures the electrical activity of the brain using small metal disks (electrodes) placed on the scalp. Bloom's taxonomy consists of his three hierarchical models used to categorize educational learning objectives into levels of complexity and specificity. The three lists include cognitive, affective, and psychomotor learning objectives. EEG signal is used to assess brain activity while the person is performing tasks that address their psychomotor domains of analysis. An extensive review has been done on methods that were used to analyze the EEG signals and how the brain wave patterns changed concerning different activities. Pre-processing was done and worked in Python and concluded the result as which type of psychomotor domain works accurately in the students

Keywords - *EEG, Bloom's taxonomy, cognitive, psychomotor, power spectrum.*

TABLE OF CONTENT

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF ABBREVIATIONS	ix
	LIST OF FIGURES	x
	LIST OF TABLES	xii
1	INTRODUCTION	1
1.1	INTRODUCTION	1
1.2	TYPES OF EEG TESTS FOR BRAINWAVE	2
1.2.1	Sleep EEG test	3
1.2.2	Sleep-deprived EEG test	3
1.2.3	Ambulatory EEG test	3
1.2.4	Neurofeedback EEG test	4
1.3	BLOOMS TAXONOMY	5
2	LITERATURE SURVEY	7
3	AIM AND SCOPE	14
3.1	INTRODUCTION	14
3.2	EXISTING SYSTEM	14
3.3	PROPOSED SYSTEM	14

	3.4	SCOPE	15
4		MATERIALS AND METHODS	16
	4.1	INTRODUCTION	16
	4.2	BIOPAC DEVICE	17
	4.3	BSL BIOPAC STUDENT LAB SOFTWARE	18
	4.4	SURFACE GEL ELECTRODE	19
	4.5	LEAD SELECTION CIRCUIT	20
	4.6	METHODS	20
	4.6.1	EEG Brain Wave Signals	20
	4.6.2	Perception	22
	4.6.3	Set	23
	4.6.4	Guided Response	25
	4.6.5	Mechanism	26
	4.7	GOOGLE COLAB	28
	4.8	DATA PRE-PROCESSING	29
	4.9	TO CREATE AND RUN	30
5		RESULT AND DISCUSSION	32
	5.1	INTRODUCTION	32

5.2	TESTING PROCEDURE	32
5.3	PYSCHOMOTOR ANALYSIS	33
5.3.1	Perception	33
5.3.2	Set	35
5.3.3	Guided Response	36
5.3.4	Mechanism	38
5.4	OVERALL PYSCHOMOTOR RESULT	39
5.5	CONFUSION MATRIX	41
5.6	CLASSIFICATION REPORT	43
5.7	OVERALL PERFORMANCE	44
6	CONCLUSION AND FUTURE SCOPE	46
6.1	CONCLUSION	46
6.2	FUTURE SCOPE	46
	REFERENCES	48

LIST OF ABBREVIATION

BSL	Biopac student lab
CSV	Comma-separated values
ECG	Electrocardiogram
EEG	Electroencephalogram
EMG	Electromyography
FN	False negative
FP	False positive
TN	True negative
TP	True positive

LIST OF FIGURES

FIGURE No.	DESCRIPTION	PAGE No.
1.1	ELECTROENCELOPGRAPHY	4
1.2	BLOOMS TAXONOMY	6
4.1	BLOCK DIAGRAM TO ACCESS EEG SIGNAL	16
4.2	BIOPAC MP45	18
4.3	BIOPAC STUDENT LAB SOFTWARE	18
4.4	SURFACE GEL ELECTRODE	19
4.5	LEAD SELECTION CIRCUIT	20
4.6	EEG BRAIN WAVE SIGNALS	21
4.7	PERCEPTION DOMAIN ACTIVITY	23
4.8	SET DOMAIN ACTIVITY	24
4.9	GUIDED RESPONSE ACTIVITY	26
4.10	MECHANISM DOMAIN ACTIVITY	27
5.1	BIOPAC MODULE SETUP	32
5.2	TRAIN ACCURACY OF PERCEPTION	34
5.3	TEST ACCURACY OF PERCEPTION	34

5.4	TRAIN ACCURACY OF SET	35
5.5	TEST ACCURACY OF SET	36
5.6	TRAIN ACCURACY OF GUIDED RESPONSE	37
5.7	TEST ACCURACY OF GUIDED RESPONSE	37
5.8	TRAIN ACCURACY OF MECHANISM	38
5.9	TEST ACCURACY OF MECHANISM	39
5.10	TRAIN ACCURACY OF THE PSYCHOMOTOR DOMAIN	40
5.11	TEST ACCURACY OF THE PSYCHOMOTOR DOMAIN	40
5.12	MODEL CONFUSION MATRIX	41
5.13	CONFUSION MATRIX	42
5.14	COMPARISON CHART OF PERCEPTION METHOD	45

LIST OF TABLES

TABLE No.	DESCRIPTION	PAGE No.
2.1	LITERATURE REVIEW COMPARISON CHART	12
5.1	CLASSIFICATION REPORT	44
5.2	OVERALL PERFORMANCE OUTPUT	44

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

An electroencephalogram (EEG) is a test that measures electrical activity in the brain using small, metal discs (electrodes) attached to the scalp. Brain cells communicate via electrical impulses and are always active, even during sleep. This activity shows up as wavy lines on an EEG recording. An EEG is one of the main diagnostic tests for epilepsy. An EEG can also play a role in diagnosing other brain disorders.

A healthy human EEG will show certain patterns of activity that correlate with how awake a person is. The range of frequencies one observes is between 1 and 30 Hz, and amplitudes will vary between 20 and 100 μ V. The observed frequencies are subdivided into various groups: alpha (8–13 Hz), beta (13–30 Hz), delta (0.5–4 Hz), and theta (4–7 Hz). Alpha waves are observed when a person is in a state of relaxed wakefulness and are mostly prominent over the parietal and occipital sites. During intense mental activity, beta waves are more prominent in frontal areas and other regions. If a relaxed person is told to open their eyes, one observes alpha activity decreasing and an increase in beta activity. Theta and delta waves are not seen in wakefulness, and if they are, it is a sign of brain dysfunction.

EEG can detect abnormal electrical discharges such as sharp waves, spikes, or spike-and-wave complexes that are seen in people with epilepsy; thus, it is often used to inform the medical diagnosis. EEG can detect the onset and spatiotemporal (location and time) evolution of seizures and the presence of status epilepticus. It is also used to help diagnose sleep disorders, depth of anesthesia, coma, encephalopathies, cerebral hypoxia after cardiac arrest, and brain death. EEG used to be a first-line method of diagnosis for tumors, stroke, and other focal brain disorders, but this use has decreased with the advent of high-resolution anatomical imaging techniques such as magnetic resonance imaging (MRI) and computed tomography (CT). (Azman A.B et al.,2014) Despite its limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis. It is

one of the few mobile techniques available and offers millisecond-range temporal resolution, which is not possible with CT, PET, or MRI.

Derivatives of the EEG technique include evoked potentials (EP), which involves averaging the EEG activity time-locked to the presentation of a stimulus of some sort (visual, somatosensory, or auditory). [A. B. Azman et.al 2014] Event-related potentials (ERPs) refer to averaged EEG responses that are time-locked to more complex processing of stimuli; this technique is used in cognitive science, cognitive psychology, and psychophysiological research

An EEG can find changes in brain activity that might be useful in diagnosing brain disorders, especially epilepsy or another seizure disorder. An EEG might also help diagnose or treat. Brain tumors, brain damage from head injury, Brain dysfunction that can have a variety of causes (encephalopathy), Sleep disorders, Inflammation of the brain (herpes encephalitis), Stroke, Sleep disorders, Creutzfeldt-Jakob disease

An EEG might also be used to confirm brain death in someone in a persistent coma. A continuous EEG is used to help find the right level of anesthesia for someone in a medically induced coma.

1.2 TYPES OF EEG TESTS FOR BRAINWAVE

A doctor may order a standard EEG test if a patient is experiencing symptoms such as persistent headaches, unexplained seizures, or behavioral changes.

Results from these tests are used to check for any abnormal brain waves that may be an indication of more serious underlying health conditions. Further tests may be required to make a diagnosis if an abnormality is found or detected. (Chan VS et al., 2022)

A Standard EEG test is usually done on an outpatient basis at a hospital or clinic. The whole process may take up to two hours with the actual recording taking as little as 20 minutes. After which the patient is free to go back home.

If the patient is being reevaluated, then the doctor may ask them to stop taking currently prescribed medications a day before the test. This is done so that whatever abnormal symptoms that the patient was being treated for can be reevaluated during the test.

1.2.1 Sleep EEG test

When a person is sleeping, the brain wave activity is different from the awake state and some types of abnormal waves are more easily detected when the patient is sleeping.

Sometimes seizures happen when the patient is asleep. Sleep EEG tests are done very much like standard EEG tests with the only exception being the patient will be asleep during the test.

Patients having difficulty relaxing and falling asleep may be given medications to assist in falling asleep. In such cases, patients may need assistance in returning home or need to stay back for a few extra hours at the hospital.

1.2.2 Sleep-deprived EEG test

A Sleep-deprived EEG test is similar to the Sleep EEG tests but the patient is asked to deprive themselves of sleep. It is a test done to improve the possibility of detection of abnormal brain wave activities. The possibility of detecting abnormal brain waves is also much higher when the patient does not have enough sleep or is tired.

In preparation for this test, the patient may be asked to stay awake the previous night or get up earlier than usual. The test is usually conducted in the morning and all caffeine should be completely avoided before a test is given.

1.2.3 Ambulatory EEG test

When a patient is experiencing unexplained seizure episodes at random intervals these episodes become very difficult to predict and if all previous tests failed to capture a seizure episode, an Ambulatory EEG test is prescribed.

This EEG test device uses similar electrodes to a standard EEG test shown in Fig.1.1 however, they are all connected to a self-contained compact recording device that can be carried around like a previous-generation portable radio. (Chatterjee D et al., 2015)

The patient is free to go through their daily routine while the device continuously records all brain wave activities. The test period can range from a few hours to a few days.

The patient is asked to keep a record of all their activities during the test period. The patient will also need an assistant who can watch them during the test period in case a seizure occurs. The assistant will be able to record helpful details about the incident.

After the testing phase is completed, the doctor can compare the written records with actual brain wave data (electroencephalogram) and get a clearer understanding of what was happening during a seizure episode.

1.2.4 Neurofeedback EEG test

Neurofeedback, also known as EEG biofeedback, is a kind of brain training activity done with the help of an EEG machine. This procedure is designed to alter and improve the brainwave activity, thereby helping the patient overcome undesirable conditions like depression, anxiety, eating disorders, etc.

Children suffering from Attention Deficit Hyperactivity Disorder (ADHD) can also benefit greatly from this procedure.

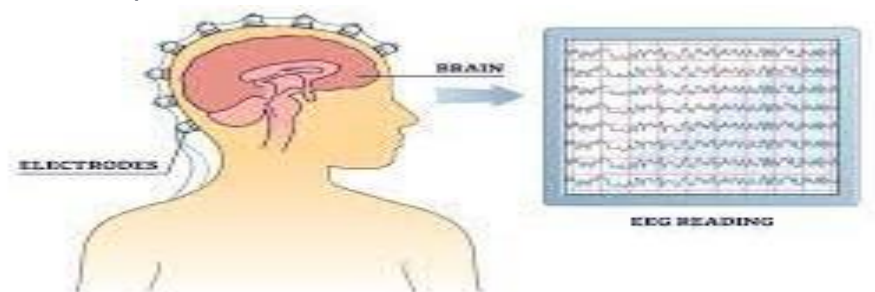


Fig:1.1: Electroencephalogram
(courtesy<https://www.simplypsychology.org/what-is-an-eeeg.html>)

1.3 BLOOMS TAXONOMY

Bloom's taxonomy is a set of three hierarchical models used for the classification of educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in cognitive, affective, and psychomotor domains. The cognitive domain list has been the primary focus of most traditional education and is frequently used to structure curriculum learning objectives, assessments, and activities (Huilan S et al., 2020)

The models were named after Benjamin Bloom, who chaired the committee of educators that devised the taxonomy. He also edited the first volume of the standard text, *Taxonomy of Educational Objectives: The Classification of Educational Goals*

The goal of educator's using Bloom's taxonomy is to encourage higher-order thinking in their students by building up from lower-level cognitive skills behavioral and cognitive learning outcomes are given to highlight how Bloom's taxonomy can be incorporated into larger-scale educational goals or guidelines. The key phrases can be used (e.g., Example Assessments) to prompt for these skills during the assessment process).

The terminology has been recently updated to include the following six levels of learning. These 6 levels can be used to structure the learning outcomes, lessons, and assessments of your course.

Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.

Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

Applying: Carrying out or using a procedure for executing, or implementing.

Analyzing: Breaking material into constituent parts, and determining how the parts relate to one another and an overall structure or purpose through differentiating, organizing, and attributing.

Evaluating: Making judgments based on criteria and standards through checking and critiquing.

Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Like other taxonomies, Bloom's is hierarchical, meaning that learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels. You will see Bloom's Taxonomy often displayed as a pyramid graphic to help demonstrate this hierarchy. We have updated this pyramid into a "cake-style" hierarchy to emphasize that each level is built on a foundation of the previous levels shown in Fig.1.2.

Bloom's taxonomy is a powerful tool to help develop learning outcomes because it explains the process of learning: Before you can understand a concept, you must remember it.

- To apply a concept you must first understand it.
- To evaluate a process, you must have analyzed it.
- To create an accurate conclusion, you must have completed a thorough evaluation

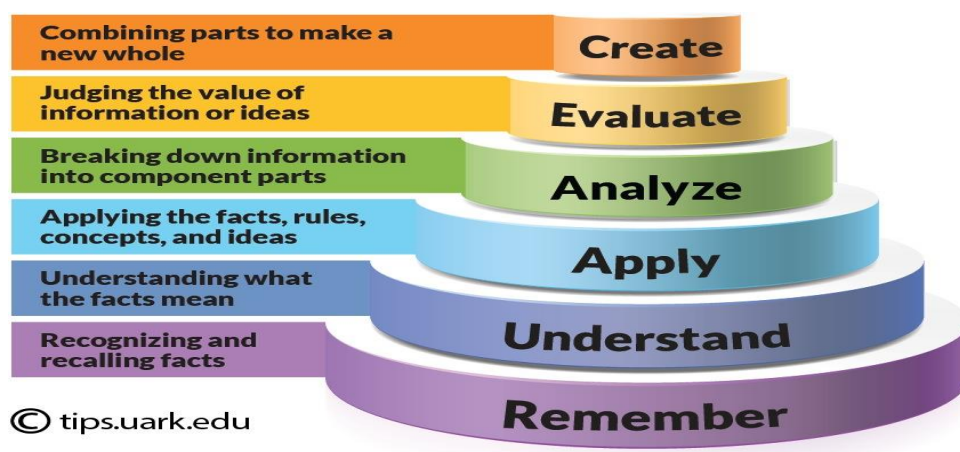


Fig:1.2: Blooms Taxonomy

(courtesy-[Using Bloom's Taxonomy to Write Effective Learning Outcomes | Teaching Innovation and Pedagogical Support \(uark.edu\)](#))

CHAPTER 2

LITERATURE SURVEY

Dustin Pulver et.al., (2023) developed a new solution for classifying cognitive load using electroencephalograms (EEG). The model uses a transformer architecture that leverages transfer learning between emotion and cognitive load. They pre-trained their model using self-supervised mask autocoding on emotion-related EEG datasets and used transfer learning with both freezing weights and fine-tuning to downstream classify the cognitive load. was executed. To evaluate this method, the researchers conducted a series of experiments using two publicly available EEG-based emotion datasets, namely SEED and SEED-IV, for pre-training. Meanwhile, for downstream cognitive classification, he uses the CL-Drive dataset[1]

Norezmi Jamal et.al., (2020) designed and proposed the collection of electroencephalogram signals (i.e. electroencephalograms (EEG)) during task performance. The use of EEG provides a promising approach to assess skills at a physiological level [4]. Therefore, tasks related to the assessed abilities must be appropriately designed to ensure that the induced EEG signals are reliable in performance assessment. A graphical user interface (GUI) allows you to capture and record the time frame of each response [2]

Olga Bazanova et.al., (2019) proposed an algorithm to develop a hybrid model called “Simultaneous execution of upper alpha power EEG and forehead EMG in response to finger movements” ($\Delta\alpha$. - ΔEMG) before EEG). This includes several subcomponents of resting and reactive EEG and EMG index transmission in response to finger movements. and they identified a system for mathematical modeling of successful psychomotor performance using electroencephalography (EEG) and electromyography (EMG) upper alpha wave reactivity in response to the performance of finger motor tasks. We presented the results of a preliminary study to develop the approach.[3]

Enrique Molina et.al., (2013) studied and investigated the EEG dynamics of participants performing a 45-minute vigilance task. High-density EEG and subject responses were recorded simultaneously and analyzed using independent component analysis and subsequent independent component clustering. Time-

frequency analysis was used to examine spectral differences between long and short reaction time (RT) trials.[6] The empirical results of this study showed that frontal beta and occipital alpha power increases with increasing RT. This is consistent with previous results on sustained attention-driving tasks[6]

Ahmad.An et.al., (2018) examined the application of practical teaching strategies in the psychomotor domain adopted by teachers in vocational schools. In this study, we observe vocational school teachers who are experts in actual technical work. This study is expected to provide new ideas for developing teachers' skills in applying psychomotor elements in teaching methods, in the form of demonstrations for teaching practical workshops.[7]

Fei Ha Chiew et.al., (2021) created a new rubric to assess students' psychomotor skills when using new course evaluation software. Points were awarded for each practical skill identified when completing the assessment. Student performance evaluation for her two-course results assigned to the psychomotor area showed that over 85% of students could achieve 50% of her KPIs for her two-course results. This indicates that most students were able to acquire the relevant practical skills required in the course when taught via her ODL[5]

Natsakon Bubphasuwan et.al., (2016) developed an authentic game to improve English and mathematics skills for beginners, defined as general learners or primary school students, with a focus on skill and knowledge acquisition. The ultimate goal for beginners is to gain knowledge, skills, and experience while practicing and learning with games. They aim to bring an authentic game to their Android platform that allows beginners to practice problem-solving skills by simulating a grocery store scene.[8]

R. Harimurti et.al., (2018) developed a method that can be used to evaluate educational data and generate useful knowledge. They focused on processing educational data to predict students' psychomotor domains using linear regression methods. In the process stage, he used four regularizations: no regularization, ridge regression, lasso regression, and elastic net regression. Furthermore, his two sampling methods such as cross-validation sampling and random sampling are used as evaluation techniques. [10] Experimental results show that the optimal

regularization in cross-validation and random sampling is net elastic regression. This is because this regularization results in the lowest prediction error.[9]

Rizal Asrul Pambudi et.al., (2016) proposed a psychomotor development game using the leap motion technique. This technology can interact with 3D space. A skeletal tracking technique is implemented to identify and detect human hand bones and fingers. His human hand recognition accuracy using the Leap Motion device in this study was 96.5%. This era overcomes the noise as a result of sunlight. The allowed distance among the user's palms is 20-50 cm above the Leap Motion device[10]

Dr. Sandeep S. Ahankari et.al., (2016) developed a total of eight POs, four each in the emotional and psychomotor domains. Establishing realistic values for achieving the outcomes of concern requires different assessment tools, their assessment methodologies, reliability, and partial weighting. They focused on various new assessment tools and different formulas to calculate more realistic performance values for different POs classified in the emotional and psychomotor domains[11]

Zhongze Hu and colleagues et.al., (2015) developed a reliable model using the EEG power spectrum to estimate task time in the psychomotor vigilance test (PVT) that can be adapted to all individuals. High correlations between estimated and actual reaction times were obtained. [13] Their results thus illustrate the feasibility of modeling performance decline over time on tasks in different individuals based on their brain activity, with potential applications in several areas, including road traffic and industrial safety[12]

Jirawit Yanchinda et.al., (2019) aim to examine the creative knowledge of the Thai jewelry designer and examine his situation from a secondary perspective. They collected the creative behavior of jewelry designers during the design process and measured it using Bloom's taxonomy: the psychomotor domain as a measure of the development of physical abilities and skills of the designer. The designer's final learning outcome is at an entry level that demonstrates originality, novelty, and innovation. Models are selected from regular jewelry designers and have a success story. Both groups were tasked with designing a new jewelry

collection and completed it in 6 hours. All activities and behaviors of the children are directly observed, interpreted, and measured for their creative knowledge.[13]

Paulo Roberto Brero de Campos et.al., (2018) developed a design. Design is the organization and application of ideas. Once the student has visualized what will be done in the laboratory, he can enter the collected data, that is, he can perceive the data. Perception is the manipulation of a device to collect data. Finally, through analyzing the results, students realize what they have achieved. Based on Simpson's classification, a new classification of the psychomotor field is proposed for use in technical training laboratories.

Nor Syamina Sharifful Mizam et.al., (2021) developed a novel approach to examine variation in practice experience to assess unintentional learning related to classical psychomotor skills in Engineering technology laboratory courses. The methodology used to construct the instrument is described and the empirical data collected to support its validity are presented. [16] The expected results of the test battery to improve the measurement of practical skills related to psychomotor variability in engineering laboratory courses were demonstrated.[14]

R. Harimurti et.al., (2018) focused on processing educational data to predict students' psychomotor domains. Here, they applied linear regression to achieve this. In the processing stage, they used four regularizations, which are: non-regularization, ridge regression, Lasso regression, and elastic net regression. In addition, they also exploited two sampling methods as evaluation techniques. Experimental results indicate that the best regularization in terms of cross-validation and random sampling is elastic net regression because this regularization achieves the lowest prediction error.[15]

N. Fuad et.al., (2020) collected a sample of EEG data from the subject's brain during psychomotor learning activities, to analyze the brain waves generated by the brain during psychomotor learning activities. psychomotor and analyze the data collected using statistical analysis and comparison in terms psychomotor activities between different genders. Based on the results obtained, almost all psychomotor people have Beta and Alpha bands, but the Beta band will have a larger area than the Alpha band.

Nanda (D) Nandagopal et.al., (2011) extracted different features from visual, tactile, auditory, and psychomotor stimuli and identified them with different cognitive aspects such as memory, emotions, excitement, fatigue, and distraction and proposed to address the effects of brain testing on EEG. Predict cognitive mental states by modeling cognitive function by relating event-related differential potentials, brain waves, spectral density, and latency of EEG results to characteristics stimulation point.

Ryan Rich and colleagues et.al., (2023) determined the accuracy of EEG phase prediction of resting-state and task-state occipital alpha waves in 484 participants across 11 publicly available datasets. They could accurately track the EEG phase across various cognitive conditions and datasets, especially during periods of high instantaneous alpha power and high signal-to noise ratio (SNR). Although the resting state generally had higher accuracy than the task state, the differences in absolute accuracy were small, with most of these differences being due to EEG power and SNR.[16] These results suggest that experiments and technologies using EEG phasing should focus more on minimizing external noise and waiting for periods of high power than on inducing a specific cognitive state.

J.A. Bakar et.al., (2020) developed the project by asking 10 engineering students from University Tun Hussein Onn Malaysia to be the data collection subjects. The cognitive domain is tested by giving the subject a set of 15 questions of different types. Questions must be answered within 5 minutes. The psychomotor domain is tested by asking subjects to design a building or statue out of Lego and subjects are also required to comply with certain conditions lasting 5 minutes. According to the experiment performed, for the cognitive and psychomotor domains, the dominant subbands are delta and beta. The Alpha subband is dominant when the person feels calm.[17]

Rateb Katmah et.al., (2021) developed existing EEG signal analysis methods to assess mental stress. The analysis highlights important differences between study findings and confirms that variations in data analysis methods contribute to some conflicting results. Differences in results may be due to a variety of factors, including lack of standardized protocol, brain region of interest, type of stressor, duration of testing, appropriate EEG processing, extraction mechanism Export

features, and taxonomy types. Therefore, the important part involved in recognizing mental stress is selecting the most relevant features. [19]

Table 2.1: Literature Review Comparison Chart

Reference	Title	Inference
MNAH Sha'bani(2020)	Development of Cognitive and Psychomotor Task for EEG Application with Matlab-based GUI	In this study, in arithmetic tasks, accuracy decreases as the difficulty level has increased. Response time has been increased from easy to difficult. inside structural construction tasks, most subjects completed the project within the specified time. Accuracy – 80%
Rateb Katmah(2021)	A Review on Mental Stress Assessment Methods Using EEG Signal	In this, the problem can be addressed by balancing sample sizes across different conditions or participants, using statistical methods that explicitly account for sample size bias, or using null connection methods. affected by sample size bias. Additionally, understanding the relationship between mental stress and complex and diverse EEG characteristics. Accuracy – 79.45 to 80.00%
N.Fuad(2019)	A Study of Non-Dyslexia Person EEG Pattern for Cognitive Activities Due to Different Gender.	In this study, the cognitive ability of men and women was determined by asking 3 sets of questions, each set of 15

		questions to be answered within 5 minutes, and determining the average alpha wave and Beta waves of men and women.
Debatri Chatterjee(2015)	Analyzing Elementary Cognitive Tasks with Bloom's Taxonomy using Low-Cost Commercial EEG device	In this study, the subject's response time and accuracy were determined and the relationship between ECT and the individual's basic cognitive skills was determined through EEG analysis.
N. Fuad(2020)	EEG pattern of cognitive activities for non-dyslexia (engineering student) due to different gender	In this study, the data collected focused on the alpha waves and beta waves that exist between a person in a conscious state. The difference between male and female brain waves during cognitive activities can be observed from the analysis and discussion
Ce Zhang(2021)	A Survey and Tutorial of EEG-Based Brain Monitoring for Driver State Analysis	In this study, through the analysis of EEG data algorithms, it was possible to develop a deeper understanding of the driver's state, control functions, and readiness, and this method helps reduce human error and improve safety
A Ahmad(2018)	Applying Psychomotor Domain for Competency-Based Teaching in Vocational Education	In this study, analysis of students' scores in the psychomotor field showed that 87.5% of the total students.

CHAPTER 3

AIM AND SCOPE

3.1 INTRODUCTION

This proposed system only uses psychomotor tasks (perception, set, guided reaction, basic proficiency) to acquire the individual. To complete this assignment, samples must play specific activities like games that stimulate both their brain activity and psychomotor ability. The BIOPAC module helps in assessing the psychomotor ability using recording EEG signals from the brain. This system neglects all the other hard methods of forcing the samples to acquire the data. BIOPAC makes their method simpler in assessing the EEG signals and doesn't make the patient feel uncomfortable. For the psychomotor domain tests, personalized psychomotor games have been prepared. An extensive literature survey has been carried out on the topic of EEG signals using psychomotor and BIOPAC.

3.2 EXISTING SYSTEM

The existing work involving Biopac devices spans across various fields, including physiology, psychology, neuroscience, biomechanics, sports science, and clinical medicine. Biopac systems are used in clinical settings for diagnostic assessments and monitoring of physiological parameters. For instance, ECG is used for diagnosing cardiac arrhythmias, while EMG may be used for assessing neuromuscular disorders. Biopac systems are used in rehabilitation settings to assess muscle function and monitor progress during physical therapy. In sports science, they are employed to analyze athlete performance and monitor physiological responses during training and competition. Overall, the existing work involving Biopac devices is diverse and interdisciplinary, spanning multiple fields and applications aimed at understanding human physiology and behavior, diagnosing medical conditions, improving performance, and enhancing human well-being (Lochotinant C., et al., 2019).

3.3 PROPOSED SYSTEM

This proposed system only uses psychomotor tasks (perception, set, guided reaction, basic proficiency) to acquire the individual. In order to complete this

assignment, samples must play specific activities like games that stimulate both their brain activity and psychomotor ability. The BIOPAC module helps in assessing the psychomotor ability by means of recording EEG signals from the brain.

This system neglects all the other hard methods of forcing the samples to acquire the data. BIOPAC makes their method simpler in assessing the EEG signals and doesn't make the patient feel uncomfortable. It's not directly applicable to assessing the psychomotor domain in education, which includes skills related to physical movement, coordination, and manipulation

Perception: Observing and understanding cues related to the task or activity.

Set: Being mentally prepared and focused on the task.

Guided Response: Following instructions and performing basic movements or actions.

Mechanism: Executing more complex movements or actions with precision and coordination.

In this project, Students were asked to play various types of games to identify the psychomotor domain, connected surface electrodes to the subjects and asked them to play those games in order to collect their EEG waveforms. Different brain waveforms are classified for the psychomotor domain. After connecting the surface gel electrode, the signal will be analyzed and stored in the BIOPAC student laboratory. After the signal is analyzed, the system will extract these EEG waveforms to provide a classification of the EEG signal. (Mizam N. S. S., et al.,2021)

3.4 SCOPE

The scope of Biopac devices is extensive, encompassing a wide range of applications across various fields Biopac devices are valuable tools for educational purposes, providing hands-on learning experiences for students in physiology, neuroscience, biomechanics, and related disciplines. They enable students to collect and analyze real-time physiological data, reinforcing theoretical concepts and practical skills. Overall, the scope of Biopac devices is broad and multidisciplinary, spanning across biomedical research, and clinical practice.

CHAPTER 4

MATERIALS AND METHODS

4.1 INTRODUCTION

The electrodes and the lead selection circuits are connected to the BIOPAC. The leads are placed in the proper position as mentioned in the BIOPAC module. The white crab electrode which is said to negative is placed on the test sample's right wrist. The red crab electrode is positive and is placed on the left ankle area of the sample. The black crab electrode is the ground and is placed on the right ankle part of the sample. All these crab electrodes are mounted on the sample's body with the help of surface gel electrodes.

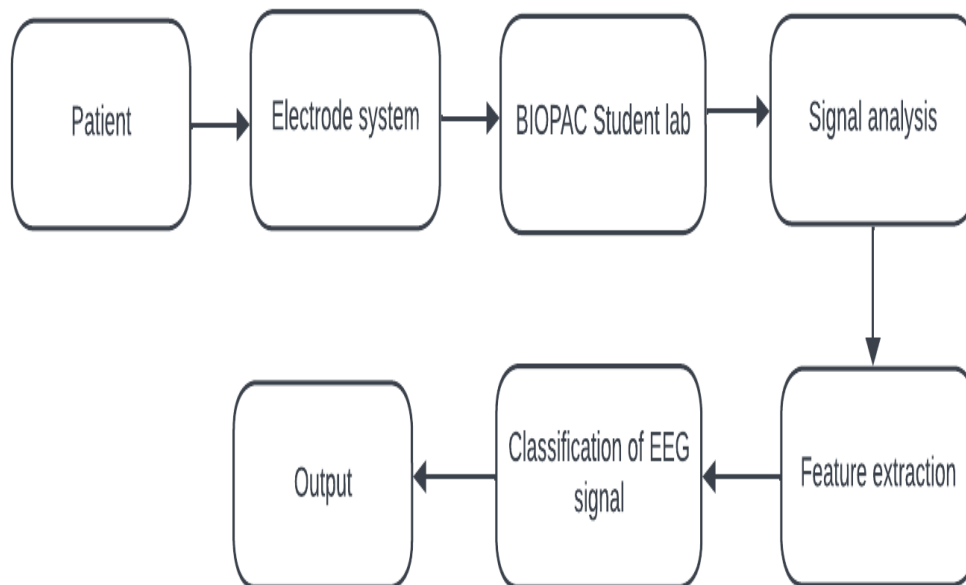


Fig:4.1: Block Diagram to asses EEG Signal using BIOPAC

Fig 4.1 describes the complete Biopac connections. Students were connected via electrodes, and these electrodes were connected to the Biopac student assay. Signal analysis was performed, features were extracted, and the EEG signal was classified to obtain the output.

4.2 BIOPAC DEVICE

A flexible system created for data collecting and analysis in research and teaching is the BIOPAC MP45 Data Collecting System which is shown in Fig.4.2. A variety of physiological signals, including ECG, EMG, and EEG, among others, can be measured using the MP45. Biopac Systems, Inc. is a company that specializes in providing physiological measurement tools and systems for researchers and educators. They offer a range of devices for collecting various types of physiological signals, including electroencephalography (EEG). This is the main device that captures the EEG signals. The amplifier is designed to pick up the tiny electrical signals produced by the brain's neurons. Biopac amplifiers are usually designed to provide high-quality amplification while minimizing noise and artifacts.

The amplifier may include signal processing capabilities to filter and process the EEG signals. This can include features such as bandpass filtering to isolate specific frequency ranges of interest, noise reduction algorithms, and impedance monitoring to ensure proper electrode contact. Biopac also offers various accessories such as electrode gel, electrode caps, and headsets to facilitate the setup and use of the EEG system. (Molina E., et al., 2013)

Overall, the Biopac EEG system is designed to provide researchers with a comprehensive tool for capturing and analyzing EEG signals in a variety of research settings, including neuroscience, psychology, cognitive science, and clinical applications.

A research-grade data acquisition device for recording and analyzing physiological data is called the BIOPAC MP45. It is a multi-channel system that has the capacity to simultaneously capture physiological data from up to 16 channels, making it an effective tool for numerous research applications. The MP45 data collection unit, a compact, transportable device that can be linked to a computer through USB, is a component of the BIOPAC MP45 system. The AcqKnowledge software, which is used to record, analyze, and visualize data, is also part of the system. A robust set of tools for data analysis, including time-domain, frequency-domain, and non-linear analytic approaches, is offered by the AcqKnowledge software. For quick and effective data processing, the software also offers automated analysis choices and editable analysis templates.



Fig:4.2: Biopac MP45

4.3 BSL BIOPAC STUDENT LAB SOFTWARE

A software called BSL (BIOPAC Student Lab) was created by BIOPAC to be used in educational settings to teach physiological concepts and carry out laboratory investigations. Because of the software's user-friendly and intuitive design, even students with little to no physiology or data-gathering experience can use it shown in Fig.4.3. The BSL software also contains a variety of tools for data analysis and visualization, including time-domain analysis, frequency-domain analysis, and trend analysis, in addition to the pre-designed lab assignments. The software additionally enables modification of the channel, sample rate, and filter parameters used in data acquisition. The BSL software is a flexible and adaptable tool for physiology instruction since it works with a variety of BIOPAC data-gathering systems and sensors. It is a useful tool for both students and teachers and is utilized in educational institutions all over the world, from high schools to colleges.

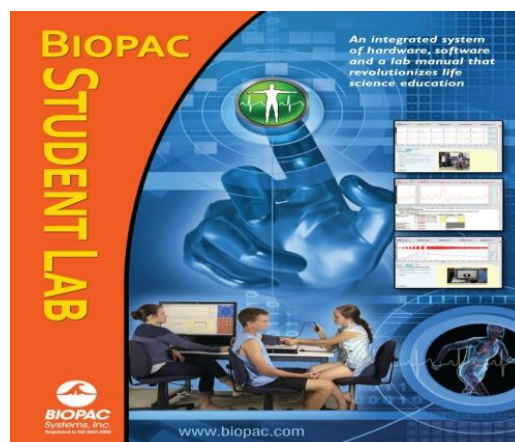


Fig:4.3: Biopac student lab software

4.4 SURFACE GEL ELECTRODES

The EEG can also be recorded using surface gel electrodes. Surface gel electrodes are adhered to the skin with conductive gel or glue to record EEG signals shown in Fig.4.4. After the electrodes are connected, a BIOPAC data acquisition device records the ECG signals and uses specialized software to analyze the HRV. Time-domain and frequency-domain analysis are frequently used in HRV studies, and both techniques can reveal information regarding the activity of the parasympathetic and sympathetic branches of the autonomic nervous system. This data can be used to evaluate stress levels, cardiovascular health, and general well-being. Overall, BIOPAC surface gel electrodes provide a practical and dependable solution for physiological data collection and analysis. These electrodes can be utilized for a wide range of physiological signals, including HRV. Surface gel electrodes are non-invasive, simple to use, and commonly used for HRV monitoring. It has been applied in a variety of clinical and scientific settings, including the evaluation of autonomic function in patients with illnesses like cardiovascular disease, diabetes, and psychiatric disorders. To reduce the danger of infection and harm, it is crucial to adhere to adequate hygiene and safety precautions when using any medical device.



Fig:4.4: Surface gel electrodes

4.5 LEAD SELECTION CIRCUIT

With BIOPAC MP45 data collecting devices, a certain kind of shielded lead is referred to as an "SS2LB." The BIOPAC MP45 system's essential component, SS2LB shielded lead, enables the precise and dependable recording of physiological data in a range of research applications. (Sagga D., 2022) It is a fully insulated cable assembly that enables high-resolution biopotential recording utilizing disposable electrodes in series. Standard pinch connections are used to connect the 2-meter adaptor to surface electrodes. The BIOPAC Student Lab data acquisition (MP45) research unit and the SS2LB are interfaced shown in Fig.4.5. The subject is covered by the leads, which have an end that resembles a crab pin, on the top surface of the surface electrodes that are adhered to the subject.



Fig:4.5: Lead selection circuit

4.6 METHODS

4.6.1 EEG Brain wave Signals

The materials are connected by the Biopac device and the subject. After connecting the EEG electrodes to the student, a calibration process is followed by a recording process. The recorded waveforms are represented by alpha, beta, delta, and theta waves.

Alpha Waves (8 - 13 Hz): Alpha waves are prominent when the brain is in a relaxed but awake state. They are typically observed when the eyes are closed, during states of meditation, or when engaged in activities that require calm focus, such as mindfulness.

Beta Waves (13 - 30 Hz): Beta waves are associated with active, alert, and focused mental states. They are most prominent during waking states, particularly during periods of concentration, problem-solving, decision-making, and active thinking.

Delta Waves (0.5 - 4 Hz): Delta waves are the slowest brainwave activity observed in the EEG. They are most prominent during deep sleep stages, particularly during non-rapid eye movement (NREM) sleep. Delta waves are associated with restorative sleep, physical healing, and unconscious processing.

Delta Waves (0.5 - 4 Hz): Delta waves are the slowest brainwave activity observed in the EEG. They are most prominent during deep sleep stages, particularly during non-rapid eye movement (NREM) sleep. Delta waves are associated with restorative sleep, physical healing, and unconscious processing. The waves are shown in the Fig.4.6.

We used beta waves for further classification because they are associated with active thinking, concentration, and problem-solving.

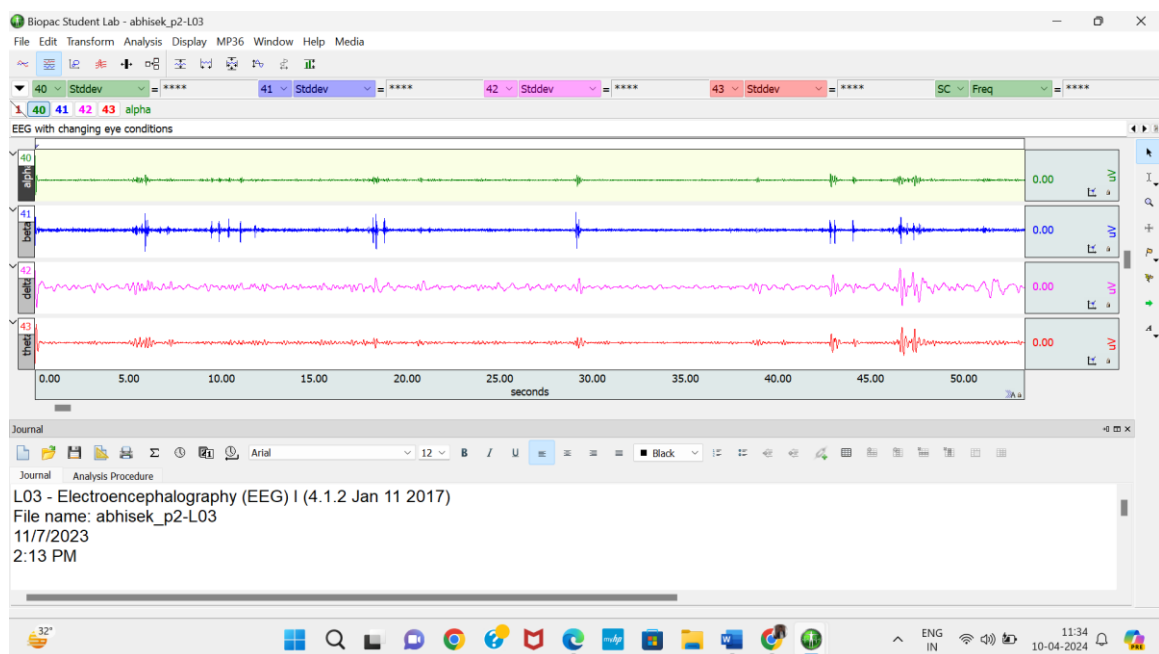


Fig:4.6: EEG Brain Wave Signals

4.6.2 Perception

Perception in the psychomotor domain refers to the ability of an individual to interpret and make sense of sensory information received from the environment, particularly in the context of motor skills and physical activities. In psychology, the psychomotor domain is one of the three domains of learning, alongside the cognitive and affective domains, as proposed by educational theorist David Krathwohl.

Here's a breakdown of perception in the psychomotor domain:

Sensory Input: Perception begins with sensory input, which involves the reception of information through the senses such as sight, hearing, touch, taste, and smell. In the context of psychomotor skills, sensory input is crucial for understanding the physical environment, the task at hand, and any relevant stimuli.

Interpretation: Once sensory input is received, it needs to be interpreted by the individual's brain. This involves processing and making sense of the sensory information. For example, in sports, a player needs to interpret the movement of opponents, the trajectory of a ball, and other environmental cues to make appropriate decisions and execute actions effectively.

Integration with Motor Skills: Perception is closely linked with motor skills, which involve the coordination of muscles and limbs to perform specific actions. The interpretation of sensory information influences the planning and execution of motor responses. For instance, a dancer's perception of rhythm and spatial awareness informs their movements and choreography.

Feedback Mechanisms: Perception also involves the continuous monitoring of feedback during motor activities. As the individual performs actions, sensory feedback (e.g., proprioceptive feedback from muscles and joints) provides information about the success or failure of those actions. This feedback loop allows for adjustments and refinements in movement to achieve desired outcomes.

Perceptual Learning: Through repeated practice and experience, individuals can improve their perceptual skills in the psychomotor domain. This includes the ability to discern relevant sensory information, anticipate changes in the environment, and adapt motor responses accordingly. For example, skilled athletes develop

heightened perceptual abilities to anticipate opponents' movements and react swiftly in competitive situations.

In summary, perception in the psychomotor domain plays a fundamental role in how individuals perceive, interpret, and respond to sensory information during physical activities and motor skill performance shown in Fig.4.7. It encompasses sensory input, interpretation, integration with motor skills, feedback mechanisms, and perceptual learning, all of which contribute to effective and efficient movement execution.



Fig:4.7: Perception domain activity

4.6.3 Set

The process of learning within the psychomotor domain typically involves a series of steps or stages. In the context of teaching and learning, instructors often use a model called the "set" model to guide the progression of skill acquisition. Here's an explanation of the set model process in the psychomotor domain:

Mental Set: Before engaging in any physical skill, learners must first develop a mental set. This involves understanding the task, its objectives, and the techniques required to perform it. Mental preparation can include demonstrations, explanations, and visualizations to help learners grasp the concept of the skill they are about to acquire. (Stucker C. et al., 2023)

Readiness Set: Once learners have a clear understanding of the task, they must prepare themselves physically and mentally to perform it. Readiness involves ensuring that learners have the necessary physical abilities and are mentally

focused on the task at hand. Warm-up activities, stretches, and relaxation techniques may be employed to help learners achieve the appropriate level of readiness.

Motor Set: The motor set stage involves the actual execution of the physical skill. Learners apply the knowledge and understanding gained in the mental set stage to perform the task. This stage often involves repeated practice and feedback from instructors to refine technique and improve performance. Motor set activities may include drills, simulations, and guided practice sessions.

Environmental Set: The environmental set considers the context in which the skill is being performed. Factors such as lighting, noise, space, and equipment can influence performance. Learners must adapt to various environmental conditions and learn how to optimize their performance accordingly. Environmental set activities may involve practicing in different settings or adjusting equipment to simulate real-world conditions.

Situational Set: Finally, the situational set stage involves applying the skill in different contexts or situations. Learners practice transferring their skills to new scenarios or challenges shown in Fig.4.8.

By progressing through these stages in the set model, learners can systematically develop their psychomotor skills while addressing various cognitive, emotional, and environmental factors that influence performance. Effective instruction within the psychomotor domain often involves carefully designing activities and providing appropriate support to guide learners through each stage of the learning process.



Fig:4.8: Set domain activity

4.6.4 Guided Response

In the psychomotor domain, guided response is a stage of learning where individuals are provided with direct instruction, demonstrations, or guidance to acquire a new skill or perform a specific task. This stage is part of the broader framework proposed by educational psychologist David Krathwohl, which outlines a hierarchy of learning objectives, with the psychomotor domain focusing on physical skills and abilities.

The process of guided response typically involves several key steps:

Observation and Demonstration: Learners observe the skill being performed by an instructor or a more skilled individual. This may involve watching demonstrations, videos, or live performances.

Instruction and Explanation: The instructor clearly explains the steps involved in performing the skill. This may include breaking down the skill into smaller components, highlighting key techniques, and providing a rationale for each step.

Modeling: The instructor or a skilled individual demonstrates the skill while explaining each step. Modeling allows learners to see the skill performed correctly and provides a visual reference for how it should be executed.

Practice with Guidance: Learners engage in guided practice under the supervision of the instructor. During this phase, learners receive feedback, corrections, and additional guidance as they attempt to perform the skill themselves. The instructor may provide verbal cues, physical assistance, or demonstrations to help learners improve their performance shown in Fig.4.9

Repetition and Refinement: Learners repeat the skill multiple times, gradually refining their technique and improving their proficiency. Repetition helps solidify the neural pathways involved in performing the skill and builds muscle memory.

Feedback and Assessment: Throughout the guided response process, learners receive ongoing feedback from the instructor and self-assess their performance. Feedback may highlight areas of strength and areas needing improvement, guiding learners in adjusting their approach and refining their technique.

Independence and Mastery: As learners progress through guided practice and receive feedback, they gradually gain confidence and proficiency in performing the skill independently. With continued practice and reinforcement, learners move towards mastery, where they can execute the skill effectively and consistently without direct supervision.

Overall, guided response in the psychomotor domain involves structured instruction, demonstration, practice, and feedback to help learners acquire and refine physical skills. It provides a scaffolded approach to skill development, gradually transitioning learners from initial exposure to independent mastery.



Fig:4.9: Guided response domain activity

4.6.5 Mechanism

In the psychomotor domain of learning, which involves physical skills and actions, the concept of "type mechanism" refers to the process by which individuals progress through different stages of skill development. This concept is often associated with the work of educational psychologist Robert Gagné.

Here's a breakdown of the process of type mechanism in the psychomotor domain:

Unskilled: At the initial stage, individuals are unskilled and lack proficiency in the particular skill or action. They may not have any prior experience or knowledge about the skill. (Shadpour S et al., 2023)

Novice: As individuals begin to learn and practice the skill, they move into the novice stage. Novices have a basic understanding of the skill but lack precision and consistency in performing it. They require explicit instruction and guidance.

Advanced Beginner: With continued practice and experience, individuals progress to the advanced beginner stage. They demonstrate improved performance and can execute the skill with more consistency and accuracy. However, they still rely on external cues and guidance.

Competent: At this stage, individuals have developed a higher level of proficiency in the skill. They can perform the skill independently and with greater efficiency. They have gained a deeper understanding of the skill and can adapt their performance to different contexts and variations.

Proficient: Proficient individuals demonstrate mastery of the skill. They can perform it smoothly, accurately, and with minimal effort. They have developed automaticity in their actions and can effectively troubleshoot problems that may arise during performance.

Expert: The highest level of skill attainment, experts have extensive experience and expertise in the particular domain. They possess a deep understanding of the skill and can perform it effortlessly in a wide range of situations. Experts often demonstrate creativity and innovation in their execution of the skill shown in Fig.4.10.

Throughout this process, individuals progress from being unskilled novices to highly skilled experts through deliberate practice, feedback, and experience. Type mechanism provides a framework for understanding how individuals develop proficiency in psychomotor skills over time.



Fig:4.10: Mechanism domain activity

4.7 GOOGLE COLAB

Google Colab, short for Google Colaboratory, is a cloud-based platform provided by Google that allows users to write and execute Python code in a browser-based environment, without requiring any setup or installation. It is particularly popular among researchers, educators, and data scientists for its ease of use, accessibility, and integration with Google Drive.

Access and Environment: Google Colab is accessible through any web browser, including Chrome, Firefox, Safari, etc. Users can access Colab using their Google account. Colab provides a Python environment that includes common libraries for data analysis, machine learning, and scientific computing pre-installed, such as NumPy, Pandas, Matplotlib, TensorFlow, PyTorch, etc.

Jupyter Notebooks: Google Colab is based on Jupyter Notebooks, which allow users to create and share documents that contain live code, equations, visualizations, and narrative text. Notebooks are organized into cells, which can contain either code or text (Markdown).

Free Cloud Computing: Google Colab provides free access to computing resources, including CPU, GPU, and TPU (Tensor Processing Unit). Users can select the type of hardware accelerator they need (GPU or TPU) for their notebooks. The free tier comes with certain limitations, such as maximum session duration and resource usage.

Integration with Google Drive: Colab integrates seamlessly with Google Drive, allowing users to create, save, and share their notebooks directly from Google Drive. Users can also import datasets and files from Google Drive into their Colab notebooks.

Collaboration Features: Multiple users can collaborate on the same notebook in real-time. Users can share their notebooks with others by providing them with a link or granting them access via email.

Interactive Data Visualization: Colab supports interactive data visualization using libraries like Matplotlib, Seaborn, Plotly, etc. Users can create interactive charts, graphs, and plots directly within their notebooks.

Markdown Support: Colab supports Markdown, allowing users to write formatted text, add headings, lists, links, images, etc., to provide explanations and documentation within their notebooks. Code

Execution and Output: Users can execute code cells individually or all at once. Output, including printed text, errors, and visualizations, is displayed directly below the code cell.

Persistent Storage: Colab provides temporary storage for notebooks and files, which is available for the duration of the session. Users can mount Google Drive for persistent storage across sessions.

Additional Features: Users can install additional Python libraries using pip directly within Colab notebooks. Colab provides access to external data sources and APIs for data retrieval and analysis. Advanced users can customize runtime settings, manage dependencies, and install system packages.

4.8 DATA PRE-PROCESSING:

Pre-processing data in the context of Biopac uploading in Google Colab involves preparing the data collected from Biopac systems for analysis. This typically includes tasks such as cleaning, transforming, and summarizing the data to make it suitable for further analysis. Here's a step-by-step explanation of how you can calculate mean, median, standard deviation, variance, skewness, and kurtosis for the data uploaded from Biopac in Google Colab:

Data Upload: First, you need to upload the data collected from Biopac into your Google Colab environment. You can use libraries like Pandas to read the data from CSV files or any other formats it may be stored in.

Data Cleaning: Check for any missing or inconsistent data entries. Handle missing data by either removing the rows containing missing values or imputing them using techniques like mean imputation or interpolation.

Data Transformation: Depending on your analysis goals, you might need to transform the data. For example, if your data is not normally distributed, you might need to apply transformations like log transformation or Box-Cox transformation to make it more normally distributed.

Calculating Descriptive Statistics:

Mean: Calculate the arithmetic mean of the data using the **mean()** function in Python.

Median: Calculate the median of the data using the **median()** function in Python.

Standard Deviation: Calculate the standard deviation of the data using the **std()** function in Python.

Variance: Calculate the variance of the data using the **var()** function in Python.

Skewness: Calculate the skewness of the data using the **skew()** function in Python.

Kurtosis: Calculate the kurtosis of the data using the **kurtosis()** function in Python.

Visualization (Optional): You may also want to visualize the data and its distribution using histograms, box plots, or density plots to gain insights into its characteristics.

Interpretation: Finally, interpret the descriptive statistics you've calculated to understand the central tendency, variability, skewness, and kurtosis of the data. This interpretation will depend on the context of your analysis and research questions.

4.9 TO CREATE AND RUN:

Step 1: Access Google Colab

- Open your web browser and go to Google Colab.
- Sign in with your Google account if you're not already signed in.

Step 2: Create a New Notebook:

- Once you're logged in, you'll see the Colab dashboard.
- Click on the "New Notebook" button to create a new notebook.
- This will open a new untitled notebook where you can start writing your code.

Step 3: Create a New Notebook:

- Once you're logged in, you'll see the Colab dashboard.
- Click on the "New Notebook" button to create a new notebook.

- This will open a new untitled notebook where you can start writing your code.

Step 4: Write Python Code:

- In a code cell, you can write Python code just like you would in a local Python environment. Type or paste your Python code into the code cell.
- Type or paste your Python code into the code cell.

Step 5: Execute Code Cells:

- To execute a code cell, click on the play button (triangle icon) on the left side of the cell.
- Alternatively, you can use the keyboard shortcut "Shift + Enter" to execute the cell.
- When you run a code cell, Colab sends the code to Google's servers, executes it, and displays the output below the cell.

Step 6: Add Markdown Text:

- In a text cell, you can write documentation, explanations, and formatted text using Markdown syntax.
- Markdown allows you to add headings, lists, links, images, and more to your notebook.
- Write your text content using Markdown syntax in the text cell.

Step 7: Execute Markdown Cells:

- Text cells don't need to be executed like code cells.
- They are rendered immediately after you finish writing them.

Step 8: Save and Name Your Notebook:

- To save your notebook, click on "File" in the menu bar and then select "Save" or press "Ctrl + S" (Cmd + S on Mac).
- You can also give your notebook a meaningful name by clicking on "Untitled" at the top of the notebook and entering a name.

CHAPTER 5

RESULT AND DISCUSSION

5.1. INTRODUCTION

The components are connected as shown in the block diagram and the data acquisition is done. The BIOPAC then generates the corresponding waveform for the test sample. Then this waveform is processed using the BSL software and the EEG signal for the individual is acquired with its help. Now this value gives us an insight into the test sample's psychomotor ability. The values are then classified according to the types of psychomotor domain

5.2 TESTING PROCEDURE

All the required components are tested and calibrated. The subject is explained about the process clearly. The test sample is made to be at ease while the recording takes place which is shown in Fig.5.1. The basic personal details of the subject are recorded. The subject is said to be still to avoid any kind of artifacts that may occur during the recording procedure. The subject is also said to be calm and composed for convenient detection of EEG signals for each domain in the psychomotor domain. The subject is given a few games and questions and is asked to perform accordingly and record the EEG signals.

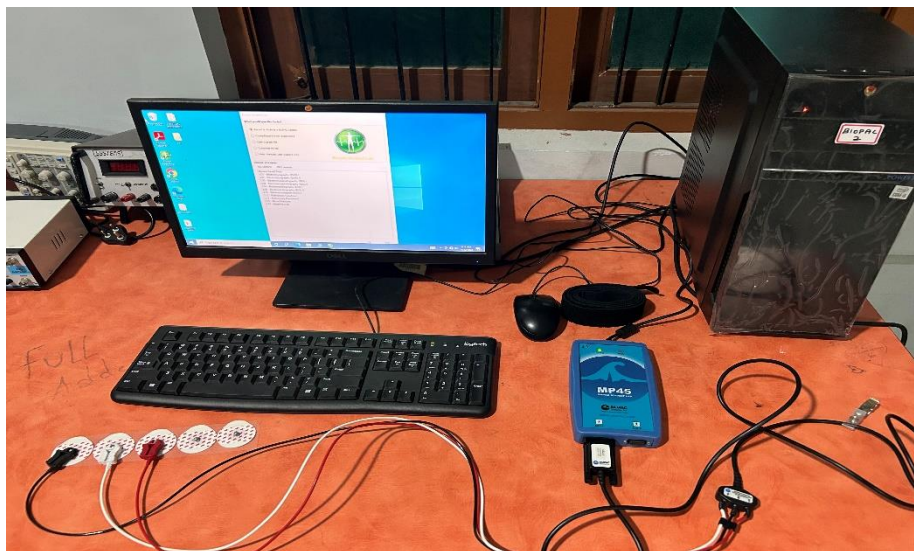


Fig:5.1: BIOPAC Module setup

5.3 PSYCHOMOTOR ANALYSIS

The appropriate steps are conducted in order to compute the individual's EEG Waveforms. For the psychomotor domain tests, personalized psychomotor games have been prepared. An extensive literature survey has been carried out on the topic of EEG signals using psychomotor and BIOPAC. Collection of data according to the psychomotor domain using blooms taxonomy has been done Data were collected from all four different levels which are mentioned above from the different students and we have converted them into the text file format. The collected text file format was converted into Excel form A demographic database has been created to maintain the subject's information. we have determined the mean, median, standard deviation, variance, skewness, and kurtosis for the collected data for pre-processing. After determining all the above processes, we imported the file into Python (colaboratory) for further processing. In this, we began to classify the four activities of the psychomotor domain and determine the accuracy rate. After coding part we concluded that the correct response rate for activity perception and mechanism (basic abilities) was higher than for set and guided responses

5.3.1 Perception

In the psychomotor domain, perception involves the ability to interpret and make sense of sensory information accurately. In the case of perception after pre-processing the signal we have got the train accuracy rate 91.78% and test accuracy 91.10% The perception method achieved an impressive accuracy rate of 91.78%. This indicates its effectiveness in accurately interpreting and analyzing data. Such a high accuracy rate is crucial for ensuring the reliability and validity of the results obtained through this method. However, it's essential to note that while perception is crucial, achieving a high accuracy rate in perception tasks does not guarantee the same level of accuracy in other cognitive domains. Consequently, this robust performance bolsters the credibility of findings and conclusions drawn from employing the perception method in research studies. And the results are shown below

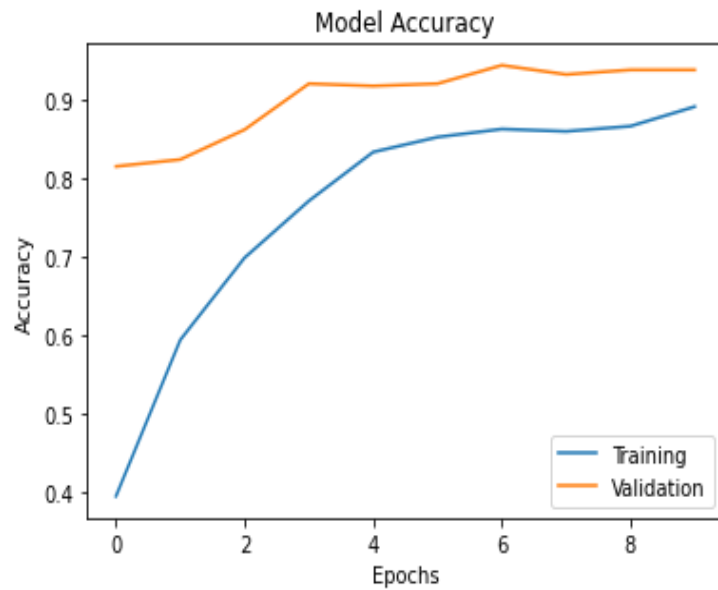


Fig:5.2: Train accuracy of perception

Fig 5.2 shows that the training accuracy for the perception method for the psychomotor domain and the training accuracy reaches the maximum of 91.78% and validation reaches 93.84%. It shows that the perception domain reaches a higher train accuracy rate than the psychomotor domain.

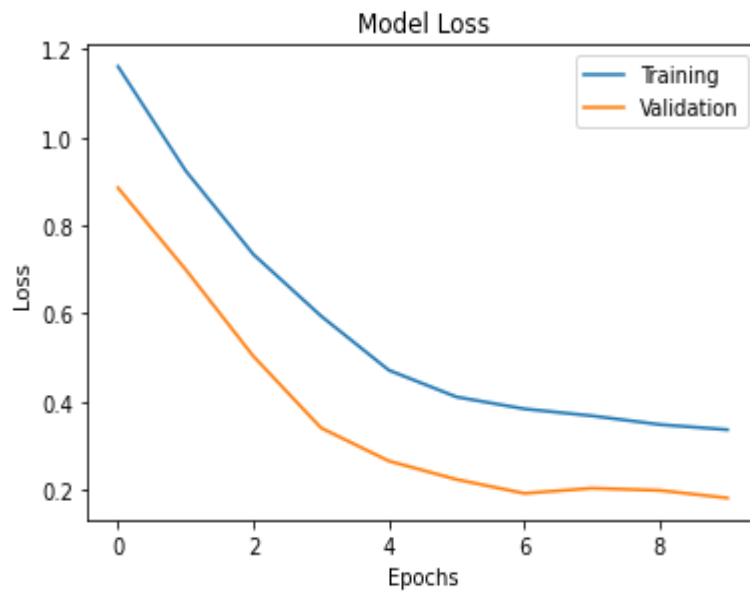


Fig:5.3: Test accuracy of perception

We have also tested the test accuracy by using train accuracy and we got the test accuracy similar to the train accuracy of 91.10% as shown in Fig 5.3 So we can conclude that the result obtained in this perception method has the best result.

5.3.2 Set

In the psychomotor domain, set domain involves the ability to interpret and make sense of sensory information accurately. In the case of perception after pre-processing the signal we have got the train accuracy rate 87.76 and test accuracy of 86.65 The set method achieved an impressive accuracy rate of 87.76. Interpreting this accuracy within the psychomotor domain context could mean that your model or classifier is performing reasonably well in predicting or classifying data related to physical actions or skills. However, without more context about the specific task or dataset, it's challenging to provide a detailed interpretation.

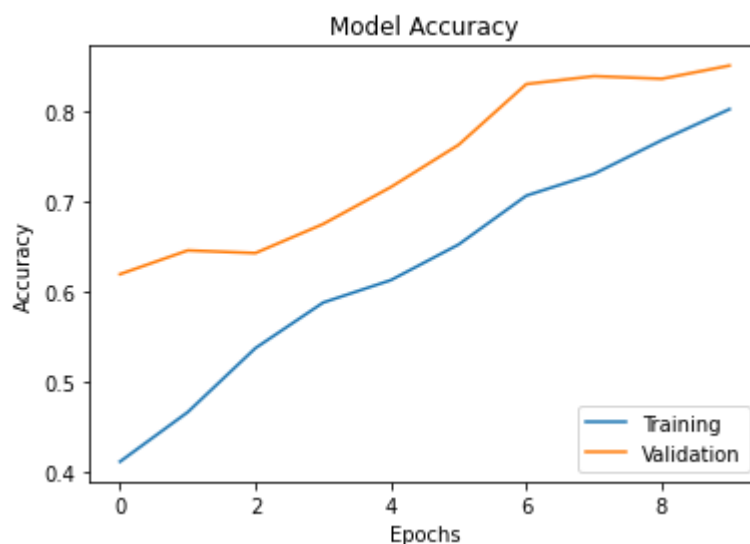


Fig:5.4: Train accuracy of set

Fig 5.4 shows that the training accuracy for the set method for the psychomotor domain and the training accuracy reaches the maximum of 87.76 and validation reaches 85.40. It shows that the set domain reaches a very good train accuracy rate in the psychomotor domain. It is less compared to the perception method.

The set domain within the psychomotor domain focuses on skills that require the learner to perform a series of coordinated movements or actions in a specific order or pattern. It involves a combination of cognitive understanding, physical

execution, and often requires structured instruction and practice to develop proficiency.

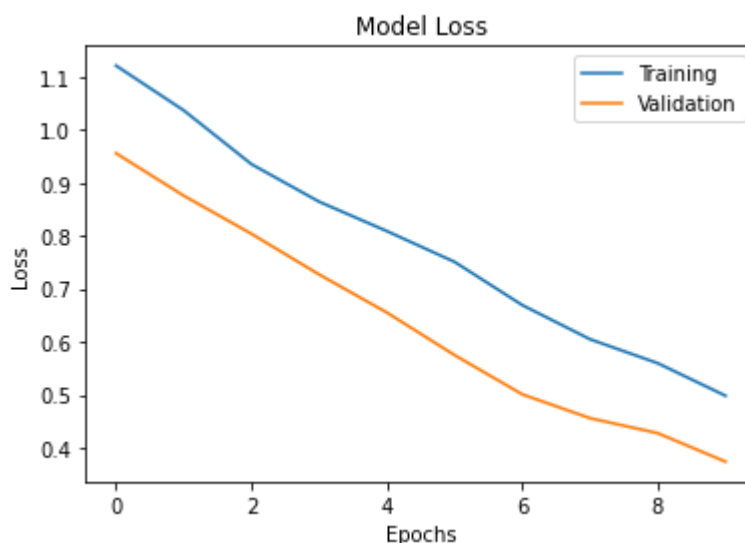


Fig:5.5: Test accuracy of set

We have also tested the test accuracy by using train accuracy and we got the test accuracy similar to the train accuracy 86.65 as shown in Fig.5.5. So we can conclude that the result that obtained in this set method also has the best result.

5.3.3 Guided Response

In the psychomotor domain, set domain involves the ability to interpret and make sense of sensory information accurately. In the case of perception after pre-processing the signal we have got the train accuracy rate 82.77 and test accuracy 83.14. Achieving an accuracy rate of 83.77% in the guided response stage indicates that learners are progressing from merely observing or understanding a skill to actively attempting to perform it under guidance. They may still rely on external cues, prompts or feedback to perform the task accurately. An accuracy rate of 83.77% for guided response in the psychomotor domain reflects a strong ability among learners to perform tasks correctly under guidance, indicating progress in skill acquisition and the effectiveness of instructional support provided. There is still room for improvement. Educators can use this information to identify specific areas where learners may need additional support or practice. It also highlights opportunities to refine instructional strategies to enhance learning outcomes within the guided response stage.

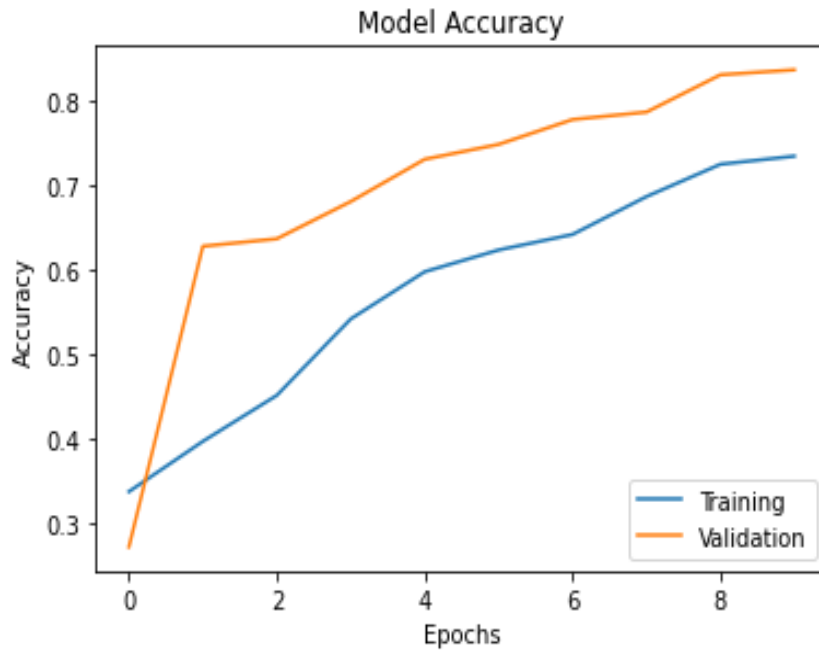


Fig:5.6: Train accuracy of guided response

Fig 5.6 shows that the training accuracy for a set method for psychomotor domain and the training accuracy reaches the maximum of 82.77 and validation reaches 83.77. It shows that the guided response domain reaches a very good train accuracy rate in the psychomotor domain. It is less compared to the perception and set method. and it shows there is still improvement needed in guides response task.

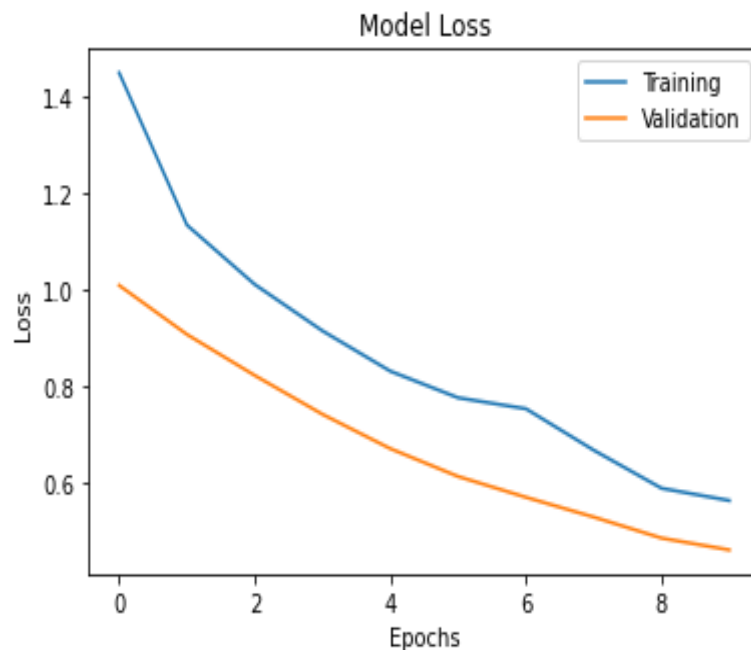


Fig:5.7: Test accuracy of guided response

We have also tested the test accuracy by using train accuracy and we got the test accuracy similar to the training accuracy of 83.77 as shown in Fig.5.7. So we can conclude that the result obtained in this guided response method also have the best result but still needed the improvement.

5.3.4 Mechanism

In the psychomotor domain, set domain involves the ability to interpret and make sense of sensory information accurately. In the case of perception after pre-processing the signal we have got the train accuracy rate 91.86 and test accuracy 90.86. An accuracy rate of 91.86% for "mechanism" in the psychomotor domain suggests that your model or classifier is performing exceptionally well in predicting or classifying data related to tasks or skills that involve mechanistic actions, physical movements, or processes.

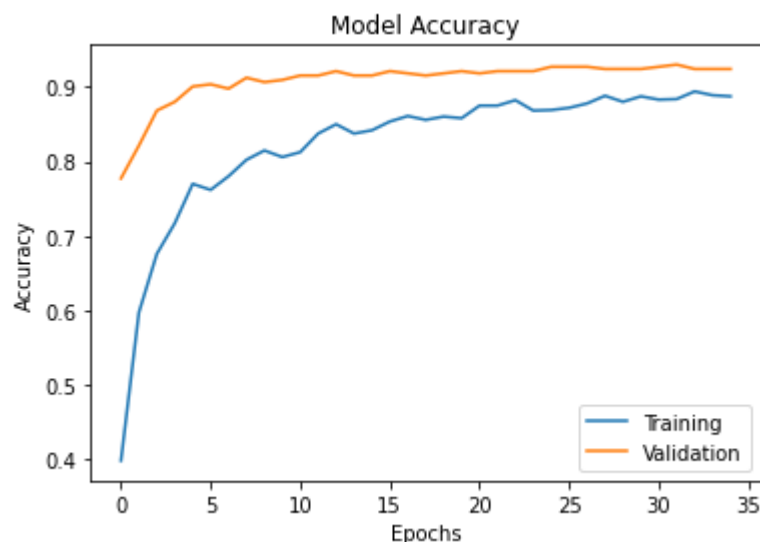


Fig:5.8: Train accuracy of mechanism

Fig 5.8 shows that the training accuracy for the mechanism method for psychomotor domain and the training accuracy reaches the maximum of 91.86 and validation reaches 90.86. It shows that the mechanism domain reaches a very good train accuracy rate in the psychomotor domain. It is a very good accuracy rate compared to the perception, set, and guided response method.

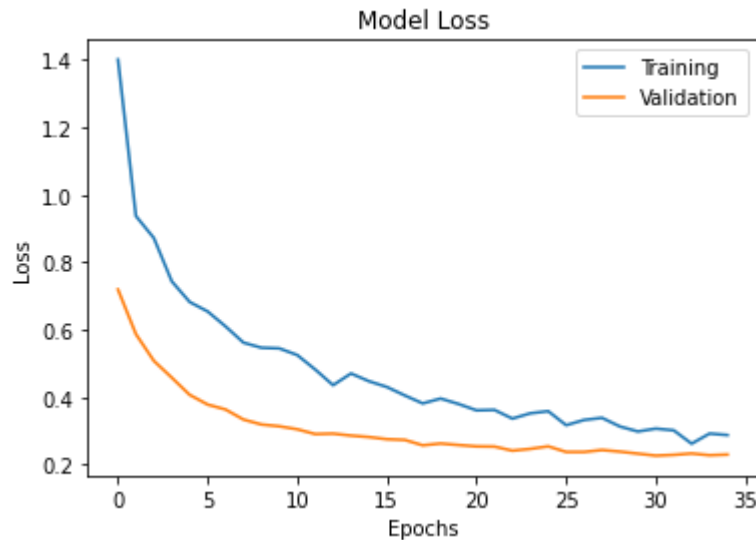


Fig:5.9: Test accuracy of mechanism

We have also tested the test accuracy by using train accuracy and we got the test accuracy similar to the train accuracy of 90.86 as shown in Fig.5.9. So we can conclude that the result obtained in this mechanism method also has the best result compared to the remaining three domains.

5.4 OVERALL PSYCHOMOTOR RESULT

Overall, achieving a high accuracy rate of 95.70% for all types in the psychomotor domain reflects the effectiveness and proficiency of your model in accurately classifying or predicting various psychomotor tasks or skills, which can have significant practical implications across a wide range of domains and applications.

This level of accuracy has significant implications for various applications within educational, training, or assessment contexts. For example, your model could be used to assess learners' proficiency or competence in psychomotor skills, provide personalized feedback for skill improvement, or even assist in designing curriculum or training programs tailored to individual needs. This level of accuracy suggests that your model has learned meaningful patterns, features, or relationships in the data that allow it to effectively distinguish between different types of psychomotor tasks or skills.

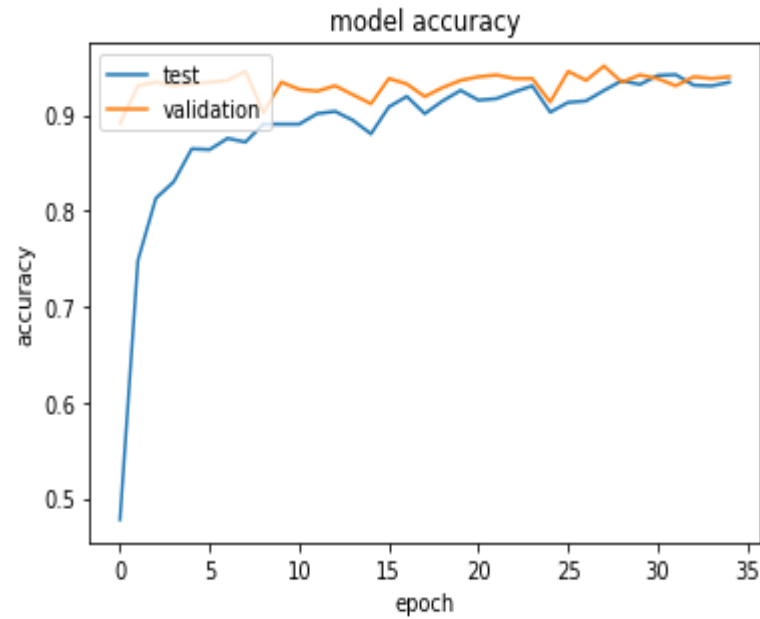


Fig.5.10: Train accuracy of the psychomotor domain

Fig 5.10 shows that the training accuracy for a method for the psychomotor domain and the training accuracy reaches the maximum of 95.70 and validation reaches to 95. It shows that the overall psychomotor domain reaches a very good train accuracy rate in the psychomotor domain. It has a very good accuracy rate compared to the cognitive method.

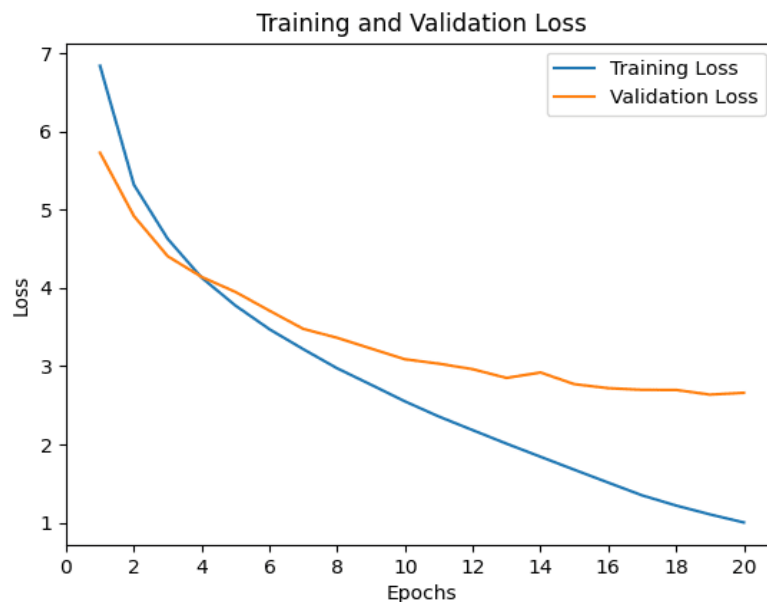


Fig.5.11: Test accuracy of the psychomotor domain

We have also tested the test accuracy by using train accuracy and we got the test accuracy similar to the train accuracy 93.43 as shown in Fig.5.11. So we can

conclude that the result obtained in this psychomotor method also has the best result compared to the cognitive.

5.5 CONFUSION MATRIX

A confusion matrix is a tabular representation that is used to evaluate the performance of the model for classification tasks. The confusion matrix organizes predictions made by the model on a test dataset and compares them to the true labels of the data. The confusion matrix for three classes looks like Each term in the confusion matrix signifies shown in Fig.5.12.

- **True Positive (TP):** The model correctly predicted the instance of the class.
- **False Positive (FP):** The model incorrectly predicted instances as belonging to this class when they belong to another class.
- **True Negative (TN):** The model correctly predicted instances as not belonging to this class when they don't belong to this class.
- **False Negative (FN):** The model incorrectly predicted instances as not belonging to this class when they do belong to this class.

The confusion matrix provides a more detailed understanding of how the model performs across different classes. It allows you to access which classes the model is better at predicting and where it may struggle. The misclassifications obtained highlight areas where the model may benefit from further refinement or additional data to improve its accuracy. From the matrix, precision, recall, and the F1 score for each class can be obtained, which gives insights into the model's performance beyond simple accuracy.

		Actual Values	
		Positive (1)	Negative (0)
Predicted Values	Positive (1)	TP	FP
	Negative (0)	FN	TN

Fig:5.12: Model Confusion Matrix

The obtained confusion matrix provides insights into the classification performance of a model designed to differentiate between four classes: **Perception**, **Set**, **Guided response**, and **Mechanism**. Each cell in the matrix denotes the number of instances predicted for a particular class compared to the actual classes.

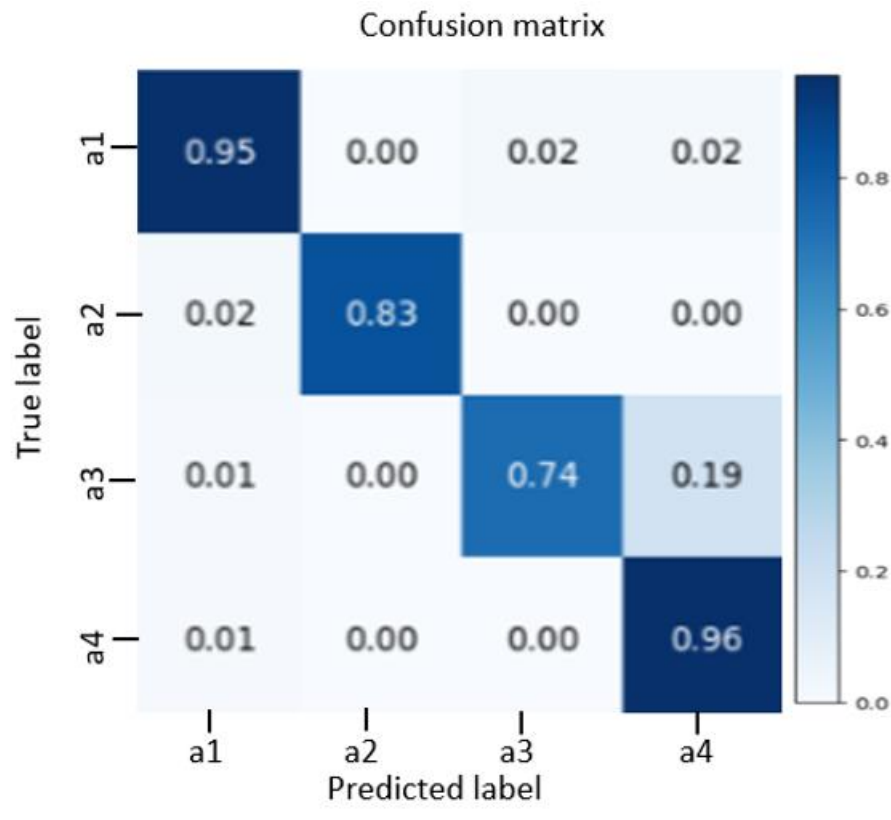


Fig:5.13: Confusion Matrix

These results demonstrate strong **perception 95%** and **mechanism 96%** skills but need improvement in **set 83%** and **guided responses 74%** as shown in the above figure. The higher accuracy rates observed in tasks involving perception and mechanism compared to set and guided responses highlight the significance of understanding and interpreting sensory stimuli effectively before initiating motor actions as shown in Fig.5.13.

This suggests that individuals who demonstrate heightened perceptual abilities and mechanistic understanding are better equipped to execute psychomotor tasks with precision and efficiency.

In essence, the emphasis on perception and mechanism in the psychomotor domain underscores the intricate interplay between sensory processing, cognitive functions, and motor performance. By leveraging these insights, educators and practitioners can enhance instructional practices, foster skill acquisition, and empower individuals to achieve greater proficiency and mastery in various psychomotor activities

Perception: This could be analogous to the true positives (correctly identified instances) in a confusion matrix. Perception involves the ability to use sensory cues to guide motor activity, so in a sense, it's the foundational level of understanding in the psychomotor domain.

Set: Set involves readiness to act. This could be represented as false positives (instances incorrectly identified) in a confusion matrix. These are cases where the system or learner is prepared to act but may not necessarily have the correct perception.

Guided Response: Guided Response is the early stages in learning a complex skill. This might correspond to false negatives (instances incorrectly rejected) in a confusion matrix. The learner is attempting to follow instructions or guidance but may not execute the skill perfectly.

Mechanism: Mechanism involves the intermediate stages in learning a complex skill. This might correspond to true negatives (correctly rejected instances) in a confusion matrix. At this stage, the learner has mastered the basics and can execute the skill correctly most of the time.

5.6 CLASSIFICATION REPORT

Classification report provides a detailed analysis of the performance of CNN Model obtained in classifying pneumonia severity. The model's effectiveness is evaluated using precision, recall, F1- score and support metrics across different classes shown in Table.5.1.

The Classification report provided presents metrics for each class, including perception,set,guided response and mechanism domains.These metrics provide insights into the model's ability to correctly classify instance of each class.

Table 5.1: Classification report

Classification Report	Precision	recall	f1-score	support
0	0.95	0.96	0.90	143
1	0.97	0.95	0.96	148
2	0.90	0.91	0.94	136
3	0.91	0.92	0.95	136
accuracy			0.95	427
Macro avg	0.93	0.93	0.93	427
Weighted avg	0.93	0.93	0.93	427

5.7 OVERALL PERFORMANCE

Accuracy: The overall accuracy of the model, calculated as the F1-score across all classes is 95.70

Macro Average: The macro average precision, recall, and F1-score are all 93, indicating balanced performance across classes.

Weighted Average: The weighted average precision, recall, and F1-score are all 97.87, suggesting slightly higher performance due to class imbalance

Table 5.2: Overall performance output

Alpha	Train Accuracy (%)	Test Accuracy (%)	Validation Accuracy (%)	AUC (%)	F1 score (%)	Precision (%)	Recall (%)	Loss
1	91.78	91.10	93.84	96.83	91	92	91	0.3357
2	87.76	86.65	85.04	93.06	87	87	87	0.4981
3	82.77	83.14	83.58	90.91	83	84	83	0.3357
4	91.86	90.86	92.37	97.73	91	91	91	0.2874
1+2+3+4	95.70	93.43	95	97.89	93	93	93	0.1869

Epochs – 50

Time taken – 40 secs per epoch

Loss – Categorical Cross entropy

Optimizer – Adam

Learning rate – 0.001

Based on the confusion matrix analysis within the psychomotor domain, it can be concluded that perception and mechanism exhibit a higher accuracy rate compared to other elements shown in Table.5.2. The precise accuracy rates associated with each element are crucial for further refining methodologies and interventions aimed at enhancing psychomotor skills. This insight can guide the development of targeted training programs and interventions to optimize learning outcomes within the psychomotor domain.

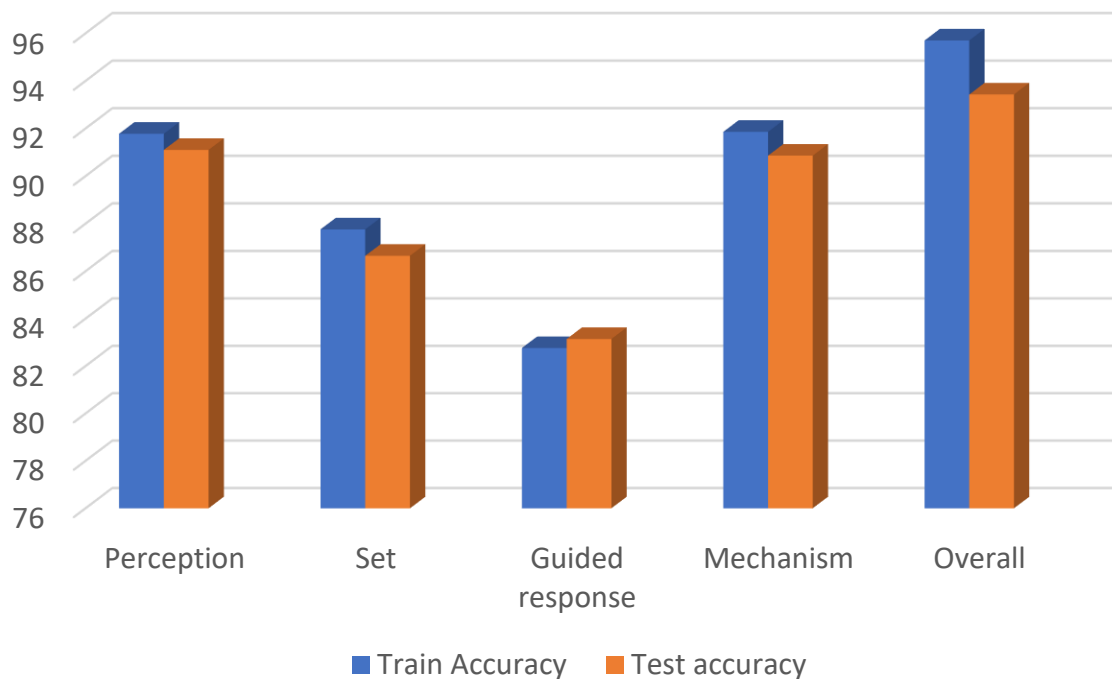


Fig:5.14: Comparison chart of perception method

The Fig.5.14 above shows that the accuracy rate in the perceptual and mechanistic domains is higher than in the conditioned and controlled responses. Therefore, I conclude that students' brains are more stimulated when there is physical movement or activity defined in the psychomotor domain.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

This research project effort provides information on the psychomotor domain abilities of various people. These results demonstrate strong perception and mechanism skills but need improvement in set and guided responses. We collected the EEG signals of 40 students, measured the EEG signals in preprocessing, divided them into four different levels of psychomotor domain, and obtained the accuracy rate for each level. The accuracy rates were high in the perception and mechanism domains at 91.86 and 91.78, respectively. In addition, the accuracy rates were relatively low for the set and guided response ranges 87.76 and 82.77, respectively. Test accuracy was also similar to train accuracy, with 91.10 and 90.86 for the perception and mechanism domains, respectively, and 86.65 and 83.14 for the set and guided responses, respectively.

In conclusion, the findings regarding perception and mechanism within the psychomotor domain underscore the importance of the higher accuracy rates observed in tasks involving perception and mechanism compared to set and guided responses highlighting the significance of understanding and interpreting sensory stimuli effectively before This suggests that individuals who demonstrate heightened perceptual abilities and mechanistic understanding are better equipped to execute psychomotor tasks with precision and efficiency. In essence, the emphasis on perception and mechanism in the psychomotor domain underscores the intricate interplay between sensory processing, cognitive functions, and motor performance. By leveraging these insights, educators and practitioners can enhance instructional practices, foster skill acquisition, and empower individuals to achieve greater proficiency and mastery in various psychomotor activities cognitive processes and sensory awareness in skill acquisition and execution

6.2 FUTURE SCOPE

Future applications for this BIOPAC gadget include a variety of hospitals, healthcare settings, educational institutions, and many other locations that demand

accurate physiological tests. Investigate the role of BIOPAC devices in monitoring and managing mental health conditions, such as stress, anxiety, and depression.

Discuss the potential for BIOPAC technology to facilitate early intervention, personalized treatment approaches, and monitoring of treatment outcomes in mental healthcare settings. Summarize the key findings and insights regarding the future scope of BIOPAC devices across different domains.

Discuss the potential impact of future advancements in BIOPAC technology on healthcare, sports science, neuroscience, mental health, education, and research.

Provide recommendations for future research directions, technological developments, and policy considerations to maximize the benefits of BIOPAC devices in improving human health, performance, and well-being.

REFERENCES

1. Azman A. B., Mohamed A. B., and Abdullah M. B., "Review Current Practical Skills Assessment in Machining Course Based on Psychomotor Domain", International Conference on Teaching and Learning in Computing and Engineering, Kuching, Malaysia, 2014, pp. 171-175, doi: 10.1109/LaTiCE.2014.40
2. Campos P. R. B. d., Neto E. d. B. C. and Moreno U. F., "Proposal of a new taxonomy of the psychomotor domain for to the engineering laboratory," 3rd International Conference of the Portuguese Society for Engineering Education (CISPEE), Aveiro, Portugal, 2018, pp. 1-8, doi: 10.1109/CISPEE.2018.8593441.
3. Chan VS., Haron HNH, Isham MIBM, Mohamed FB. "VR and AR virtual welding for psychomotor skills: a systematic review". *Multimed Tools Appl.* 2022;81(9):12459-12493. doi: 10.1007/s11042-022-12293-5. Epub 2022 Feb 19. PMID: 35221778; PMCID: PMC8857740.
4. Chatterjee D., Das R., Sinha A. and S. Datta, "Analyzing elementary cognitive tasks with Bloom's taxonomy using low cost commercial EEG device," IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Singapore, 2015, pp. 1-6, doi: 10.1109/ISSNIP.2015.7106928
5. Cura O. K., Yilmaz G. C., Türe H. S. and Akan A., "Classification of Psychogenic Non-epileptic Seizures Using Synchrosqueezing Transform of EEG Signals," 29th European Signal Processing Conference (EUSIPCO), Dublin, Ireland, 2021, pp. 1172-1176, doi: 10.23919/EUSIPCO54536.2021.9615988.
6. Ergin T., Ozdemir M. A. and Akan A., "Emotion Recognition with Multi-Channel EEG Signals Using Visual Stimulus," Medical Technologies Congress (TIPTEKNO), Izmir, Turkey, 2019, pp. 1-4, doi: 10.1109/TIPTEKNO.2019.8895242.
7. Harimurti R., Yamasari Y., Ekohariadi, Munoto and Asto B. I. G. P., "Predicting student's psychomotor domain on the vocational senior high school using linear regression," International Conference on Information and Communications Technology (ICOIACT), Yogyakarta, Indonesia, 2018, pp. 448- 453, doi: 10.1109/ICOIACT.2018.8350768)
8. Huilan S., "Educational management in Critical Thinking Training Based on Bloom's Taxonomy and SOLO Taxonomy," International Conference on Information

Science and Education (ICISE-IE), Sanya, China, 2020, pp. 518- 521, doi: 10.1109/ICISE51755.2020.00116.

9. Kim B, Erickson BA, Fernandez-Nunez G, Rich R, Mentzelopoulos G, Vitale F, Medaglia JD. "EEG Phase Can Be Predicted with Similar Accuracy across Cognitive States after Accounting for Power and Signal-to-Noise Ratio". *eNeuro*. 2023 Sep5;10(9): doi:10.1523/ENEURO.0050 -23.2023. PMID: 37558464; PMCID: PMC10481640

10. Lochotinant C., and Yanchinda J., "Creativity Knowledge of Jewelry Design Measurement using Bloom's Taxonomy:Psychomotor Domain,"Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMTNCON), Nan, Thailand, 2019, pp. 266-270, doi: 10.1109/ECTINCON.2019.8692305.

11. Marois A, Kopf M, Fortin M, Huot-Lavoie M, Martel A, Boyd JG, Gagnon JF, Archambault PM. "Psychophysiological models of hypovigilance detection: A scoping review". *Psychophysiology*. 2023 Jun 23:e14370. doi: 10.1111/psyp.14370. Epub ahead of print. PMID: 37350389.

12. Mizam N. S. S., "Can Psychomotor Skills From Electrical Circuit Laboratory be Evaluated?"2nd SEA-STEM International Conference (SEA-STEM), Hat Yai, Thailand, 2021, pp. 100-103, doi: 10.1109/SEA-STEM53614.2021.9668007.

13. MNAH, S., Fuad, N., Jamal, N., Marwan, M., Mohd Helmy, A. W., & Syed Zulkarnain,S.I. "Development of cognitive and psychomotor task for EEG application with Matlab-based GUI. IOP Conference Series.Materials Science and Engineering,2020, 917(1) doi:https://doi.org/10.1088/1757- 899X/917/1/012050

14. Molina E., Correa A., Sanabria D. "Tonic EEG dynamics during psychomotor vigilance task," 6th International IEEE/EMBS Conference on Neural Engineering (NER),SanDiego,CA,USA,2013, pp. 1382-1385, doi: 10.1109/NER.2013.6696200.

15. Pambudi R. A., Ramadijanti N. and Basuki A., "Psychomotor game learning using skeletal tracking method with leap motion technology,"International Electronics Symposium (IES), Denpasar, Indonesia, 2016, pp. 142-147, doi: 10.1109/ELECSYM.2016.7860991

16. Sagga D., Echtioui A., Khemakhem R., Kallel F. and Hamida A. B., "Epileptic Seizures Detection on EEG Signal Using Deep Learning Techniques," 6th International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), Sfax, Tunisia, 2022, pp. 1-6, doi: 10.1109/ATSIP55956.2022.980
17. Shadpour S, Shafqat A, Toy S, Jing Z, Attwood K, Moussavi Z, Shafiei SB. Developing cognitive workload and performance evaluation models using functional brain network analysis. NPJ Aging. 2023 Oct 6;9(1):22. doi: 10.1038/s41514-023-00119- PMID: 37803137; PMCID: PMC10558559.
18. Stucker C., Junker-Tschopp C, Fernandes AM, Revol A, Mili ID, Kliegel M, Frisoni GB, Brioschi Guevara A, Marie D. "Musical and psychomotor interventions for cognitive, sensorimotor, and cerebral decline in patients with Mild Cognitive Impairment (COPE)": a study protocol for a multicentric randomized controlled study. BMC Geriatr. 2023 Feb 6;23(1):76. doi: 10.1186/s12877-022-03678-0. PMID: 36747142; PMCID: PMC9900212
19. Xu S., Xuhui Chen, and Dapeng Liu, "Classifying software visualization tools using Bloom's taxonomy of cognitive domain," Canadian Conference on Electrical and Computer Engineering, St. John's, NL, 2009, pp. 13-18, doi: 10.1109/CCECE.2009.5090082.

NATIONAL CONFERENCE ON BIOTECHNOLOGY AND
BIOMEDICINES (NCBB - 23)

4th November 2023 Pune, India

Acceptance Letter

Authors Name: Jinu Jacob Y, Dr. P.Grace Kanmani Prince, Rishon V

Dear Authors,

We are pleased to inform you that your paper has been accepted by the review committee for Oral / Poster Presentation at the **NATIONAL CONFERENCE ON BIOTECHNOLOGY AND BIOMEDICINES (NCBB - 23)**

Article Title: "Analysis of EEG signals to assess psychomotor domains based on Bloom's taxonomy method: A Review"

Paper ID: National Conference_2816479

This conference will be held on **4th November 2023 in Pune, India**

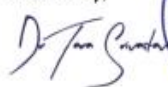
Your paper will be published in the conference proceeding and Well reputed journal after registration.

Please register as soon as possible in order to secure your participation:

<https://www.nationalconference.in/event/registration.php?id=2168065>

You are requested to release the payment and mail us the screen of successful payment release with your name and title of paper to confirm your registration.

Sincerely,



Dr. Tara Srivastava
National Conference

