AI-Assisted Eye-Controlled Human–Computer Interaction and IoT-Based Home Automation for People with Disabilities and Paralysis

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Abstract—People with severe motor disabilities and paralysis often face difficulties in operating conventional computers and communicating independently. This research presents an artificial intelligence-assisted eye-controlled human-computer interaction system that provides an alternative input mechanism using eye movement, slight head movement, and intentional blinking. A computer vision module using the built-in laptop webcam and OpenCV with MediaPipe Face Mesh detects iris movement and slight head movement and translates the detected movements into mouse cursor movement, while a blink sensor connected to an Arduino enables hands-free selection. The system incorporates a virtual keyboard with predictive word and sentence assistance to reduce the effort required for eye-based typing. A text-to-speech facility converts typed messages into audible speech. Emergency short message service alerts, caretaker calling, and a local buzzer-based emergency alert are integrated to provide additional assistance. An ESP8266-based home automation interface enables users to control appliances such as lights, fans, and windows. The proposed system was developed as a low-cost prototype integrating assistive communication, computer interaction, emergency assistance, and environmental control into a unified platform for individuals with motor disabilities.

Index Terms—Assistive technology, eye tracking, home automation, human-computer interaction.

I. LITERATURE REVIEW

People with severe motor disabilities and paralysis may experience significant difficulty while operating conventional computers and household devices. Standard input devices such as keyboards, mice, touchscreens, and physical switches generally require hand or body movement. For individuals with severe motor limitations, these conventional interaction methods may not always be accessible. This can affect their ability to communicate, operate computers, request emergency assistance, and independently control their surrounding environment. As a result, assistive human-computer interaction technologies are important for providing alternative methods of interaction and reducing dependence on caregivers or family members.

Assistive technologies based on eye movement provide an alternative approach for users who retain controlled eye movement but have limited control over their hands and other body movements. Eye movement can be used as an input mechanism because it does not require physical contact with a conventional input device. However, an assistive system intended for practical use should not only provide cursor movement but should also support selection, communication, emergency assistance, and control of the user's surrounding environment. Integrating these functions into a single platform can reduce the need for users to operate multiple independent systems. Previous studies have also investigated eye-gaze tracking and hands-free cursor control systems to assist people with motor disabilities [2]– [5]. Head-movement-based cursor control techniques have been explored as an additional input mechanism for assistive computer interaction [6]. Recent research has further demonstrated the use of eye-tracking technologies for assistive systems and accessible human-computer interaction [8], [9].

An eye-controlled computer project published by Electronics for You demonstrates the concept of controlling a personal computer using eye-related movements and blinking. This demonstrates the feasibility of using eye-based interaction as an alternative to conventional computer input [1]. The present work takes inspiration from this basic concept and extends it into a broader assistive platform. The additional functionalities presented in this work, including intentional blink-based selection, communication assistance, emergency mechanisms, and Internet of Things-based home automation, are integrated as part of the developed system.

The proposed system uses the built-in webcam of a laptop to capture the user's facial information. Computer vision techniques are applied to identify relevant eye and facial landmarks. The detected eye movement and slight head movement are translated into cursor movement, allowing the user to control the computer without physically operating a mouse. While eye and head movements are used for cursor navigation, intentional blinking is used as the primary selection and clicking mechanism. An eye blink sensor attached to spectacles provides the intentional blink input and is connected to an Arduino-based control mechanism.

Communication is another important aspect of the system. A virtual keyboard allows the user to enter text through eye-controlled cursor movement and intentional blinking. However, selecting individual characters can require considerable time and effort during prolonged interaction. To address this issue, word and sentence prediction is incorporated to reduce the number of selections required for constructing messages. The user can select suitable words or sentences instead of entering every character individually. Once a message is completed, the text-to-speech facility converts the generated text into audible speech, providing an alternative communication method for users who may have difficulty communicating verbally.

The system also incorporates multiple mechanisms for emergency assistance. The user can send an emergency short message service notification or initiate a caretaker call when assistance is required. However, phone-based communication may not always immediately attract the caretaker's attention. For example, the caretaker's phone may be switched off, in silent mode, unavailable, or physically away from the caretaker. To address this limitation, a dedicated emergency button with a buzzer is included as a local backup mechanism. When activated by the user, the buzzer produces an audible alert that can attract the attention of family members or other people located near the user's room. This provides an additional layer of emergency support when remote communication does not produce an immediate response.

In addition to computer interaction and communication, independent control of the surrounding environment is an important requirement for users with severe motor disabilities. Therefore, eye-tracking interfaces have also been applied to smart-home and Internet of Things environments [7]. The proposed system provides home automation using an ESP8266-based module. The home automation component allows the user to control selected household devices without physically reaching their switches. In the developed prototype, the system provides control of a light, fan, and window. The light is controlled using a relay-based mechanism, while DC motors and a motor driver are used for the fan and window mechanisms.

A major objective of the developed system is to bring these functions together rather than treating computer control, communication, emergency assistance, and home automation as separate systems. The integration allows the same user interface and input mechanisms to be used for different assistive tasks. This can simplify interaction for users and potentially reduce their dependence on physical assistance. The system is also developed as a prototype using commonly available hardware and software components, making the overall approach suitable for further experimentation and development.

The work therefore focuses on the integration of eye-controlled cursor movement, slight head movement, intentional blink-based selection, predictive text entry, text-to-speech communication, emergency assistance, and IoT-based home automation into a unified assistive platform. The developed prototype demonstrates how computer vision, human-computer interaction, embedded systems, and Internet of Things technologies can be combined to address multiple challenges faced by people with severe motor disabilities and paralysis.

The main contribution of this work is the development of an integrated assistive platform in which eye and slight head movements provide navigation, intentional blinking provides selection, predictive communication reduces typing effort, emergency mechanisms provide both remote and local assistance, and IoT-based controls provide access to selected household devices. The system is intended to provide a more convenient and accessible method of interacting with computers and the surrounding environment, with the broader goal of supporting greater independence in daily activities.

II. RELATED WORK

Eye-controlled computer interaction provides an alternative method for people who are unable to operate conventional input devices. The Electronics for You project *Control PC Using Eyes* demonstrates a system based on eye-related interaction for controlling a personal computer. The project discusses eye movement and blinking as mechanisms for interacting with the computer. [1]

The proposed system takes the basic concept of eye-controlled computer interaction as an inspiration and extends it with several additional functions. The external source is used only as a reference for the basic concept of controlling a personal computer using eye interaction. The additional features presented in this work are part of the proposed system.

The proposed system introduces slight head movement for cursor control, along with intentional blinking for selection and clicking. It further integrates a virtual keyboard, predictive word and sentence assistance, text-to-speech communication, emergency short message service, caretaker calling, a local emergency buzzer, and Internet of Things-based home automation.

Therefore, the main focus of the proposed work is the integration of multiple assistive functions into a unified platform, rather than merely reproducing an eye-controlled mouse.

III. PROBLEM STATEMENT

People with severe motor disabilities and paralysis may be unable to operate conventional computer peripherals, communication devices, and household switches independently.

Existing basic computer-control approaches may provide an alternative input mechanism but may not address other important requirements such as communication, emergency assistance, and environmental control within the same system.

Therefore, there is a need for a low-cost and integrated assistive platform that enables a user to:

1. Operate a computer without using a conventional mouse;
2. Communicate through typed and spoken messages;
3. Request emergency assistance using multiple mechanisms; and
4. Control selected household appliances independently.

The proposed system addresses these requirements by integrating eye-controlled interaction, intentional blink-based selection, intelligent communication assistance, emergency alert mechanisms, and Internet of Things-based home automation.

IV. OBJECTIVES

The main objectives of the proposed system are:

1. To provide hands-free computer interaction using eye and slight head movement.
2. To use intentional blinking as a selection and clicking mechanism.
3. To provide a virtual keyboard for eye-controlled text entry.
4. To reduce typing effort using word and sentence prediction.
5. To provide text-to-speech functionality for audible communication.
6. To provide emergency short message service and caretaker calling.
7. To provide a local buzzer-based emergency alert.
8. To provide home automation for controlling lights, fans, and windows.
9. To integrate computer interaction, communication, emergency assistance, and home automation into a single assistive platform.

V. EXPERIMENTAL SETUP

The experimental setup consists of hardware and software components integrated to develop and test the proposed assistive system. The setup combines laptop-based computer vision, intentional blink detection, computer interaction, communication assistance, emergency alerting, and Internet of Things-based home automation. The major hardware and software components used in the prototype are described below.

A. Hardware Components

The hardware setup consists of an Arduino Uno, eye blink sensor, spectacles, breadboard, ESP8266, two-channel relay module, L293D motor driver, two DC motors, bulb, and plastic fan. The eye blink sensor is mounted on spectacles so that it can detect the user's intentional blinking during interaction. The sensor is connected to the Arduino Uno, which receives the sensor input and provides the required control signal.

The breadboard is used as an interconnection platform for the electronic components. An ESP8266 Wi-Fi module is used for the Internet of Things-based home automation functionality. A two-channel relay module is used for switching the connected light. The L293D motor driver is used to control the two DC motors. One motor is used for the window mechanism, while the other motor is connected to the plastic fan to provide rotational movement. Thus, the hardware setup enables control of the light, fan, and window.

The computer interaction component uses the built-in webcam of the laptop rather than a separate external webcam. The laptop webcam captures the user's facial information for eye and slight head movement detection.

B. Computer Vision and Cursor Control

The built-in laptop webcam continuously captures frames containing the user's face. OpenCV is used for image-processing operations [15], while MediaPipe Face Mesh provides facial landmark information [14]. Relevant eye landmarks are analysed to determine iris movement, while facial landmarks are used to determine slight head movement. The detected eye and head movements are mapped to screen coordinates and converted into mouse cursor movement, allowing hands-free navigation of the computer interface.

C. Intentional Blink Detection

An eye blink sensor attached to spectacles is used to detect intentional blinking. The sensor is connected to the Arduino Uno and provides the required input when the user performs an intentional blink. The detected signal is interpreted as a selection or clicking command, allowing the user to select virtual keyboard characters, buttons, and other interface elements without physically operating a conventional mouse.

D. Virtual Keyboard and Communication

A virtual keyboard is implemented on the computer to enable text entry through eye-controlled cursor movement and intentional blinking. Eye-gaze-based virtual keyboards have been widely investigated as communication tools for users with severe speech and motor impairments [10], [11]. The user moves the cursor to the required character using eye and slight head movement and selects the character using an intentional blink. To reduce the effort involved in selecting individual characters, the system incorporates word and sentence prediction. The user can select an appropriate predicted word or sentence using the same intentional blink mechanism. Prediction-assisted virtual keyboards can significantly reduce the number of selections required during text entry and improve communication efficiency [12]. Research on eye typing has also highlighted the importance of prediction techniques for improving typing speed and usability in gaze-based communication systems [13].

After completing a message, the text-to-speech module converts the generated text into audible speech. This provides an alternative communication method for users who may have difficulty communicating through conventional speech or physical typing.

E. Emergency Assistance Setup

The emergency functionality consists of emergency SMS, caretaker calling, and a local emergency buzzer. The emergency SMS function allows the user to send an emergency notification to the designated caretaker, while the caretaker calling function enables direct communication when assistance is required.

In addition, a dedicated emergency button and buzzer are incorporated as a local backup mechanism. When the user activates the emergency button, the buzzer produces an audible alert. This can attract the attention of family members or other people near the user's room when the caretaker's phone is switched off, in silent mode, unavailable, or does not immediately attract attention.

F. IoT-Based Home Automation Setup

The home automation setup uses an ESP8266 to provide wireless connectivity and control the connected household devices. The prototype includes three controllable devices: light, fan, and window. The light is controlled through the two-channel relay module, while the two DC motors are controlled through the L293D motor driver. One motor operates the window mechanism and the other drives the plastic fan.

The user accesses the home automation interface through the assistive computer system and selects the required command using eye movement, slight head movement, and intentional blinking. The corresponding control command is transmitted to the ESP8266, which operates the selected device.

G. Software Environment

The software component of the experimental setup consists of the computer vision and interaction modules required for eye-controlled computer operation. Python is used for implementing the computer vision and control functionality. OpenCV is used for image processing, and MediaPipe Face Mesh is used for facial and eye landmark detection. Additional software components implement cursor control, the virtual keyboard, word and sentence prediction, text-to-speech functionality, emergency features, and the home automation interface.

H. Integrated Experimental Setup

The complete experimental setup integrates the laptop-based computer vision system with the Arduino-based intentional blink input and ESP8266-based home automation hardware. The user interacts with the computer through eye movement and slight head movement for cursor navigation and intentional blinking for selection. The same interaction mechanism is used to access the virtual keyboard, communication functions, emergency options, and home automation controls. The hardware arrangement and major component relationships are illustrated in Fig. 1.

VI. SYSTEM ARCHITECTURE

The overall architecture of the proposed system is illustrated in Fig. 1.

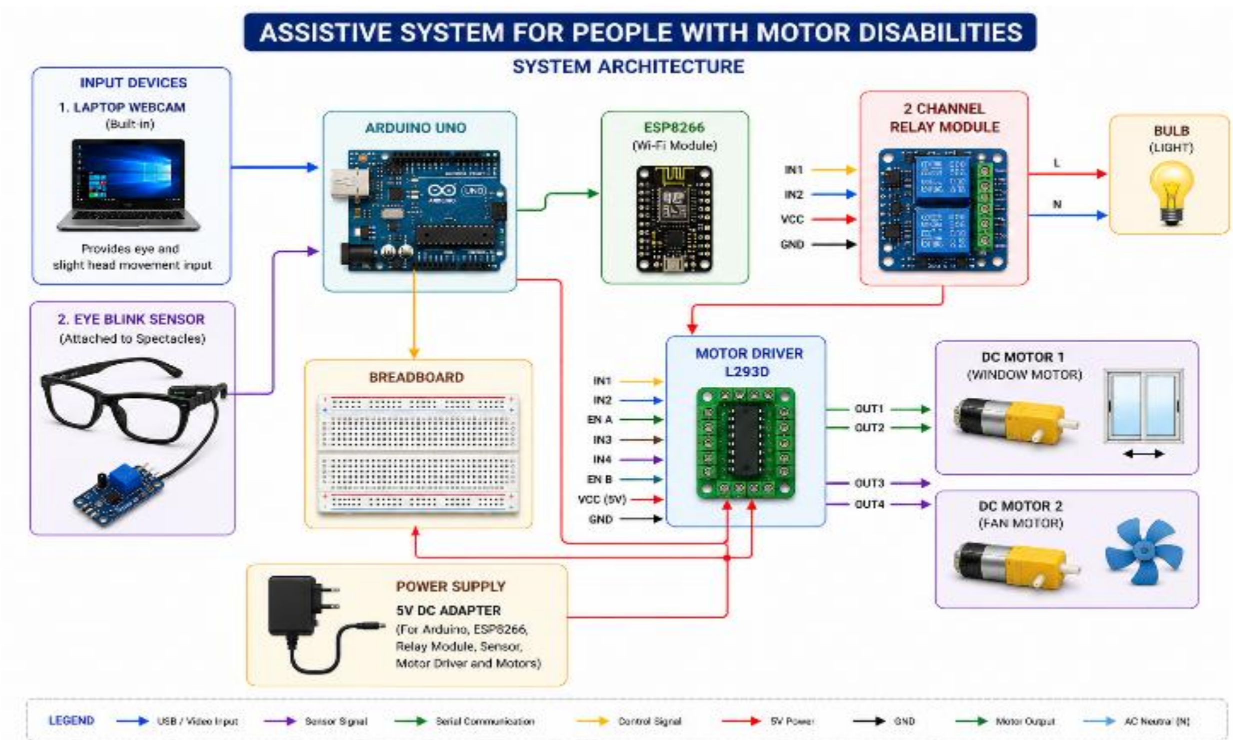

Figure 1. Block diagram of the proposed assistive system

The system integrates the laptop-based eye and slight head movement interface with an intentional blink sensor and an Internet of Things-based home automation setup. The major hardware components include the built-in laptop webcam, eye blink sensor attached to spectacles, Arduino Uno, breadboard,

ESP8266, two-channel relay module, L293D motor driver, two DC motors, and a bulb.
The built-in laptop webcam captures the user's eye and slight head movements. These movements are processed by the computer-based eye-control system to enable cursor movement and hands-free interaction. For selection and clicking, an eye blink sensor attached to spectacles is used to detect the user's intentional blink. The sensor is connected to the Arduino Uno, which receives the blink signal and provides the required control input. The Arduino is also connected to the breadboard, which serves as an interconnection platform for the hardware components.

For home automation, the ESP8266 provides the required wireless connectivity and communicates with the control system. A two-channel relay module is used for switching the connected electrical appliance, with the current prototype controlling the bulb (light) through the relay. The relay is therefore used for appliance switching and is not connected to the plastic fan.
The L293D motor driver is used to control the two DC motors. The first DC motor is connected to the window mechanism and is used for window movement, while the second DC motor is connected to the plastic fan and provides the fan's rotational movement. Thus, the motor driver enables control of both the window and fan motors.
As shown in Fig. 1, these components are interconnected to form the hardware architecture of the assistive system. The architecture provides the required foundation for eye-controlled computer interaction, intentional blink-based selection, and IoT-based control of the light, fan, and window. The figure represents the major hardware components and their interconnections, while the detailed sequence of operation is described separately in the System Workflow section.

VII. SYSTEM WORKFLOW

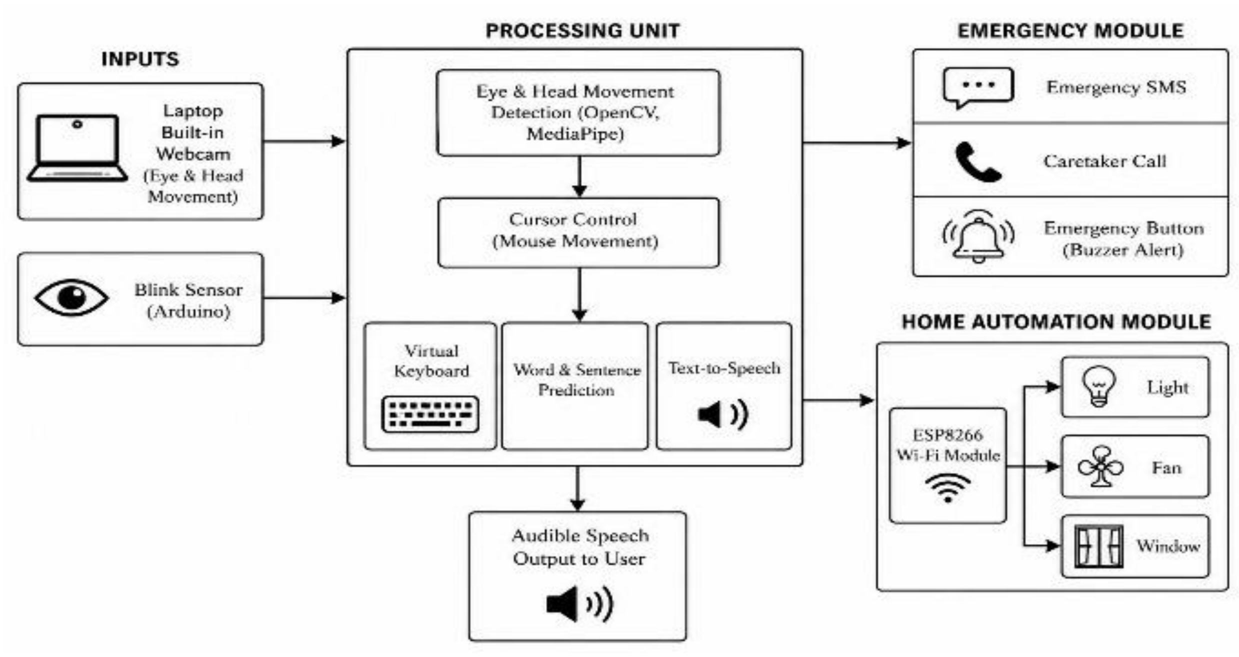

Figure 2. Workflow of the proposed assistive system

The workflow begins when the built-in laptop webcam captures the user's face. The captured frames are processed using OpenCV and MediaPipe Face Mesh to identify facial landmarks and relevant eye information. The system then determines the user's eye movement and slight head movement. These movements are mapped to screen coordinates and translated into mouse cursor movement.

When the user wants to select an option, an intentional blink is performed. The blink sensor detects the intentional blink and sends the corresponding signal through the Arduino. The signal is interpreted as a selection or mouse-click command. The user can therefore move the cursor to a required character on the virtual keyboard using eye and slight head movement and select the character using an intentional blink. The entered text is processed by the word and sentence prediction component. Suitable suggestions are displayed to reduce the number of selections required during communication. After completing the message, the user can select the text-to-speech option through an intentional blink. The system then converts the text into audible speech.

If the user requires emergency assistance, the emergency options can be activated. The system can send an emergency SMS or initiate a caretaker call. If the caretaker does not respond because the phone is switched off, silent, unavailable, or otherwise unable to attract attention, the user can press the emergency button to activate the buzzer. The buzzer alerts family members or other people located near the user's room. For environmental control, the user selects the required appliance command through the same interface. The command is transmitted to the ESP8266, which controls the connected light, fan, or window.

Thus, Fig. 2 represents the sequential flow of user input, processing, computer interaction, communication, emergency assistance, and home automation in the proposed system.

VIII. IMPLEMENTATION

A. Built-in Laptop Webcam-Based Computer Vision

The built-in webcam of the laptop continuously captures frames containing the user's face. The captured frames are processed using OpenCV for image-processing operations, while MediaPipe Face Mesh is used to obtain facial landmark information. The relevant eye landmarks are analyzed to determine iris movement, while facial landmark information is used to detect slight head movement. The detected eye and head movements are then mapped to screen coordinates and converted into mouse cursor movement, enabling hands-free navigation of the computer interface.

B. Cursor Control

The detected eye and head movement is mapped to the computer screen. Horizontal movement is used to control horizontal cursor movement, while vertical movement is used to control vertical cursor movement. The system therefore allows the user to navigate the computer interface without physically moving a mouse.

C. Intentional Blink Detection

The blink sensor is connected to an Arduino. The system is designed to respond to an intentional blink rather than treating every normal blink as a selection command. When the intended blink action is detected, the Arduino generates the corresponding signal. The computer interprets this signal as a selection or mouse-click action. This mechanism allows the user to interact with virtual keyboard keys and other graphical interface elements.

D. Virtual Keyboard

The virtual keyboard contains selectable characters and interface controls. The user moves the cursor to the required character using eye and slight head movement. The character is selected by performing an intentional blink. The prediction mechanism then provides possible words or sentences to reduce further typing effort.

E. Text-to-Speech

The completed text is passed to the text-to-speech module. When the user selects the speak option, the generated message is converted into audible speech. This provides an alternative communication method for users who may have difficulty communicating verbally.

F. Emergency Module

The emergency subsystem contains remote and local alert mechanisms. The remote mechanisms consist of emergency SMS and caretaker calling. The local mechanism consists of a dedicated emergency button connected to a buzzer. When the emergency button is pressed, the buzzer is activated. The purpose of the buzzer is to attract the attention of people who are physically near the user's room. This provides an additional emergency mechanism when remote phone-based communication does not immediately receive a response.

G. Home Automation Module

The home automation module uses an ESP8266 controller. The controller receives commands from the assistive interface and operates the connected appliances.

The prototype includes:
ESP8266 → Light
ESP8266 → Fan
ESP8266 → Window
This allows the user to control selected household devices without physically reaching their switches.

IX. RESULTS AND DISCUSSION

The developed prototype demonstrates the integration of hands-free computer interaction, communication assistance, emergency alerting, and home automation into a unified assistive platform. The complete operation of the developed system is illustrated in Fig. 3 through an AI-generated step-by-step representation. The figure presents the overall sequence of interaction, beginning with the use of the eye blink sensor spectacles and continuing through eye and head movement-based cursor control, intentional blink-based selection, virtual keyboard interaction, text-to-speech communication, emergency assistance, and home automation.
The AI-generated representation in Fig. 3 provides a visual overview of how the different functions of the developed system are accessed through a common interaction mechanism. The user first wears the spectacles equipped with the eye blink sensor.

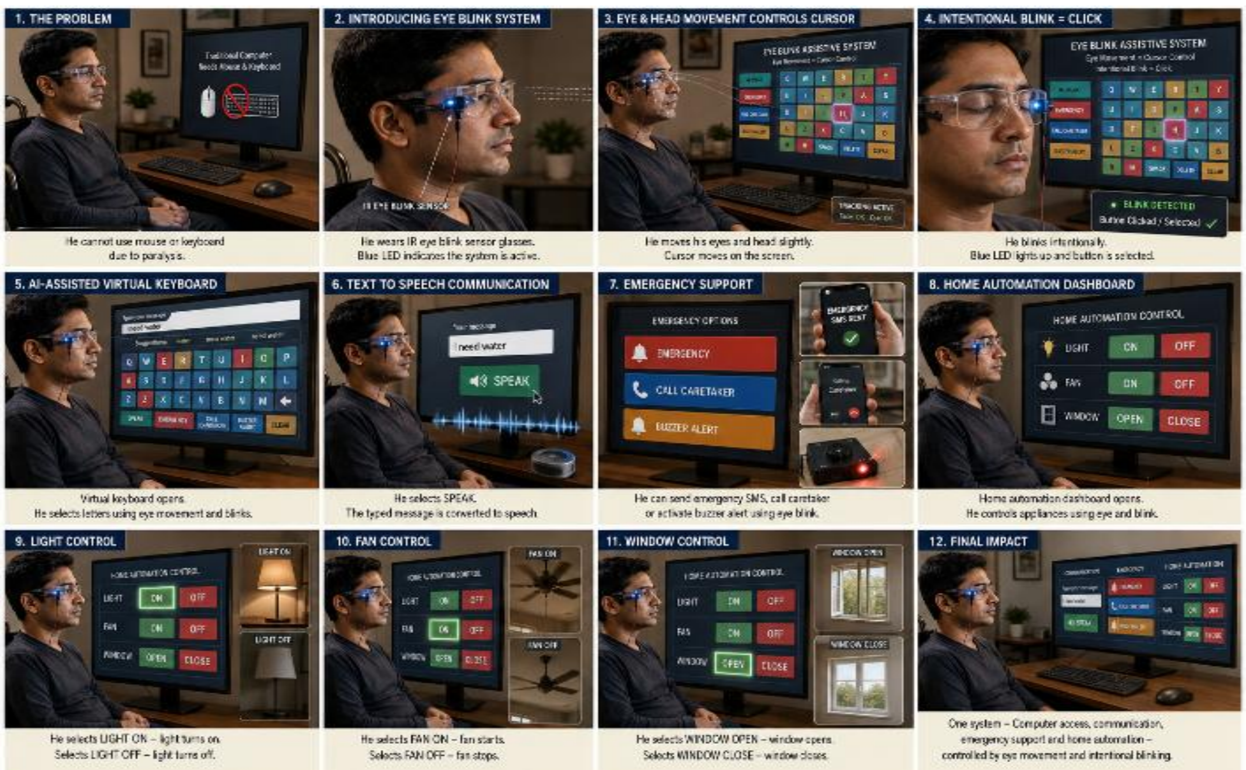

Figure 3. AI-generated visual representation of the complete step-by-step operation of the developed assistive system

The built-in laptop webcam captures the user's facial information, and the system uses eye movement and slight head movement for cursor navigation. An intentional blink is then used to select a character, button, or other interface element. The figure further illustrates the use of the virtual keyboard, text-to-speech communication, emergency SMS, caretaker calling, buzzer alert, and home automation functions.

The computer interaction component uses the built-in laptop webcam to capture the user's facial information. The eye-tracking component identifies the user's iris position and uses the detected eye movement for cursor control. An example of the detected iris position, represented by a green marker on the eye, is shown in Fig. 4. The system also incorporates slight head movement to support cursor navigation.

Intentional blinking is used as the selection mechanism, allowing the user to select virtual keyboard characters and other interface elements without using a conventional mouse.

Figure 4. Iris detection using the built-in laptop webcam.

The communication interface provides a virtual keyboard for text entry using eye-controlled cursor movement and intentional blinking. The keyboard includes alphabetic characters along with space, delete, and clear functions. The interface also provides options for speech output and emergency assistance. The developed virtual keyboard interface is shown in Fig. 5. Word and sentence prediction further assists the user by reducing the number of individual character selections required during message construction. The completed text can be converted into audible speech using the text-to-speech function.

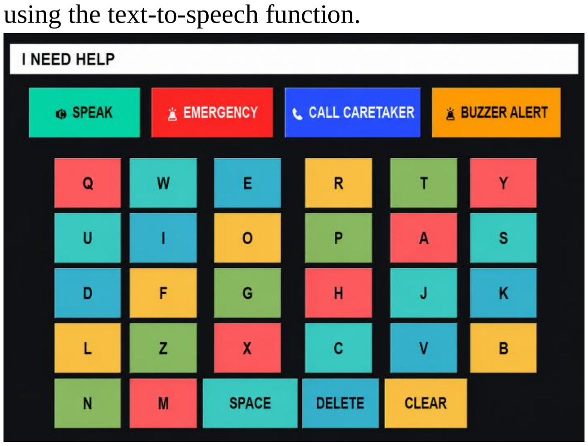

Figure 5. Virtual keyboard interface for eye-controlled text entry.

The system also provides multiple mechanisms for emergency assistance. The interface includes options for emergency notification and caretaker calling, while the dedicated emergency button activates a local buzzer. The buzzer serves as an additional alert mechanism when phone-based communication does not immediately attract the caretaker's attention, such as when the caretaker's phone is switched off, silent, unavailable, or physically away from the caretaker. This provides an additional local means of attracting the attention of family members or other people nearby.

The home automation component extends the functionality of the system beyond computer interaction. The developed dashboard provides control options for light, fan, and window, as shown in Fig. 6. The user can select the required appliance command through the same assistive interface. The light can be switched ON or OFF, the fan can be switched ON or OFF, and the window can be opened or closed. This interface provides a convenient method of controlling selected household devices without requiring the user to physically operate conventional switches.

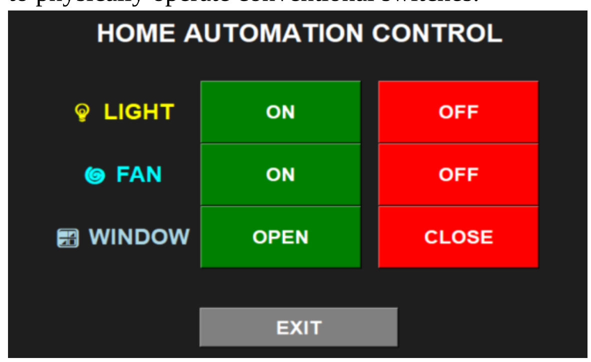

Figure 6. Home automation dashboard for controlling light, fan, and window.

Overall, the developed prototype demonstrates the feasibility of combining eye-controlled cursor movement, slight head movement, intentional blink-based selection, virtual keyboard interaction, communication assistance, emergency alerting, and IoT-based home automation within a single assistive platform. The results demonstrate the functional operation of the major system components and interfaces. However, broader testing with users having different levels and types of motor impairment would be required to evaluate the system's usability, reliability, comfort, and practical effectiveness in real-world conditions.

X. ADVANTAGES

The proposed system provides several advantages for people with severe motor disabilities and paralysis by combining multiple assistive functions into a single platform. It enables hands-free computer interaction through eye and slight head movement, allowing users to control the cursor without physically operating a conventional mouse. The use of intentional blink-based selection provides an additional input mechanism through which users can select virtual keyboard keys, buttons, and other interface elements. The virtual keyboard enables text entry, while word and sentence prediction reduce the number of selections required and consequently decreases the effort involved in eye-based typing. The integrated text-to-speech facility converts typed messages into audible speech, providing an alternative means of communication for users who may have difficulty communicating verbally. The system also offers multiple emergency assistance mechanisms, including emergency SMS, caretaker calling, and a local emergency buzzer. The buzzer acts as an additional safety mechanism when the caretaker's phone is switched off, silent, unavailable, or does not immediately attract attention. Furthermore, the Internet of Things-based home automation module enables users to control lights, fans, and windows without physically reaching the corresponding switches. By integrating computer interaction, communication, emergency assistance, and environmental control using commonly available hardware and software components, the proposed system can reduce dependence on others and potentially provide greater independence and convenience to people with severe motor disabilities.

XI. LIMITATIONS

The proposed system has certain limitations that may affect its usability and reliability in practical situations. The webcam-based eye-control mechanism can be influenced by lighting conditions, camera position, user distance, and facial orientation, which may affect the accuracy of cursor movement. Continuous eye-based interaction may also cause visual fatigue during prolonged use. The intentional blink detection mechanism may require individual calibration to distinguish intentional blinks from natural blinking. The word and sentence prediction component may not always provide the desired suggestion and may require further improvement to support different communication patterns. The emergency SMS and caretaker calling functions depend on network and communication availability, while the local buzzer can provide an alternative alert only when another person is within an audible range. The home automation module is currently limited to the devices connected to the prototype, namely the light, fan, and window. Furthermore, the system requires additional testing with users having different types and levels of motor disabilities to evaluate its practical usability and reliability.

XII. FUTURE SCOPE

The proposed system has significant scope for further development and improvement. Personalized calibration can be introduced to automatically adjust cursor sensitivity, eye movement ranges, and intentional blink detection according to the individual user's abilities and interaction patterns. The word and sentence prediction module can be enhanced using advanced natural language processing and personalized language models to provide more accurate and context-aware suggestions, thereby reducing the effort required for communication. The eye-tracking mechanism can also be improved to provide more accurate and stable cursor control under different lighting conditions and user positions.

The emergency subsystem can be further enhanced by incorporating multiple buzzers, visual indicators, battery backup, and additional notification mechanisms to improve reliability during critical situations. The home automation module can be expanded beyond the current light, fan, and window controls to include additional household appliances, environmental sensors, and automated safety features. Future versions may also integrate a mobile application, individual user profiles, remote monitoring, and caregiver dashboards, allowing caretakers to monitor system status and receive important notifications remotely. Voice feedback and customizable interface layouts could also be introduced to improve accessibility and personalization.

Finally, the system can be tested with a larger group of users having different levels and types of motor disabilities to evaluate usability, comfort, accuracy, reliability, and long-term effectiveness. These improvements could help transform the prototype into a more robust, personalized, and practical assistive technology platform for independent living.

XIII. CONCLUSION

This paper presents an integrated assistive platform designed for people with severe motor disabilities and paralysis. The system provides hands-free computer interaction using eye movement, slight head movement, and intentional blinking.

The eye and head movement mechanism enables cursor control, while the intentional blink mechanism provides selection and clicking functionality. A virtual keyboard with word and sentence prediction is provided to reduce the effort associated with eye-based typing. The text-to-speech facility allows generated messages to be converted into audible speech.

The emergency subsystem provides emergency SMS, caretaker calling, and a local buzzer-based emergency alert. The buzzer acts as an additional safety mechanism when phone-based emergency communication may not immediately attract the caretaker's attention.

The ESP8266-based home automation subsystem further extends the system by allowing the user to control a light, fan, and window through the same assistive interface.

The main contribution of the proposed work is the integration of computer interaction, communication, emergency assistance, and environmental control into a unified low-cost assistive platform. The prototype demonstrates the potential of combining computer vision, intelligent interaction, embedded systems, and Internet of Things technologies to support greater independence for people with motor disabilities.

Further testing with target users and quantitative evaluation will be required to establish the accuracy, reliability, usability, and practical effectiveness of the complete system.

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