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CONTROL-WAVE: GESTURE CONTROL GLOVE

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ABSTRACT

This Research work aims to address the challenges faced by teaching professionals in the Education as well as industry sector by developing an innovative wearable device known as Gesture control Glove named as control-wave equipped with advanced gesture recognition technology. Through a comprehensive understanding of the issues encountered by all the Teaching professionals, particularly regarding the navigation of digital content during lectures, the proposed research work seeks to create a comfortable, intuitive, and efficient tool that enhances their teaching experience. The proposed solution includes wearable hand glove using flex sensors which performs operation on customizable gestures like Mouse click mode and Presentation mode. This glove allows teaching professionals to tailor the device to their individual teaching preferences and styles. Mouse click mode focuses on left and right mouse click to open or close the apps, files, and folder whereas presentation mode facilitating seamless transitions and interactions with slide content. Control-Wave is not just a technological advancement; it signifies a transformation towards a more intuitive, seamless, and user-focused way of engaging with technology. The research work aims to provide teaching professionals with a seamless and empowering tool for optimizing their workflow, promoting engagement, and improving overall teaching effectiveness with 95% of accuracy.

I. INTRODUCTION

Control-Wave's impact extends beyond the professional realm; it has the potential to redefine how we interact with technology in our daily lives. Imagine seamlessly controlling your smart home devices [1-3] with a flick of the wrist, adjusting the lighting, temperature, and entertainment systems with effortless gestures. Control-Wave transforms mundane tasks into moments of intuitive interaction, enhancing the overall user experience and fostering a deeper connection with our digital ecosystems. Furthermore, Control-Wave opens doors to new frontiers in entertainment and gaming [4], offering immersive experiences that transcend traditional input methods. From controlling virtual avatars with precise hand movements to interacting with virtual environments in augmented reality [5], Control-Wave unlocks a world of possibilities for developers and enthusiasts alike, pushing the boundaries of what's possible in interactive entertainment.

Moreover, Control-Wave's potential applications extend to industries such as retail and hospitality, where intuitive gesture controls can enhance customer experiences and streamline operations. Picture a retail associate effortlessly navigating through product catalogs or a hotel concierge providing personalized recommendations with a simple wave of their hand [6]. The researchers have surveyed few techniques for controlling the mouse movement [6] and PowerPoint (PPT) controlling [7] to navigate digital content through the technique of sign language or by using few gestures.

Control-Wave transforms unexciting interactions into memorable experiences, leaving a lasting impression on customers and guests. In essence, Control-Wave represents more than just a technological innovation; it embodies a shift towards a more intuitive, seamless, and human-centred approach to interacting with technology. By bridging the gap between the physical and digital worlds, Control-Wave has the power to enrich our lives in ways we've only begun to imagine, making every interaction with technology a moment of magic and delight.

Looking at the future, Control-Wave serves as a beacon of possibility, inspiring us to rethink the boundaries of human-computer interaction and envision new ways to bind technology for the betterment of society. With Control-Wave, the future is not just about being more productive-it's about embracing a new paradigm of human-centred technology that empowers us to achieve our full potential, both individually and collectively.

I.1 OBJECTIVES

The objectives of proposed research work are as follows.

- Develop Gesture Recognition Technology: Design and implement advanced gesture recognition technology capable of accurately interpreting hand movements and translating them into control commands for digital devices.
- Create an Ergonomic Wearable Device: Engineer a comfortable and user-friendly wearable glove that seamlessly integrates gesture recognition sensors while prioritizing ergonomic design to minimize physical strain during prolonged use.
- Ensure Compatibility and Integration: Ensure seamless compatibility and integration of Control-Wave with a wide range of digital devices and software commonly used in educational settings, facilitating easy adoption and implementation.
- Optimize Performance and Accuracy: Continuously refine and optimize the performance and accuracy of Control-Wave gesture recognition system through iterative testing and feedback gathering.
- Enhance User Experience: Implement visual and auditory feedback mechanisms to provide immediate confirmation of successful gesture recognition and execution, enhancing user confidence and usability.
- Prioritize Accessibility: Ensure that Control-Wave is accessible to users of varying technical proficiency and physical abilities, promoting inclusivity and usability for all the teaching professionals.

It must define the problem and importance of the research carried out; it presents a (not very extensive) review of the literature on the subject of the article, including the authors' contributions to the state of the art. If you use abbreviations or acronyms, first write the words that identify them and then, in parentheses, the acronym. This set also establishes the research question, the objectives of the work and hypothesis, if necessary, the importance and limitations of the study. Establishes the method used at work. It is written in the present tense.

I.2 LITERATURE REVIEW

The paper [8] introduces "Gesture Contro," a gesture-controlled glove designed to enhance human-computer interaction by enabling gesture-based control of gaming and PowerPoint presentations. This research work highlights the benefits for presentations, seminars, and gaming. The paper concludes by suggesting potential future applications, such as medical use and robotics integration. Disadvantage of this model is mouse movement is not detected; Wireless communication used by the authors in this research publication is through Zigbee module whereas in proposed research work wireless communication is done through Bluetooth low energy (BLE). Advantages of BLE is it has high frequency up to 2MBPS and power consumption is low.

In this research work [9], the authors delve deeply into the realm of Human-Computer Interaction (HCI) by exploring the effective communication by using hand gesture reorganization by using Convolutional Neural Networks (CNNs). The model goes through a multi-stage process, involving image capture, hand tracking, feature extraction, gesture recognition, and classification with 85.90% accuracy in recognizing gestures. Disadvantage of this paper is that it is not used for controlling the different operations on computer system.

The hand data glove, as described in this article [10], represents a significant leap forward in the realm of Human-Computer Interaction (HCI) [11],[12]. This article underscores the significance of Human-Computer Interaction by introducing an innovative approach that utilizes a data glove and a k-NN classifier for real-time gesture recognition. This method significantly enhances the accuracy and naturalness of interactions in comparison to conventional input devices like keyboards and mice. The successful application of this approach to various tasks, including air writing, 3D sketching, and image browser control, highlights its potential to redefine and enhance human-computer interactions for a more intuitive and effective user experience.

Paper [13] explores the fascinating world of interactive technology in smart environments. The authors discussed about the significance of recognizing not only simple gestures but also complex 3-D postures, which allows for more natural interactions between humans and smart environments. They explore various techniques and algorithms used for posture and gesture recognition. The article highlights the potential applications of these technologies across a wide range of domains, including human-computer interaction, surveillance, healthcare, and robotics. By enabling seamless interaction with smart environments, gesture and posture recognition systems have the potential to revolutionize how we interact with technology in our daily lives.

The article "Glove-Talk II" [14], presents a groundbreaking project focused on developing a wearable device called Glove-Talk II. This device aimed to enable individuals with speech disabilities to communicate more effectively by translating hand gestures into speech. Authors explored the use of neural networks and sensor technology to interpret hand movements captured by the glove. By analyzing the data collected from sensors embedded in the glove, the system could recognize specific gestures associated with different words or phrases. This enabled users to convey messages simply by making hand movements, providing them with a means of communication that was both intuitive and accessible. Advantage of this research work is to facilitate communication for individuals with disabilities.

In our research work of developing a gesture-controlled glove, this article [15] provided valuable insights into how human hands work together to perform complex tasks. By studying synergies, which are coordinated patterns of movement that enable efficient and coordinated actions, we gained a deeper understanding of how to design our gesture-controlled glove to mimic natural hand movements. The research highlighted in the article provides a framework for designing algorithms and sensors that can recognize and interpret gestures accurately. By understanding how synergies are utilized in dual-arm manipulation tasks, we were able to implement similar principles in our glove design to enable intuitive and seamless control of devices and applications.

In this paper [16], the authors have proposed a system of recognition of hand gesture using flex sensors and Arduino UNO. The acquired sensors data of hand gesture are analyzed through machine learning algorithms. The proposed system gives accuracy of 88.32% with a precision of 81.77%, a recall of 84.37% and F1-score of 82.78%. The motivation of this research work is to develop a text to speech application.

In references [17–20], the authors discussed vision-based recognition and its application in controlling machines. They highlighted that vision-based gesture recognition techniques are crucial for developing highly efficient and intelligent human-machine interfaces. These techniques allow users to interact with machines in a natural, creative, and intuitive manner, making the experience of engaging with computers as seamless as interacting with another person.

In paper [21], the researchers aim to create a Windows-based application for real-time motion gesture recognition using a webcam as input device. This input will be utilized to control a video/audio player (specifically VLC media player). The application will combine motion detection and gesture recognition to detect user gestures via the webcam, allowing for basic controls such as play/pause, volume adjustment, and navigating to the next or previous track.

The authors in paper [22] presented a method for capturing hand posture using a monochrome glove with a pattern of AR markers drawn on the palm. Finger states were determined using structured markers. They conducted an experiment to recognize 122 hand postures from a large dataset and demonstrated that the proposed system could successfully recognize at least 96 of these postures with 78.69 % of accuracy.

I.3 EXISTING SYSTEMS

This research work also shows the survey of few existing systems which are currently available in Online and offline market, are explained below.

Gesture Control Devices: Devices like the Microsoft Kinect, Leap Motion, and various smart TVs with built-in cameras offer gesture-based control for presentations, gaming, and other applications like controlling the home appliances as explained in paper [23-25]. These systems allow users to control on-screen actions using hand and body gestures. *Limitations of these types of devices are*; Limited Gesture Recognition: These devices may have limited gesture recognition capabilities, making them less precise and responsive for complex gestures. The second limitation is Range and Field of View: They often require a specific range and field of view, limiting their use in larger or obstructed spaces. And the last one is related to Environmental Factors: Changes in lighting and background can affect their performance.

Wireless Presenters [26]: For PowerPoint presentations, there are wireless presenter devices or clickers that enable users to remotely control slide transitions and other presentation functions. They do not rely on gesture control but provide a convenient way to manage slides without being tied to a computer. *Drawbacks of this device are* it has Limited Functionality as it is used to serve a single purpose (i.e. slide control in presentations) and lack versatility for other applications. And it has Lack of Precision; this device may not provide fine-grained control, limiting their use for tasks that require precise input.

Remote Control Systems for RC Cars and Drones: Many remote control systems for RC cars and drones are available on the market, allowing users to control these devices wirelessly. They often come with specialized controllers or apps that offer precise control. The limitations of these remote control systems are as follows; Device Compatibility: These systems are usually tailored to specific devices and may not be easily adaptable to control other types of devices. Learning Curve: Mastering the controls can be challenging for newcomers. The control range for RC cars and drones is typically limited to avoid interference.

Gesture-Controlled Desktop Mice: Some companies have developed gesture-controlled mice that allow users to perform actions like scrolling or zooming by making specific hand movements while holding the mouse. *Few drawbacks of this gesture controlled mice* is that it has Limited Gestures: They often support a limited set of gestures, which may not cover all the functions of a traditional desktop mouse. And *Learning Curve*: Users may need time to adapt to the new control method, and precision can be a concern.

I.4 PROBLEM STATEMENT

Teaching professionals in educational systems often encounter difficulties when navigating digital presentations and content during lectures or sessions. Traditional methods of control, such as keyboards, mice, and handheld devices, can disrupt the teaching flow by requiring frequent trips back to a computer or projector. These challenges lead to interruptions in the learning process and distract from the overall classroom experience. Moreover, the physical strain and inefficiency of these methods can impact a Teaching professionals ability to deliver effective and dynamic lessons. There is a clear need for an innovative, hands-free solution that simplifies the process of managing digital content, enhances teaching efficiency, and supports a more engaging and interactive classroom environment.

II. PROPOSED SYSTEM

The proposed system focuses on creating a user-friendly, efficient tool for teaching professionals. At its core, the system relies on advanced gesture recognition technology that accurately interprets hand movements and translates them into commands for digital devices. The wearable glove is designed to be lightweight and ergonomic, with sensors that capture hand movements precisely. It uses wireless connectivity, such as Bluetooth, to seamlessly integrate with computer systems, projectors, and other digital devices. In this research paper the proposed features can be accessible from anywhere within the range of 50 meters.

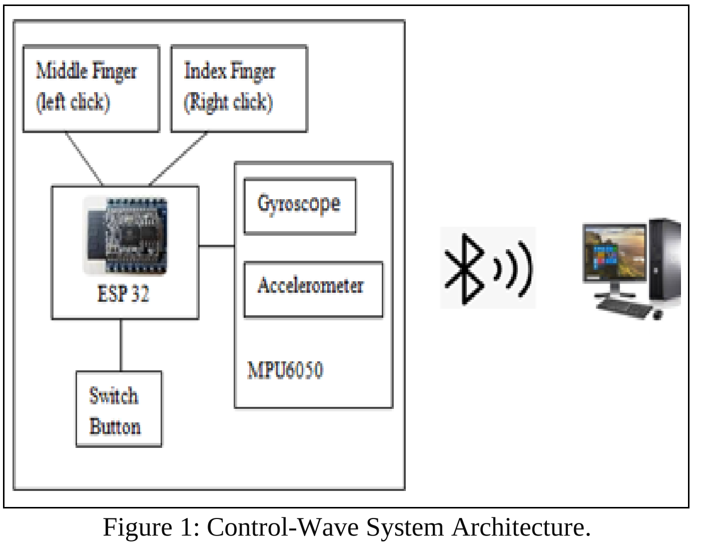

Figure 1: Control-Wave System Architecture.
Source: Authors, (2024).

The above Figure 1 shows the prototype design architecture of proposed research work, where three major hardware components are used in the design that are namely Flex sensors, MPU-6050, ESP 32 Microcontroller. The detail description of all hardware components are as follows and shown in Figure 2.

Figure 2.a shows the Flex sensor it measures bending or flexing in a material, providing variable resistance based on its angle. It's commonly used in applications like wearable technology and robotic controls [27],[28] to detect and respond to physical movement. In this research work as shown in Figure 1 two flex sensors have been used one for Index figure, and other for middle finger to perform right click and left click operation respectively. MPU6050 is a sensor module, is as shown in Figure 2.b. It combines a 3-axis gyroscope and a 3-axis accelerometer to measure angular velocity and linear acceleration. It is used in applications like motion tracking, stabilization systems, and gesture recognition. The MPU6050 features an I2C interface for easy communication with microcontrollers [27],[28]. Its ability to track movements makes it ideal for applications requiring precise control and stabilization.

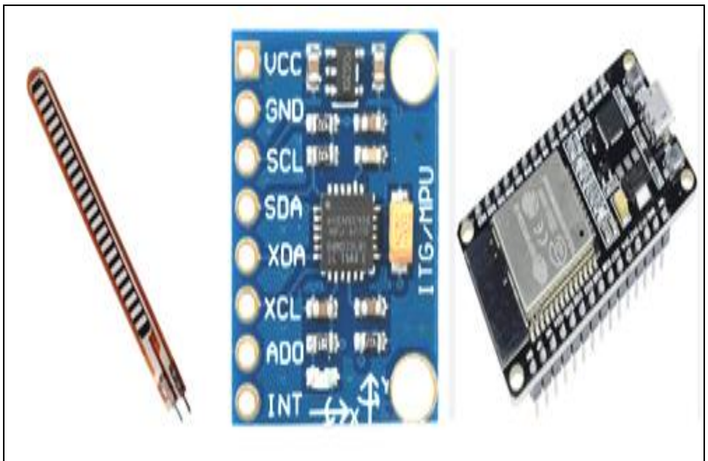

Figure 2: Hardware components used in prototype design (a) Flex Sensor (b) MPU 6050 (c) ESP 32.
Source: Authors, (2024).

Fig. 2.c. shows the ESP 32 Microcontroller, this have several inbuilt modules Bluetooth is one of them which enables serial communication over Bluetooth, allowing microcontrollers and other devices to connect and exchange data wirelessly. Additionally, the research work is developed using Arduino IDE, Along with various libraries such as Wire.h, MU6050.h, Mouse.h, SoftwareSerial.h, and Keyboard.h.

Teaching professionals can control the settings through pre-defined gestures [28] to perform common task. Visual or auditory feedback mechanisms confirm successful gesture recognition and command execution. The glove is equipped with all the required hardware components as shown in Figure 3. This holistic approach ensures Control-Wave delivers a reliable, effective tool that enhances teaching experience of teaching professionals.

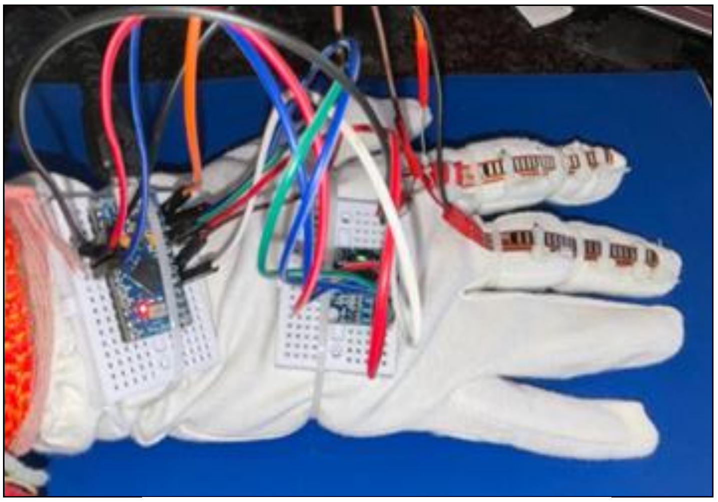

Figure 3: Prototype of Control-wave Glove.
Source: Authors, (2024).

Advantages of the proposed system are as follows:

This streamlined approach improves focus and eliminates the need to constantly return to devices or handle handheld controls, allowing professors to concentrate on delivering effective lessons. Second advantage of the proposed system is that it seamlessly integrates with existing devices and software, enabling a smooth transition for teaching professionals without major changes to their current setup. By facilitating efficient and time-saving teaching processes, Control-Wave boosts productivity and engagement in the classroom. And lastly, it uses wireless connectivity, such as Bluetooth, to seamlessly integrate with computer systems, projectors, and other digital device along with the biggest advantage is Control-Wave features can be accessible from anywhere within the range of 50 meters.

III. METHODOLOGY

As shown in the below flow of control-wave in Figure 4, the first step is to initialize all the hardware components and establish the Blue tooth connection with the target machine. The system works for two different modes, one is mouse mode featured with mouse clicked operations and other is Presentation mode which is used to perform operations on power point presentation slides. The system is continuously monitoring the state of the mode-switching button and sensor data to toggle between these two modes to achieve the desired result.

The detail step wise description of proposed “control-wave” is given in below algorithm.

Step 1: Initialize all hardware components (ESP32, flex sensors, gyroscope, accelerometer) along with Mode switching button.

Step 2: Establish a Bluetooth connection with the target device (computer or Bluetooth-controlled device).

Step 3: Set variable current_mode = 0 for mouse mode and current_mode = 1 for presentation mode.

Step 4: Continuously monitor the state of the mode-switching button and sensor data.

Step 5: Check if the mode-switching button is pressed. If pressed, toggle current_mode between 0 and 1.

Step 6: Detect hand movements using gyroscope and accelerometer data for mouse cursor movement.

gyroscope_data = Gyroscope.read ()
accelerometer_data = Accelerometer. read ()
{x,y} = accelerometer_data<threshold

Step 6.1: Translate hand movements into cursor movements.

if gyroscope_data.tilt_up:
set_mouse_pointer (x,y+1)
elif gyroscope_data.tilt_down:
set_mouse_pointer (x,y-1)
elif gyroscope_data.tilt_left:
set_mouse_pointer (x-1,y)
elif gyroscope_data.tilt_right:
set_mouse_pointer (x+1,y)

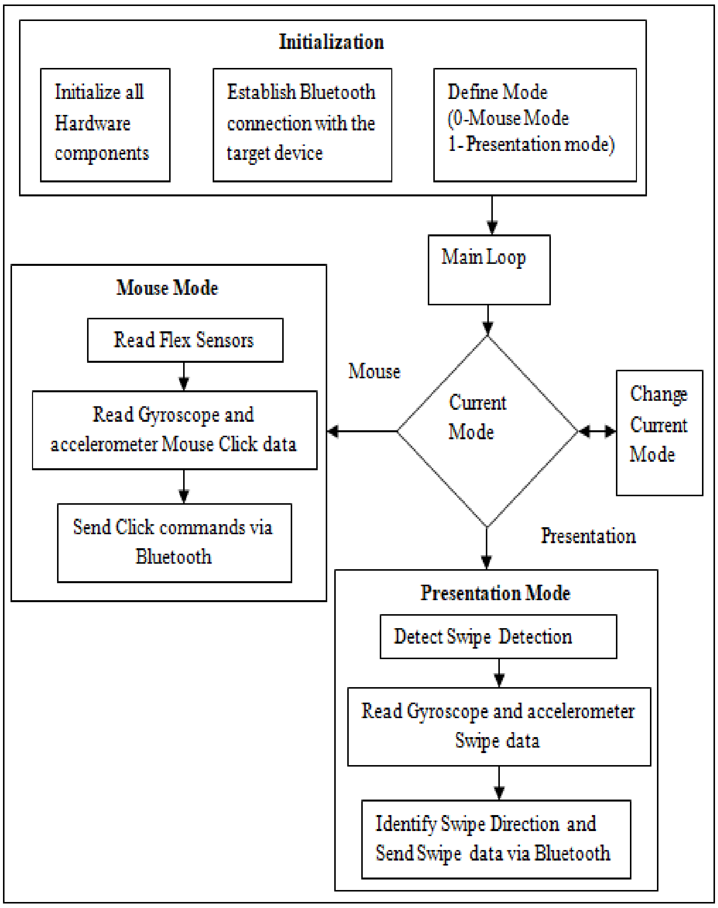

Figure 4: Flow of Control-Wave.
Source: Authors, (2024).

Step 7: Detect clicks using flex sensors on fingers
Where, mf= Middle Finger, if= Index Finger
If (mf_flex_sensor=bent) perform a left click.
If (if_flex_sensor=bent) perform a right click.
Step 8: Send the cursor movement and click commands via Bluetooth to the connected device.
Step 9: Detect swipe gestures using gyroscope and accelerometer data for Presentation Mode Operations. Where, rt_swipe=right swipe for next slide,
lt_swipe for left swipe to go to next slide
gyroscope_data = Gyroscope.read ()
accelerometer_data = Accelerometer.read ()
If (flag=rt_swipe), go to the next slide
If (flag=lt_swipe), go to the previous slide
Step 10: Send the corresponding presentation control commands via Bluetooth to the connected device.
Step 11: Continuously send the appropriate commands based on the detected movements, clicks, or swipes via Bluetooth.
Step 12: Go to Step4 till Bluetooth disconnect
Step 13: Process Exit

IV. RESULTS AND DISCUSSIONS

The performance of the research project involved comparing it with existing products in the market, namely the RTS wireless laser pointer and camera-based PowerPoint changers. This work focused on key factors such as ease of use, distance coverage, and performance in different environments. In terms of ease of use, the proposed system excelled due to its emphasis on comfort and simplicity. The breathable gloves as shown in Figure 4 provides increased comfort during prolonged use, while the intuitive hand gestures eliminated the need to hold any additional equipment, unlike the RTS laser pointer. This ergonomic design facilitated better movement of the hand during lectures, enhancing the overall user experience. Regarding distance coverage, this research work demonstrated superior versatility. Utilizing Bluetooth technology, it enabled professors to control presentations from anywhere in the classroom without being restricted by line-of-sight limitations, unlike the camera-based PowerPoint changer.

Furthermore, the research work showcased robust performance across various environments. Whether in brightly lit or dimly lit rooms, the system operated seamlessly, delivering consistent performance as long as it remained within the Bluetooth range. This reliability ensured uninterrupted usage regardless of environmental conditions. The below is the explanation about confusion matrix for Mouse Mode in Table 1 and Presentation mode in Table 2.

1. Mouse mode

Table 1: Performance analysis of Mouse Mode.

Confusion Matrix	lc	rc	Mm	Nm	TC
lc	80	0	0	20	100
rc	0	70	0	30	100
mm	0	0	100	0	100
nm	0	0	10	90	100

Source: Authors, (2024).

Where, lc=left click
rc=right click
mm= mouse movement
nm=no movement
TC= total number of clicks
TC_lc= total number of left click
TC_rc= total number of right click
TC_mm= total number of mouse movement
TC_nm= total number of no mouse movement

For the proposed research work, extensive testing and iteration are carried out with 50 professors within a campus. And in above Table 1 shows the 100 tested data values for each operation i.e. total predictions (TP) =100.

Total Correct Predictions (TCP) is the addition of left mouse click, right mouse click, mouse movement, and no movement of mouse pointer. The Equation 1 shows the Total correct mouse predications in mouse mode operation.

TCP=LC+RC+MM+NM………................................. (1)
= 80+70+100+90=340

Total Predictions (TP) is the count of total number of left click, right click, Mouse click, and no mouse click operation perform during testing as given in Equation 2.

TP= TC_lc+TC_rc+TC_mm+TC_nm …..................... (2)
=100+100+100+100 =400

Total Incorrect Predictions (TIP) is number of mouse clicked not detected during mouse mode operation.
TIP=TP-TCP ……………….................................. (3)
= 400-340=60

Accuracy and Error rate of Mouse mode is calculated with the Equation 4 and Equation 5. Accuracy and Error rate are inversely proposal and sum of both is 100%. Accuracy is nothing but correct predictions in percentage whereas error rate gives incorrect predictions in percentage.
Accuracy:
Accuracy= (TCP/TP)*100=(340/400)*100=85% …...... (4)
Error Rate:
Error Rate=(TIP/TP)*100=(60/400)*100=15% ....…. (5)

Precision (for each gesture): Precision is the number of true positives divided by the number of true positives plus false positives.

Precision= (true_postive/ True_postive+false_postitive)*100 (6)

Precision for each gesture is calculated by using Eq.6.
Left Click: Precision_LC= (80/ (80+0))*100=100
Right Click: Precision_RC= (70/ (70+0))*100=100
Mouse Movement: Precision_MM= (100/ (100+0))*100= 100
No Movement: PrecisionNo = (90/ (90+10))*100=90%

As discussed above the Accuracy of the proposed system in Mouse mode 85%, Error rate is 15 % and precision for all the mouse click operations are 100% except No Movement operation which has 90% precision.

Presentation Mode

Similarly, Table 2 shows the performance analysis for presentation mode. The presentation mode is used performs slide change operation to move to next slide or previous slide, or no movement.

Table 2: Performance analysis of Presentation Mode.

Confusion Matrix	ns	ps	Nm	TME
ns	90	0	10	100
ps	0	80	20	100
nm	0	0	100	100

Source: Authors, (2024).

Where, ns =next slide
ps =previous slide
nm =no slide movement
TME = total movement executed
TM_ps= total movement executed to perform previous Slide operation
TM_ns = total movement executed to perform next slide operation
TM_no= total movement executed to perform no operation

Total Correct Predictions (TCP), gives the total number of correct slide change operations and it is evaluated by using Equation7.

TCP=ns+ps+nm = 90+80+100= 270…....… (7)

Total Predictions (TP) is the total number of prediction done in presentation mode to all presentation mode operations as given in Equation 8.
TP= TM_ps +TM_ns+TM_nm = 100+100+100=300............. (8)

Total Incorrect Predictions (TIP) is the difference between total predictions and total correctly identified predictions as given in equation 9.
TIP=TP-TCP = 300-270=30 ....….….….. (9)
The accuracy of the presentation mode is calculated using Equation 4, while the error rate is determined using Equation 5.

Accuracy= (TCP/TP)*100 = (270/300)*100= 90 %
Error Rate= (TIP/ TP)*100 = (30/300)*100= 10%

Precision for each presentation mode gesture is measure using equation 6.

Next Slide: Precision_ns = (90/90+0)*100=100
Previous Slide: Precision_ps = (80/80+0)*100=100 %
No Movement: Precision_nm= (100/100+0)/100= 100 %

As discussed in above section the Accuracy of the proposed system in presentation mode 90%, Error rate is 10 % and precision for all the slide change operations are 100%.

Comparison between Control-Wave Vs existing systems:

As discussed in section I.3, there are a few existing systems currently available in both online and offline markets. The detail comparison is explained in Table 3 below.

Table 3: Comparison between Control-Wave Vs existing systems.

Name of the System	Range (in meters)	Power Consumption	Purpose	Price (₹)
Microsoft Kinect [24]	1.2 -3.5	2.25 W	Motion controller e.g. Play station	2990 and above
Leap Motion [25]	0.6	USB 2.0	AR/VR Gaming	18350
Wireless Presentors [26]	10-15	2 AAA battries	PPT control and lasor pointer	1400-2600
Control-Wave	Upto 50	ESP 32 Blue-Tooth Module	Mouse Click and PPT Slide Changer	1013-1200

Source: Authors, (2024).

The Above Table 3 summarize that the range of proposed work is higher than all other existing technology due to the use of ESP 32 Bluetooth module. The cost of proposed system is not more than 1300 ₹ whereas, all other existing systems cost is more than 1300 ₹.

Overall, research work emerged as a standout solution for teaching professionals seeking a user-friendly, comfortable, and reliable mechanism for daily use in classroom settings. Its superior ease of use, extended distance coverage, and consistent performance in diverse environments set it apart from existing products, making it a valuable tool for enhancing the teaching experience.

V. CONCULSION AND FUTURE SCOPE

In conclusion, the proposed research work presents a groundbreaking solution to the persistent challenges encountered by the teaching professionals in educational environments. By leveraging advanced gesture recognition technology, it offers a transformative approach to navigating digital content during lectures. Its hands-free operation allows professors to maintain uninterrupted engagement with their students while effortlessly managing presentations and interactive materials. The customizable nature of the proposed work ensures adaptability to individual teaching styles and preferences, fostering a more personalized and dynamic classroom experience.

Furthermore, its ergonomic design prioritizes user comfort and convenience, mitigating physical strain and fatigue associated with traditional input methods. Its seamless integration with existing devices and software streamlines implementation, enabling quick adoption without disruption to established workflows. Moreover, the project's commitment to accessibility ensures that it is inclusive to users of varying technical proficiency and physical abilities. Overall, the proposed research work represents a significant advancement in educational technology, promising to enhance teaching efficiency, student engagement, and overall learning outcomes with 85% accuracy and 15% Error rate in mouse mode and 90% accuracy with 10% Error rate in presentation mode, along with 100% precision in both the modes. By providing professors with a powerful tool to facilitate seamless interaction with digital content, it paves the way for a more immersive, interactive, and effective educational experience in classrooms worldwide.

The future research work can be extended by incorporating machine learning algorithm for to continually improve gesture recognition accuracy and adaptability. Along with exploring opportunities for integrating Control-Wave with existing educational tools and platforms commonly used in classrooms. This could involve partnerships with software providers to develop seamless integrations, enabling enhanced functionality and interoperability for professors.

VI. AUTHOR'S CONTRIBUTION

Conceptualization: Dr. Yogita Mane, Dr. Neeta Patil and Akshay Agrawal
Methodology: Dr. Yogita Mane, Dr. Neeta Patil.
Investigation: Dr. Yogita Mane, Akshay Agrawal.
Discussion of results: Dr. Yogita Mane, Dr. Neeta Patil and Akshay Agrawal.
Writing – Original Draft: Dr. Yogita Mane. Akshay Agrawal.
Writing – Review and Editing: Dr. Neeta Patil.
Resources: Akshay Agrawal.
Supervision: Dr. Yogita Mane, Dr. Neeta Patil.
Approval of the final text: Dr. Yogita Mane, Dr. Neeta Patil and Akshay Agrawal.

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