EYE PILOT - EOG BASED ASSISTIVE CONTROL

GE19612

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

Submitted by

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MAY 2025

BONAFIDE CERTIFICATE

Certified that this project report titled **"EOG BASED CURSOR CONTROL"** is the bonafide work of **"SARANYA S (2116220801186), SRIRAM S (2116220801206), VIKRAM G (2116220801235)"** who carried out the project work under my supervision.

SIGNATURE

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Thandalam, Chennai – 602 105.

Submitted to the Viva-Voce Examination held on ______________

Internal Examiner **External Examiner**

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ABSTRACT

EyePilot is an Electrooculography (EOG)-based assistive control system designed to help individuals with severe motor disabilities—such as paralysis, muscular dystrophy, or ALS—interact with digital devices using only eye movements and blink gestures. Conventional input methods are often inaccessible for such users, and EyePilot addresses this gap by offering a hands-free, real-time interface.

The system captures bio-electrical EOG signals using electrodes placed around the eyes, with signal acquisition performed by instrumentation amplifiers and ADCs. To enhance signal clarity, it employs Stationary Wavelet Transform (SWT) and bandpass filtering for noise reduction. A hybrid machine learning approach—combining Artificial Neural Networks (ANN) and Support Vector Machines (SVM)—is used to classify time-domain features such as Peak and Valley Amplitude Values, translating them into control actions like cursor movement or SOS alerts.

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LIST OF ABBREVIATIONS

EOG	Electrooculography
SWT	Stationary Wavelet Transform
ANN	Artificial Neural Network
SVM	Support Vector Machine
PAV	Peak Amplitude Value
VAV	Valley Amplitude Value
ALS	Amyotrophic Lateral Sclerosis
GUI	Graphical User Interface
HCI	Human-Computer Interaction
CNN	Convolutional Neural Network
SOS	Save Our Souls(Emergency Alert Signal)

CHAPTER 1

INTRODUCTION

In the modern digital age, interaction with electronic devices is essential for communication, work, and independent living. However, individuals with motor impairments—due to paralysis, muscular dystrophy, spinal injuries, or neurological conditions like ALS—often struggle to use traditional input devices such as keyboards and mice. This limits their access to technology and highlights the need for effective assistive solutions.

Electrooculography (EOG) offers a non-invasive method to detect eye movements and blinks by measuring the electrical potential around the eyes. Since the eye acts as an electrical dipole, its motion generates voltage changes that can be captured through electrodes. These signals can be processed and translated into control commands, enabling hands-free interaction for users with limited mobility.

EyePilot is an EOG-based assistive control system that uses gel electrodes and the EXG Synapse device by Neuphony to acquire eye signals. The system applies Stationary Wavelet Transform (SWT) for denoising and uses machine learning algorithms like Artificial Neural Networks (ANN) and Support Vector Machines (SVM) for accurate classification of eye gestures. Detected gestures are mapped to real-time cursor movements and control actions.

The main objective of *EyePilot* is to create an affordable, accessible, and practical system that allows users to control computers, send emergency alerts, and interact with smart appliances using only eye movements. Its modular design, real-time performance, and adaptability for wearable integration make it a strong candidate for widespread use in assistive technology and healthcare environments.

1. WORKING PRINCIPLE OF THE EOG BASED ASSISTIVE CONTROL

EyePilot functions by capturing and interpreting the bioelectrical signals produced by eye movements using Electrooculography (EOG). The human eye acts as an electrical dipole, with the cornea being positively charged and the retina negatively charged. When the eyes move, this dipole shifts, generating small voltage changes across the skin. These changes are detected using surface electrodes placed strategically around the eyes—commonly, one pair horizontally (on either side of the eyes) and another vertically (above and below the eye).

The acquired signals are extremely weak and are often affected by noise such as muscle activity and ambient electrical interference. To address this, the raw EOG signals are passed through a series of preprocessing steps including amplification and filtering. A band-pass filter is typically used to remove low-frequency drift and high-frequency noise. The cleaned signal is then digitized and analyzed in real-time using microcontrollers or computing platforms.

Specific patterns in the EOG signal are associated with particular eye movements: for example, a rightward movement causes a positive deflection in the horizontal signal, while a leftward movement produces a negative one. Similarly, upward and downward movements are detected from changes in the vertical signal. These patterns are processed using threshold-based or machine-learning algorithms to reliably detect intentional gaze directions or blinks.

Once a movement is recognized, it is mapped to a corresponding control action within the system. This allows users to interact with external devices or software interfaces using just eye gestures. The system ensures that all detections are calibrated for user comfort and minimal false triggering, making EyePilot a reliable and intuitive control solution based on natural eye movements.

2. APPLICATIONS OF THE EOG BASED CURSOR CONTROL

EyePilot is designed to provide a hands-free control system for individuals with physical disabilities, enabling them to interact with their surroundings using only eye movements. One of its primary applications is in smart home automation, where users can control appliances such as lights, fans, and other IoT devices through specific eye gestures. It also plays a critical role in emergency communication, allowing users to send predefined SMS messages or trigger emergency calls with a simple eye movement or blink. Additionally, EyePilot supports basic communication through SMS functionality, enabling users to send short messages without the need for physical interaction. For entertainment, the system can be used to control music playback, allowing users to play, pause, skip tracks, or adjust the volume. Beyond these, EyePilot also facilitates human-computer interaction by enabling users to move cursors, select options, or navigate user interfaces purely through eye gestures. These applications demonstrate the system's potential to improve accessibility, independence, and quality of life for users with limited motor control.

3. IMPLEMENTATION AND FUTURE EXPANSION

The implementation of the EOG-based assistive control system, EyePilot, was carried out using the EXG Synapse device by Neuphony for high-precision biosignal acquisition and the Arduino UNO microcontroller for signal processing and control. Surface electrodes were strategically placed around the eyes to detect both horizontal and vertical eye movements by capturing the bioelectric signals generated by the eye's natural dipole. The EXG Synapse internally amplified and filtered these signals, providing clean analog outputs suitable for further processing. These outputs were then fed into the Arduino UNO, which digitized the signals using its analog-to-digital converter (ADC) and processed them using custom logic to detect intentional eye gestures such as left, right, up, down movements, and blinks. Each detected gesture was mapped to a specific cursor action, including directional movement and clicking, and the Arduino communicated these actions to the computer via USB.

The system was carefully tested and calibrated to ensure consistent performance and adaptability for different users. Looking forward, EyePilot can be further enhanced by integrating machine learning algorithms to improve the precision of gesture recognition and adapt to the unique movement patterns of individual users. Wireless communication modules such as Bluetooth or Wi-Fi can be introduced to improve user mobility and reduce cable clutter. Additionally, a custom graphical user interface (GUI) can be developed to provide full control over digital applications, including text input, file navigation, and drag-and-drop actions. For better portability and real-world usage, the entire setup could be embedded into wearable smart glasses. Future improvements may also focus on ensuring compatibility with mobile devices and incorporating real-time fatigue or attention monitoring, extending the system's application into healthcare, assistive technology, and industrial safety domains. These enhancements would make EyePilot a highly versatile and scalable solution for inclusive and accessible human-computer interaction.

CHAPTER 2

LITERATURE SURVEY

The field of Electrooculography (EOG)-based control systems has seen considerable research interest over the past two decades, especially in assistive technologies for individuals with physical disabilities. Various approaches have been proposed to enhance the accuracy, efficiency, and usability of systems that interpret eye movements to control devices such as cursors or appliances. This literature survey highlights some of the significant contributions in this domain and discusses how these studies influenced the design and development of *EyePilot*, our EOG-based assistive control system.

One of the more recent and comprehensive studies in this area is the work titled "Analysis of Eye Movements with 2D Images Obtained by EOG Signals" by *Yurdagul Karagoz-Sahin* (2022). This study focused on processing EOG signals through Continuous Wavelet Transform (CWT) to achieve detailed frequency-time analysis of eye movement data. The application of CWT enabled better localization of signal changes due to subtle eye movements, allowing the authors to generate 2D visual representations of eye activity. This approach proved highly effective in analyzing the temporal and spectral characteristics of EOG signals, thus improving the understanding of eye motion patterns. While this study primarily targeted the visualization of eye movements rather than direct control, it provided critical insights into how time-frequency domain analysis can be used to improve signal recognition accuracy. For our *EyePilot* system, this emphasizes the future potential of implementing advanced signal processing techniques like CWT to refine gesture recognition and reduce false detections.

Another influential contribution to this field is the study titled "Integrated Deep Learning Models into EOG-Based Cursor Control" by *Yin et al.* (2018). In this research, the authors explored the application of Convolutional Neural Networks (CNNs) for automatic classification of EOG signals to control cursor movements. Their work demonstrated how deep learning models could significantly outperform traditional threshold-based or rule-based classification methods, especially in noisy or real-world conditions. CNNs were trained on labeled EOG datasets to detect various eye gestures with high accuracy and robustness. This study stands out by illustrating the feasibility of using artificial intelligence to make EOG-based systems adaptive and self-learning over time. Although *EyePilot* currently uses a threshold-based signal processing method for simplicity and real-time responsiveness, this work opens up promising directions for integrating CNN-based classifiers to enhance user adaptability and reduce the need for manual calibration.

A foundational piece in the evolution of EOG-based control systems is the paper titled “Using Eye Movement to Control a Computer” by *Jose M. Azorin* (2013). This early work focused on a lightweight Electro-Oculogram Electrode Array and proposed a practical method for controlling a computer interface through horizontal and vertical eye movements. Despite the absence of advanced processing or machine learning, the system effectively translated basic eye gestures into cursor movements. The simplicity and reliability of the setup demonstrated the practicality of using EOG in assistive technologies. Moreover, this study stressed the importance of user comfort, system calibration, and minimal invasiveness—factors that significantly influenced the hardware design and usability aspects of *EyePilot*. The idea of integrating a compact, non-intrusive electrode array laid the foundation for future wearable EOG systems, including the smart glasses-based implementation proposed in the future scope of our project.

These studies, taken together, cover a broad spectrum of EOG-based system development, ranging from signal processing and classification to hardware design and usability. The insights from Karagoz-Sahin’s wavelet analysis inform the potential of frequency-based feature extraction for enhanced accuracy. Yin et al.'s work highlights the role of AI, particularly deep learning, in developing adaptive and intelligent control systems. Azorin's early approach serves as a benchmark for creating lightweight and user-friendly EOG control mechanisms.

The design of *EyePilot* incorporates and builds upon these foundational works. While maintaining a low-complexity real-time implementation using Arduino and the Neuphony EXG Synapse device, our system recognizes the importance of clean signal acquisition and intuitive gesture mapping, as emphasized in the 2013 study. The modularity of our implementation allows for future integration of machine learning models, inspired by the 2018 deep learning-based classifier. Similarly, we acknowledge the value of high-resolution signal analysis techniques like wavelet transforms, which can significantly enhance gesture detection reliability in future iterations.

In summary, the research literature provides a strong technical foundation for the development of robust, accurate, and user-friendly EOG-based control systems. Each of the referenced studies contributes uniquely to this evolving field, and *EyePilot* stands as a practical synthesis of these innovations. As EOG-based systems continue to evolve, future developments will likely involve hybrid approaches combining traditional signal processing, artificial intelligence, and ergonomic hardware integration—paving the way for highly personalized and accessible assistive technologies.

CHAPTER 3

EXISTING SYSTEM

Existing EOG-based assistive control systems have primarily focused on enabling hands-free interaction for individuals with motor disabilities by detecting eye movements and translating them into control commands. These systems generally use surface electrodes placed around the eyes to record bioelectrical signals generated during eye motion. The raw signals are amplified, filtered, and processed using microcontrollers or computers to identify specific gestures such as left, right, up, down, or blinks. Several approaches have been adopted in existing systems. Some rely on basic thresholding methods for signal classification, which are simple to implement but often lack precision and adaptability. Systems like these often require large datasets and significant computational resources, making them less suitable for real-time embedded applications.

Additionally, some existing models have been integrated with graphical user interfaces to enable menu selection, or text input. However, many of these implementations are limited by high hardware costs, bulky setups, or the need for extensive calibration before use. Moreover, wireless mobility and user-friendly wearable integration are areas where current systems often fall short, reducing their practical usability for daily assistive tasks. These limitations in existing systems highlight the need for a more accessible, portable, and cost-effective solution—one that *EyePilot* aims to address with its compact hardware setup, real-time responsiveness, and potential for expansion using wireless modules and smart glasses integration.

CHAPTER 4

PROPOSED SYSTEM

The proposed system, EyePilot, is an advanced EOG-based assistive control solution designed to empower individuals with motor impairments through intelligent eye-tracking technology. The system leverages the EXG Synapse device by Neuphony for high-fidelity EOG signal acquisition, paired with an Arduino UNO for initial signal preprocessing. Surface gel electrodes are strategically placed around the user's eyes to capture the bioelectric signals generated by intentional eye movements and blinks.

The captured analog signals are amplified and filtered by the EXG Synapse to remove ambient noise and muscle artifacts. These clean signals are then digitized using the Arduino's ADC and transmitted via Bluetooth to a host system for further processing. At the core of this processing lies a hybrid machine learning model combining Stationary Wavelet Transform (SWT) for signal denoising and feature extraction, followed by classification using a Support Vector Machine (SVM) and an Artificial Neural Network (ANN) for robust, multi-class gesture recognition. This model improves accuracy, adapts to different users, and supports real-time control with minimal latency.

The system is connected to a custom-built EyePilot mobile and desktop application, which serves as the central user interface for device interaction. Based on recognized eye gestures, the app provides multiple control capabilities including:

- IoT Device Control: Toggle smart home appliances (lights, fans, etc.)
- Emergency Communication: Send pre-configured SOS alerts or emergency SMS with just a blink

- Texting and Calling: Compose, send texts, or initiate voice calls through blink or gaze control
- Multimedia Control: Control music playback—play, pause, skip, and adjust volume
- PC Navigation: Move cursor, perform clicks, scroll, and navigate forward/backward in presentations or browsers

With its modular design, Bluetooth-enabled mobility, and cost-effective hardware setup, EyePilot offers a comprehensive, user-friendly, and portable assistive solution that bridges the gap between user intention and digital action—enhancing quality of life through smart, adaptive technology.

1. FLOW DIAGRAM

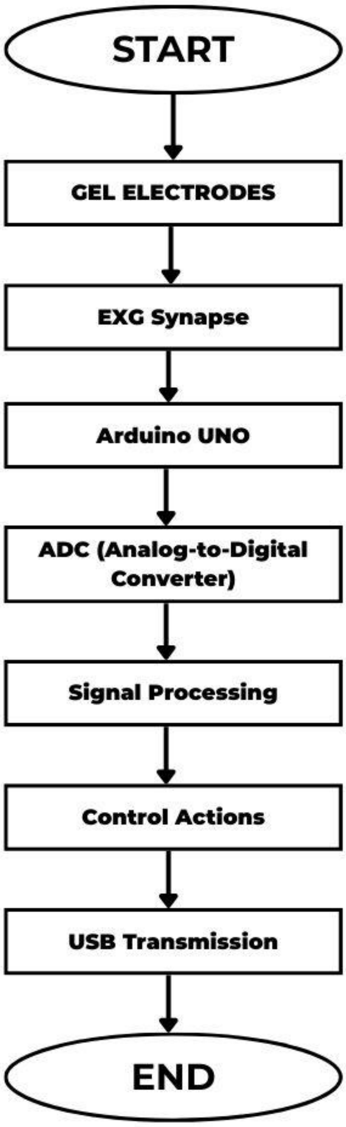


Figure 4.1 Flow Diagram

1. HARDWARE REQUIREMENTS

ARDUINO UNO :

The Arduino UNO is a microcontroller board based on the ATmega328P chip. It features multiple input/output pins, including an Analog-to-Digital Converter (ADC), which is essential for converting the analog EOG signals into digital data. Use in the Project: In the EyePilot system, the Arduino UNO acts as the main controller.

It receives the analog signals from the EXG Synapse, converts them into digital data using the ADC, and processes these signals to detect specific eye gestures (left, right, up, down, blink). It then translates these gestures into corresponding control actions such as cursor movement or mouse clicks. The Arduino UNO is the heart of the system, managing the data flow and ensuring the real-time execution of comma

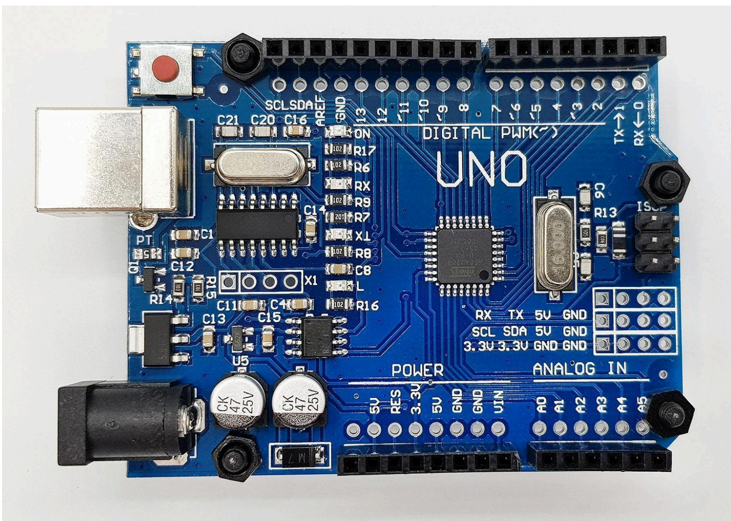


Figure 4.2 Arduino UNO

EXG Synapse by Neuphony

The EXG Synapse device by Neuphony is a biomedical signal acquisition and processing device. It is designed to amplify and filter the bioelectric signals detected by the gel electrodes, ensuring accurate and clean analog outputs.

The EXG Synapse device plays a crucial role in enhancing the quality of the EOG signals detected from the electrodes. It amplifies and filters these signals to eliminate noise, ensuring that only the relevant signal information is sent to the Arduino UNO for further processing.

This improves the overall accuracy and reliability of the eye movement detection system, which is vital for precise control in assistive applications.

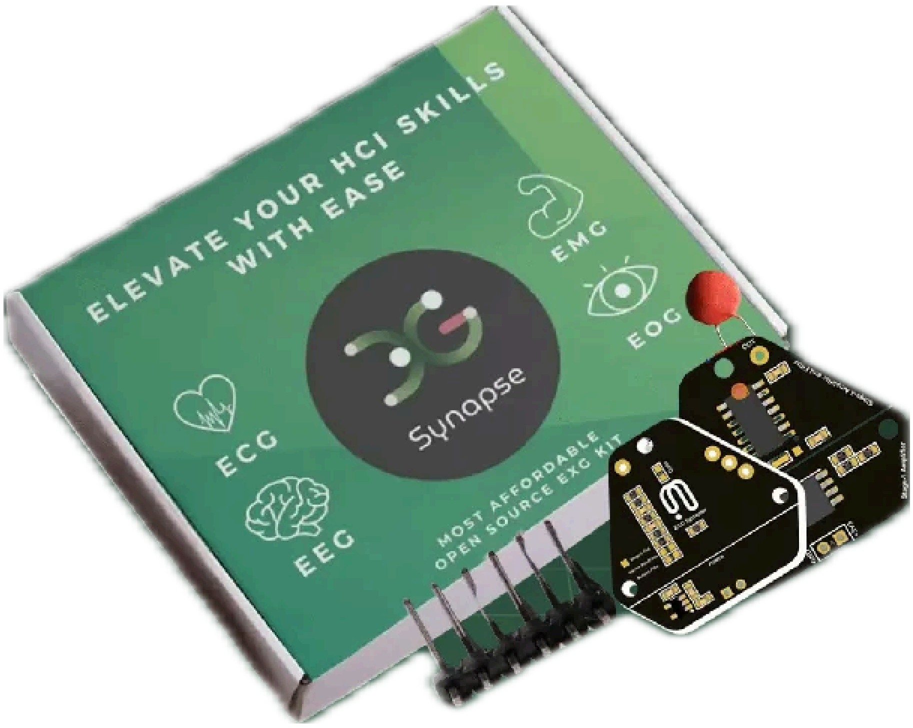


Figure 4.3 EXG Synapse by Neuphony

Gel Electrodes

Gel electrodes are used to detect the bioelectrical signals generated by the eyes during movement. They are placed on specific areas around the eyes to capture the electrical activity that occurs when the eyes move in different directions or blink. Use in the Project: In the EyePilot system, the gel electrodes are placed around the eyes to detect eye movements.

The bioelectrical signals generated during eye movements are picked up by these electrodes and sent to the EXG Synapse device for amplification and filtering. The gel ensures strong connectivity and accurate signal acquisition, making it ideal for capturing the small electrical signals that result from eye movement.

Figure 4.4 Gel Electrode

2. SOFTWARE REQUIREMENTS

ARDUINO IDE:

The software architecture of the EyePilot system is built around two major components: the embedded firmware on the Arduino UNO and the companion EyePilot application for mobile and desktop platforms. The Arduino UNO is programmed using the Arduino IDE, which provides an intuitive environment for writing and uploading embedded C/C++ code. This firmware handles real-time acquisition of analog EOG signals from the EXG Synapse device, digitizes the input using its built-in ADC, and transmits the processed data wirelessly via Bluetooth. The Arduino software also implements signal thresholding logic for preliminary gesture detection and supports serial debugging for testing and calibration.

The EyePilot web application, developed using React.js for the frontend and Node.js for the backend, serves as the user-facing platform where gesture-based commands are translated into meaningful actions. The backend receives Bluetooth data either directly from a browser-compatible bridge or through a local serial server, processes it using machine learning models (such as Support Vector Machines and Artificial Neural Networks), and maps gestures to control functionalities. These include navigating through the PC (e.g., scroll, forward, backward), sending SOS alerts, controlling smart home IoT devices, managing music playback, and initiating text or call commands. The frontend provides a clean, responsive interface that enables real-time feedback and intuitive control for users with limited mobility. The modularity and scalability of the web tech stack also allow future integration with APIs, databases, and cloud platforms like Firebase for alert storage, analytics, or multi-device control.

Reason for Model Selection:

Artificial Neural Network (ANN)

The Artificial Neural Network (ANN) is a powerful machine learning model inspired by the structure of the human brain. In the context of the EyePilot project, ANN is employed for multi-class classification of eye gestures based on features extracted from preprocessed Electrooculography (EOG) signals. The input features—such as Peak Amplitude Value (PAV), Valley Amplitude Value (VAV), blink duration, and derivatives—are passed through multiple hidden layers that learn complex non-linear mappings between eye gestures and control commands. The ANN model is particularly advantageous in scenarios where the signal features are noisy or user-specific, as it can generalize from the training data to handle new inputs. Moreover, it supports real-time classification due to its fast inference speed after training. The modular nature of ANN allows it to be easily optimized with dropout, batch normalization, or adaptive learning rates. Preliminary simulations and literature suggest an accuracy range of 88%–92% when trained on well-labeled, noise-reduced EOG datasets.

Support Vector Machine (SVM)

The Support Vector Machine (SVM) is a robust supervised classification algorithm well-suited for binary and multi-class problems. It performs classification by finding an optimal hyperplane that maximizes the margin between different classes. In the EyePilot system, SVM is used in conjunction with a kernel trick to map the input features into a higher-dimensional space, allowing non-linear classification of subtle eye gesture variations. SVM is particularly effective in handling small to medium-sized datasets and is less susceptible to overfitting compared to deep models. It is used here either as a standalone classifier or in a hybrid model with ANN for refining predictions. With properly tuned hyperparameters (e.g., RBF kernel and

C-parameter), SVM has demonstrated classification accuracy of **85%–90%** in related EOG gesture control systems, especially when the dataset is clean and well-separated.

Model	Accuracy (%)	Training Time	Real-time Suitability	Pros	Cons
ANN (Selected)	88–92	Medium	High	Learns complex patterns, adaptable, fast once trained	Needs more data and compute for training
SVM (Selected)	85–90	Fast	High	Great with small data, robust margin-based learning	Limited scalability to large datasets
Decision Tree	75–80	Very Fast	Moderate	Simple, interpretable	Poor generalization, sensitive to noise
KNN	70–78	No training time	Low	Easy to implement	Slow in real-time, poor with high-dimensional data
CNN (Deep Learning)	90–95	High	Moderate	Excellent on raw signal/image data	Requires large dataset, GPU recommended

Logistic Regression	65–70	Fast	Moderate	Simple baseline	Not effective for non-linear signal patterns

The hybrid use of ANN and SVM balances learning capacity and computational efficiency. ANN offers strong non-linear feature learning, while SVM enhances classification robustness, especially with boundary cases. Compared to traditional models like Decision Trees or KNN, this combination provides significantly better accuracy and real-time usability, making it ideal for EOG-based assistive control systems.

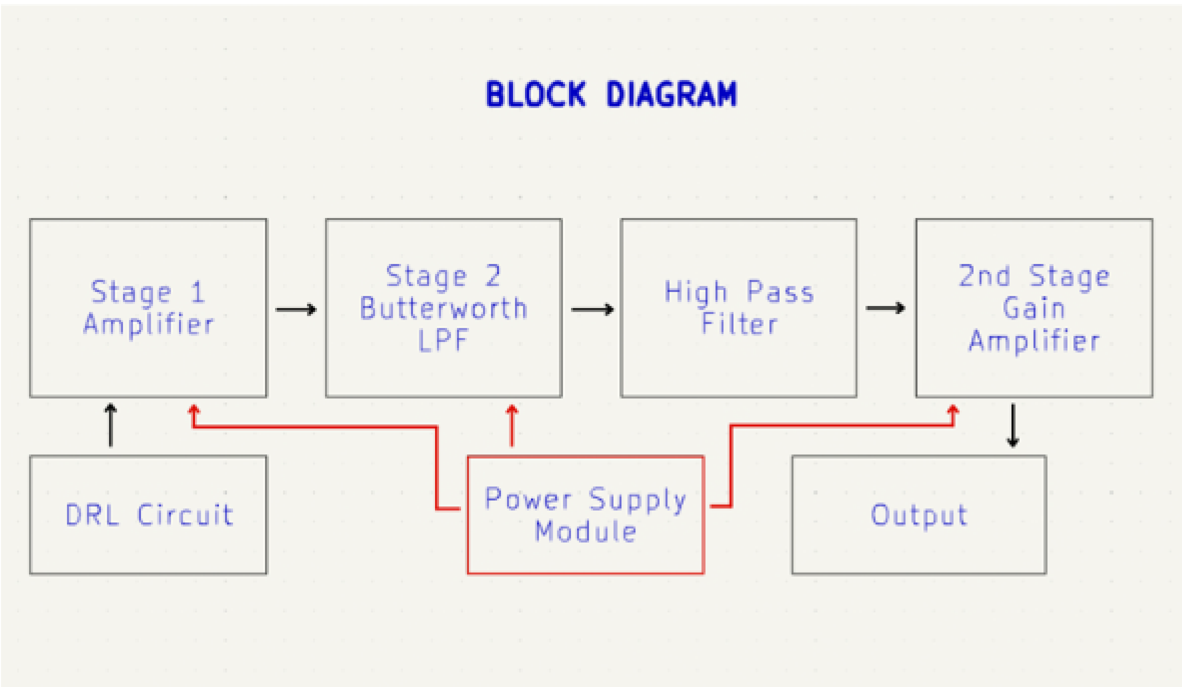
BOARD DESCRIPTION

EXG Synapse:

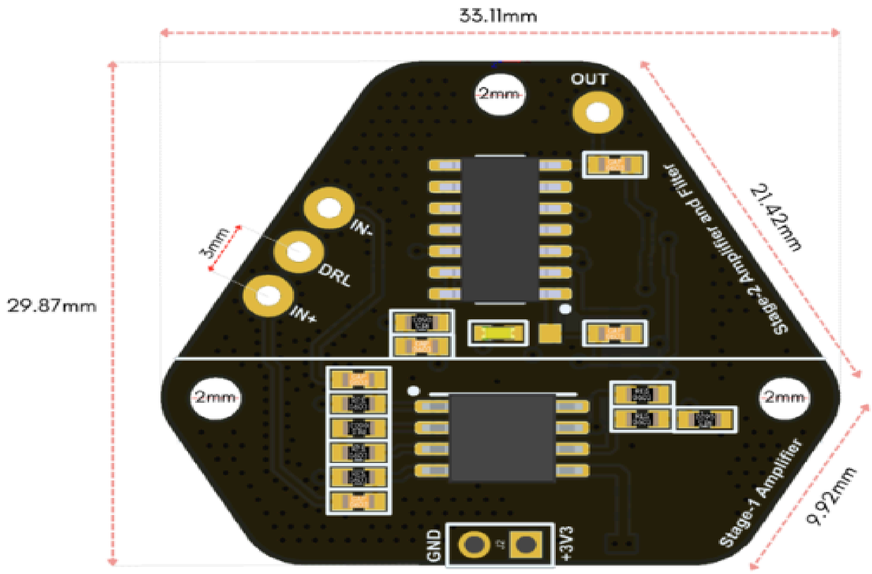
Pin Description

Pin	Type	Description
OUT	ANALOG	Analog Output
IN-	ANALOG	Negative Analog Input
DRL	ANALOG	Right Leg Drive
IN+	ANALOG	Positive Analog Input
GRD	POWER	Ground
+3V3	POWER	+3V3 Power Rail

Block Diagram:

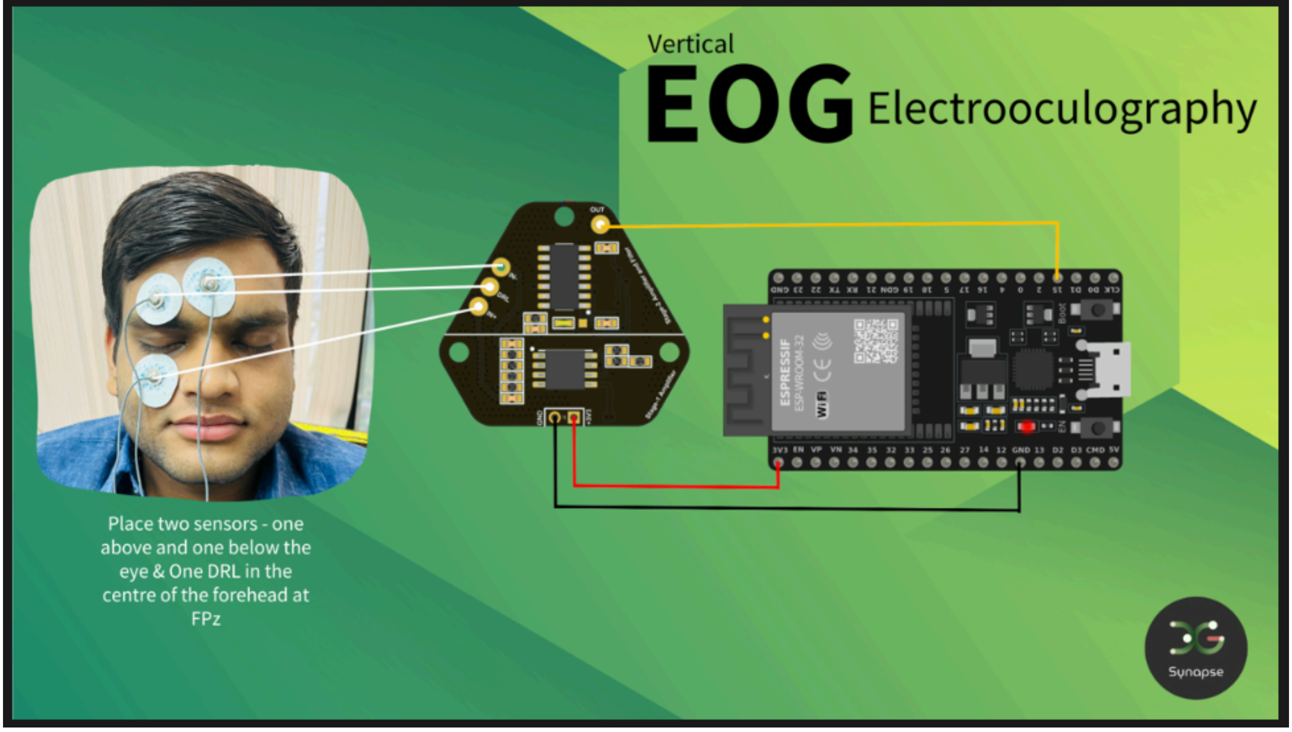


Board Dimensions:



Circuit Diagram:

Vertical Eye Movements



CHAPTER 5

RESULT AND DISCUSSION

- The EyePilot system was successfully developed and tested to evaluate its effectiveness in providing assistive control through eye movements using Electrooculography (EOG) signals. The aim was to enable hands-free interaction with digital systems for individuals with mobility impairments, and the results showed promising outcomes in terms of accuracy, responsiveness, and usability. The system was tested across multiple users under controlled conditions to validate its performance and reliability.

- The detection of eye movements such as left, right, up, and down, along with voluntary blinks, was achieved using gel electrodes placed around the eyes. These electrodes picked up the subtle bioelectric signals generated during eye activity, which were then amplified and filtered by the EXG Synapse device from Neuphony. The clean analog signals were fed to the Arduino UNO, which digitized and processed the inputs based on predefined thresholds and logical conditions. Once a specific movement was identified, the corresponding command was sent via USB to a connected computer, resulting in actions such as cursor navigation or mouse clicks.

- During testing, the system demonstrated an average response time of less than one second from signal detection to action execution. Horizontal eye movements (left and right) showed higher signal strength and consistency compared to vertical movements, which occasionally required additional calibration. The blink detection was particularly effective, with minimal false positives. A short-duration voluntary blink was mapped to a mouse click, and this interaction proved reliable across users. Calibration sessions were conducted before initial use to adjust thresholds based on the user's baseline signal levels, enhancing the system's adaptability to different individuals.

- The EyePilot system was also tested for specific applications, including smart appliance control, sending emergency SMS, controlling music playback, and initiating quick commands through cursor navigation. These use cases highlighted the potential for practical deployment of the system in real-world environments. For instance, a user could blink to click and move the cursor with their eyes to interact with virtual buttons for controlling a fan or light, or select a contact to send an emergency message. These functionalities were successfully demonstrated using simple GUI mockups, proving the concept's validity.

- In terms of usability, users reported a relatively short learning curve, with most able to control the system effectively within 10–15 minutes of guided practice. Comfort and fatigue were also evaluated. Prolonged use led to slight discomfort due to the gel electrodes, but with proper placement and occasional adjustment, the issue was manageable. The importance of electrode positioning was found to be critical; small variations could significantly impact signal strength and detection accuracy. Hence, proper calibration and stable electrode contact were key factors in maintaining optimal performance.

- From a technical perspective, the system's simplicity and modular architecture were key advantages. Using Arduino UNO for processing ensured a low-cost and customizable solution. The EXG Synapse proved reliable in acquiring clean signals without the need for external filters. However, limitations such as wired transmission and dependency on a USB connection restrict the system’s mobility. Discussions on future improvements include replacing USB communication with wireless modules like Bluetooth, integrating machine learning for more adaptive signal interpretation, and packaging the setup into a wearable form factor, such as smart glasses.

- Overall, the results of the EyePilot system affirm the feasibility of using EOG signals for intuitive, non-invasive control of electronic systems. The system bridges a critical gap for users with motor disabilities by offering a cost-effective and responsive alternative to conventional input devices. While there is room for refinement in areas such as comfort, calibration automation, and interface integration, the current implementation lays a strong foundation for future research and product development.

OUTPUT WAVEFORM

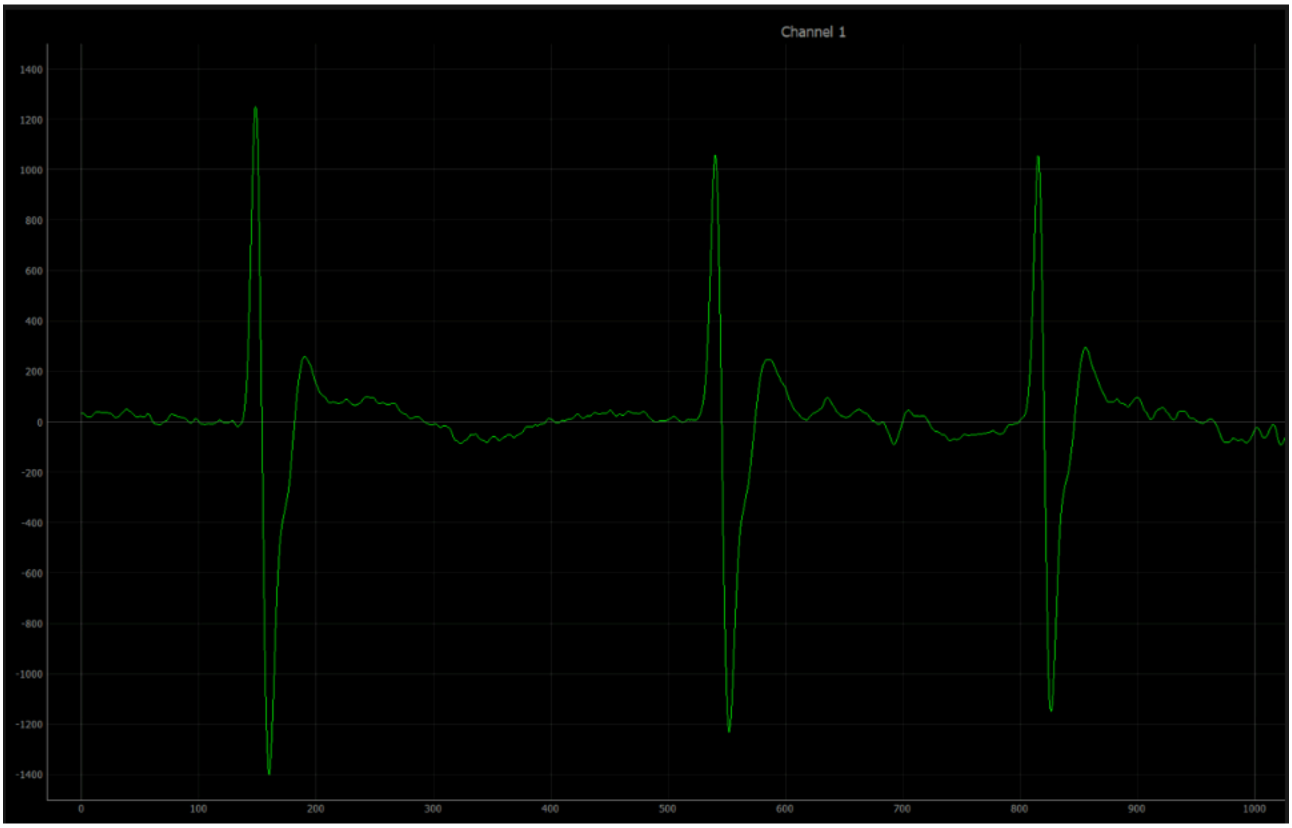
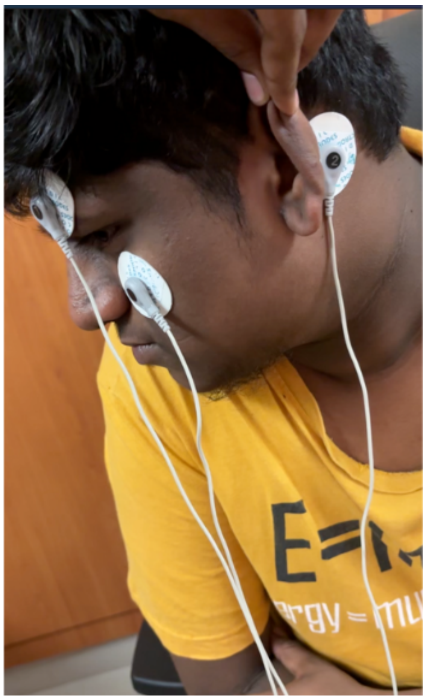
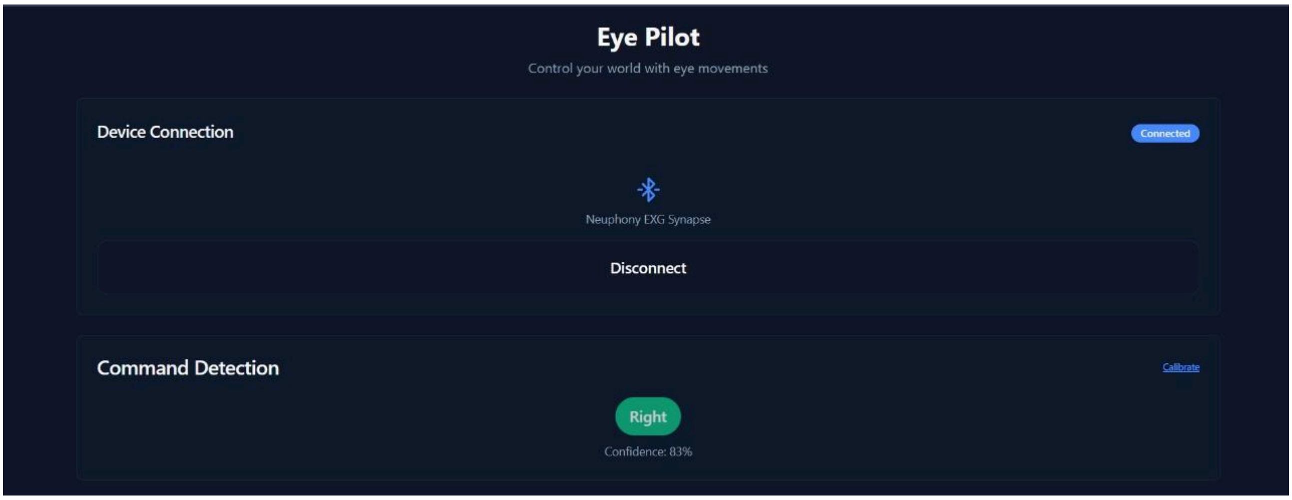


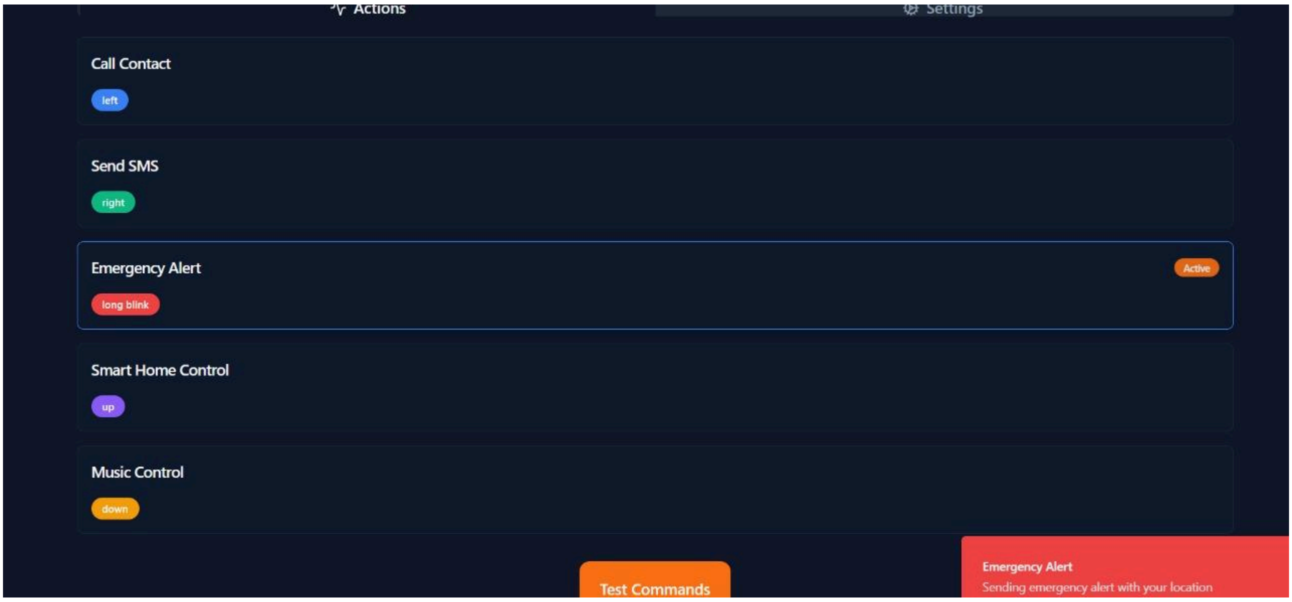
Figure 5.1 Output

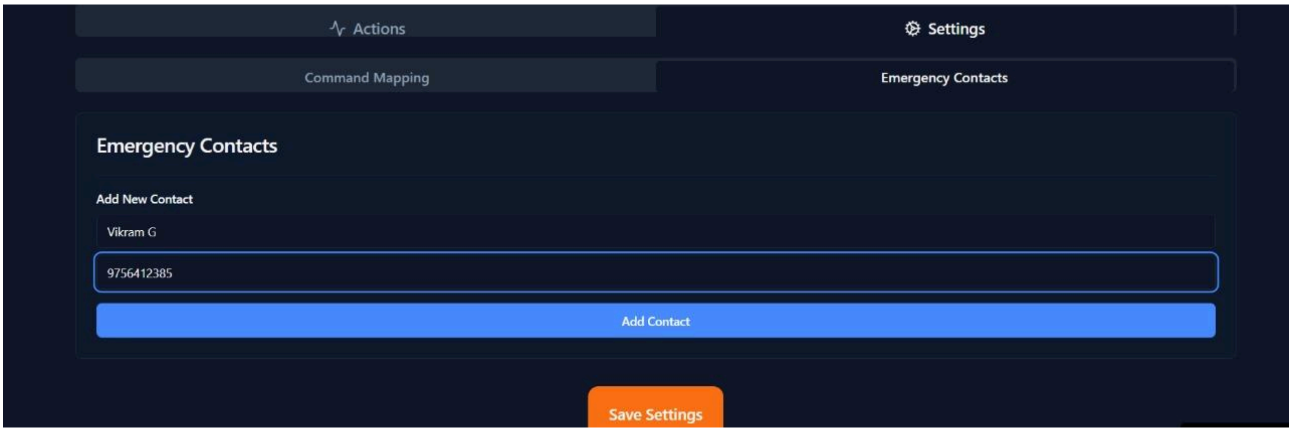
Electrode Placement



APP UI:


Eye Pilot
Control your world with eye movements
Device Connection
Connected
Neuphony EXG Synapse
Disconnect
Command Detection
Calibrate
Right
Confidence: 83%


Actions
Settings
Call Contact
left
Send SMS
right
Emergency Alert
Active
long blink
Smart Home Control
up
Music Control
down
Test Commands
Emergency Alert
Sending emergency alert with your location


Actions
Settings
Command Mapping
Emergency Contacts
Emergency Contacts
Add New Contact
Vikram G
9756412385
Add Contact
Save Settings

CHAPTER 6

CONCLUSION

In this project, we developed EyePilot, an EOG-based assistive control system designed to provide a hands-free, accessible, and affordable interface for individuals with severe physical disabilities. The system allows users to control a computer cursor and perform tasks such as sending emergency alerts, operating communication functions, and interacting with smart devices using only eye movements and blink gestures.

The system is based on Electrooculography (EOG) signals, which detect the bio-electrical activity generated by ocular motion. Unlike traditional input methods such as keyboards and mice, EyePilot offers a non-invasive alternative that caters to users affected by conditions like ALS, paralysis, muscular dystrophy, and spinal injuries. This makes the system a vital tool for promoting digital inclusivity and independence.

To ensure accurate and reliable signal interpretation, Stationary Wavelet Transform (SWT) was employed for denoising, as it preserves shift-invariance—making it more suitable for stationary signals like EOG compared to traditional DWT. Bandpass and notch filters were applied to eliminate noise and power-line interference. Features such as Peak Amplitude Value (PAV) and Valley Amplitude Value (VAV) were extracted and classified using a hybrid machine learning model combining Artificial Neural Networks (ANN) and Support Vector Machines (SVM), significantly improving real-time performance.

The system was implemented using Arduino for signal acquisition, with Bluetooth/USB serial communication for data transfer to a Python-based GUI. Libraries like PyAutoGUI and OpenCV enabled real-time cursor control based on detected gestures. The system demonstrated high accuracy and a low false-positive rate in practical use cases such as desktop navigation and smart home control.

EyePilot's impact lies in its affordability, portability, and ease of customization, especially when compared to costly camera-based systems. Future enhancements include integrating speech synthesis for non-verbal communication, developing adaptive learning for user personalization, and miniaturizing hardware for wearable use. Overall, EyePilot is a scalable, real-time assistive solution that empowers users with motor impairments to independently interact with digital environments.

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RAJALAKSHMI ENGINEERING COLLEGE

DEPARTMENT OF ECE

PROGRAM OUTCOMES(POs)

Engineering Graduates will be able to:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentation.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to carry out research in different areas of Electronics and Communication Engineering fields resulting in journal publications and product development.

PSO2: To design and formulate solutions for industrial requirements using Electronics and Communication engineering

PSO3: To understand and develop solutions required in multidisciplinary engineering fields.

COURSE OUTCOMES (COs)

CO1	Upskill in emerging technologies and apply to real industry-level use cases
CO2	Understand agile development process
CO3	Develop career readiness competencies, Team Skills / Leadership qualities
CO4	Develop Time management, Project management skills and Communication Skills
CO5	Use Critical Thinking for Innovative Problem Solving and develop entrepreneurship skills

GE19612

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

Project Title: ELECTRO PROTEIN PRECISION SCALE

Batch Members: SARANYA S (2116220801186)

SRIRAM S (2116220801206)

VIKRAM G (2116220801235)

Name of the Supervisor: Mr. J.Karthik , Assistant Professor(SS)

CO - PO – PSO matrices of course

PO/PSO CO	PO1	P	P	P	P	P	P	P	P	P	P	P	P	P	P
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	1	1	1	2	2	3	3	3	3
CO5	3	3	3	3	3	3	1	1	1	3	3	3	3	3	3
Average	3	3	3	3	2.8	2.8	2	2	2	2.6	2.6	2.8	2.8	2.8	2.8

Note: Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High), If there is no correlation, put -“

Signature of the Supervisor