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Morse Code-Based Assistive Communication System for Individuals with Partial Paralysis

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Abstract: Individuals with partial paralysis often face challenges in communication due to limited mobility. This project presents a Morse code-based assistive communication system that enables users to convey messages using a six-button interface. The system processes Morse inputs in real-time, providing predictive text suggestions on an OLED display, which can be selected with minimal effort. Once a word or phrase is confirmed, the text is converted into speech using a Bluetooth-enabled audio device such as a speaker or headset. By offering an intuitive and efficient communication aid, this system enhances accessibility and independence for individuals with mobility impairments, ensuring smoother and more effective interaction in daily life.

Keywords: Assistive Communication, Morse Code, Accessibility, Predictive Text, Speech Output, Human-Computer Interaction.

I. INTRODUCTION

Communication is a fundamental aspect of human life, enabling individuals to express thoughts, emotions, and needs. However, individuals with partial paralysis, caused by conditions such as strokes, spinal cord injuries, or neurological disorders, face significant communication barriers, often leaving them dependent on caregivers or complex assistive devices. Existing assistive communication technologies are often expensive, complex, or require extensive learning, making them inaccessible to many users. Morse code, a time-tested communication method, offers a simple and effective alternative that requires minimal physical effort. This project aims to develop a Morse code-based communication system that enables individuals with limited mobility to express themselves efficiently and independently. The system translates physical inputs, such as button presses or eye blinks, into Morse code, which is then converted into text or synthesized speech, ensuring seamless communication in everyday life.

II. LITERATURE REVIEW

Bera (2021) proposed a real-time gesture detection system using OpenCV, TensorFlow API, and Google Protobuf. The system captures hand gestures from a webcam feed and translates them into corresponding meanings with an accuracy percentage. This research aimed to enhance gesture recognition efficiency and improve communication for individuals relying on sign language. However, the study primarily focused on static gestures, leaving room for improvements in dynamic gesture recognition.. [1]

Negi (2022) explored AI-based gesture detection using image processing techniques in C++ and OpenCV. The system was designed to detect hand movements in real-time without requiring a solid background, leveraging signal processing methods to reduce noise. While this approach enhanced human-robot interaction, it required advanced sensor data for improved accuracy, which could be a limitation in resource-constrained environments. [2]

Patil (2022) conducted a survey on gesture-controlled systems using OpenCV and Python, emphasizing their significance in artificial intelligence and human-computer interaction (HCI). The study outlined an approach for capturing, pre-processing, and mapping hand gestures to specific actions, improving machine usability through non-verbal communication. However, it primarily focused on Python-based implementations, limiting its applicability to other platforms and hardware configurations. [3]

Mary (2024) investigated hand gesture recognition using MediaPipe and OpenCV for Business 4.0 applications in HCI. The research developed a system that translates gestures into commands without requiring physical input devices. MediaPipe's pre-trained models extracted gesture features, enabling real-time responses. While the study highlighted gesture recognition's potential in accessibility and gaming, it did not extensively address challenges related to gesture misinterpretation in different lighting conditions.[4]

Sankar (2024) presented a machine learning-based system for real-time fingerspelling recognition in American Sign Language (ASL). The system employed preprocessing techniques to filter hand gestures and classified them using a neural network, achieving an accuracy of 95.7%. While the study significantly contributed to assistive technology, it focused solely on ASL fingerspelling, limiting its generalizability to broader gesture-based communication systems. [5]

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III. PROPOSED METHODOLOGY

This project introduces a Morse code-based assistive communication system developed for individuals with partial paralysis, utilizing the Raspberry Pi Zero 2W as the central controller. The system enables communication through Morse code using a six-button interface. Of these buttons, two are designated for Morse code input (dot and dash), while the remaining four buttons assist with navigation, backspace, and selection confirmation.

Once Morse code input is provided, the system displays text suggestions on an OLED screen. These suggestions allow users to select commonly used words or phrases with minimal effort, enhancing communication efficiency. For example, if the input corresponds to the letter "W", the system may offer words like "water" or "washroom" as quick selection options. Users can navigate through these suggestions and confirm their selection using the dedicated navigation and confirmation buttons.

After the user selects or completes the desired text, the system converts the input into speech using a Bluetooth-enabled audio device, such as a speaker, Air Pods, or headband. This feature ensures seamless verbal communication, enhancing interaction with caregivers and others in the user's environment. It significantly improves the quality of life for individuals with severe mobility impairments by providing a faster and more effective means of communication.

The Raspberry Pi Zero 2W serves as the processing unit, handling the interpretation of Morse code, providing predictive text suggestions, and managing the real-time communication flow. Furthermore, the system is designed to be highly customizable, allowing users to modify the interface and input methods according to their individual needs. It also provides a simple calibration process, making it adaptable for various levels of motor ability and user preferences.

By emphasizing accessibility, ease of use, and reliability, the proposed methodology offers an intuitive and efficient solution for individuals with disabilities. The integration of Morse code input, predictive text, and speech synthesis using Google TTS presents an innovative approach to assistive technology, empowering users to gain greater independence and significantly reducing communication barriers. Additionally, the system is designed for easy maintenance, with regular software updates to improve functionality and introduce new features based on user feedback, ensuring its long-term relevance and usability.

IV. BLOCK DIAGRAM

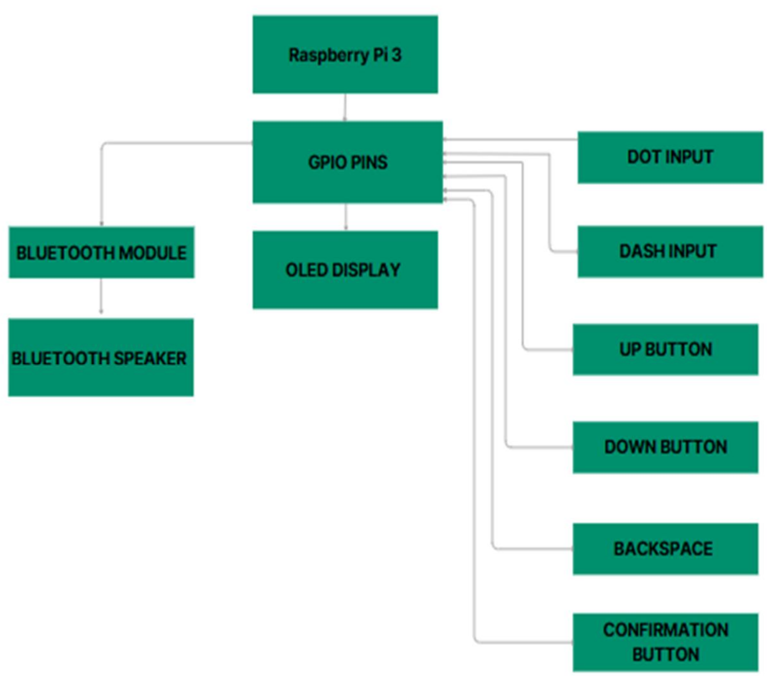

Fig 1. Block diagram of the system

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V. FLOWCHART

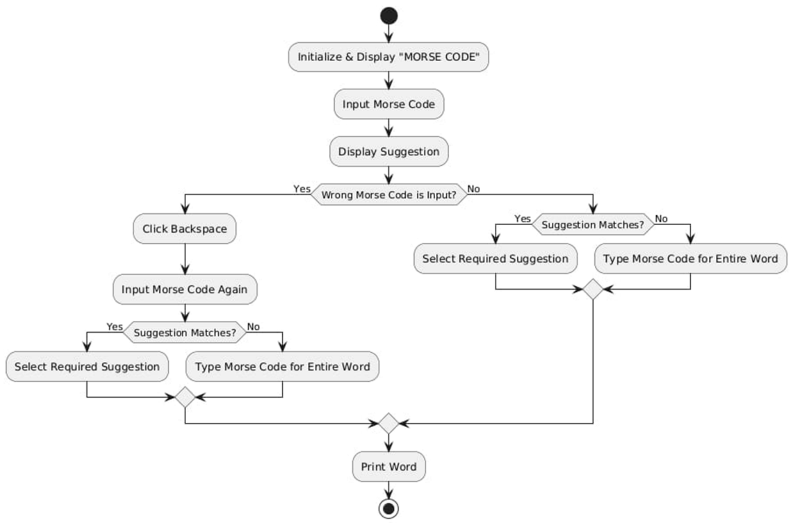

Fig 2. Flowchart of the system

The overall working of the system is as follows:

1) Raspberry Pi Zero 2W

The Raspberry Pi Zero 2W serves as the central processing unit, handling Morse code interpretation, predictive text generation, and real-time communication processing. It efficiently processes user input, executes text-to-speech conversion via Google TTS, and manages Bluetooth audio transmission. Additionally, it integrates real-time health monitoring features, continuously tracking the user's well-being and triggering alerts in case of abnormalities. The Raspberry Pi Zero 2W ensures seamless system operation, providing users with an intuitive and accessible communication experience.

2) Input Buttons

The system employs a six-button interface, where two buttons are dedicated to Morse code input (dot and dash), and the remaining four facilitate navigation, backspace, and selection confirmation. This interface is ergonomically designed to accommodate users with limited motor control, ensuring ease of use and accuracy in communication. The tactile feedback of the buttons enhances user interaction, making Morse code input effortless and efficient.

3) OLED Display Module

The OLED screen provides a real-time visual representation of the inputted Morse code, converting it into readable text. To optimize communication, the system offers predictive text suggestions based on the user's input, significantly reducing the number of keystrokes required. For instance, if the user enters the letter "W", the display suggests frequently used words like "water" or "washroom", allowing for quick selection. The display's high contrast and low power consumption make it ideal for prolonged use, ensuring visibility in different lighting conditions.

4) Bluetooth Audio Output System

To enable seamless verbal communication, the system converts text into speech using Google TTS (Text-to-Speech) and transmits it to a Bluetooth-enabled audio device such as speakers, AirPods, or a headband. This feature allows individuals with partial paralysis to express their thoughts vocally, significantly enhancing their ability to interact with caregivers and the external environment. The speech synthesis function ensures clear and natural voice output, making communication more efficient and expressive.

5) Predictive Text and Word Suggestions

The system is integrated with a predictive text algorithm that suggests commonly used words and phrases based on Morse code input. This feature minimizes typing effort and speeds up communication, making it especially beneficial for users with limited mobility. The machine learning-based algorithm continuously adapts to the user's communication patterns, improving accuracy over time. The customizable dictionary allows users to add frequently used words, further enhancing the efficiency of the system.

6) Real-Time Health Monitoring System

Precision farming requires the sprinkler system, particularly when combined with drone-based plant health monitoring. By modifying output in response to real-time data from soil moisture sensors and drones equipped with ESP32 cameras, it guarantees that crops receive the proper amount of water. By avoiding overwatering or underwatering, this adaptive method maximises resource use and enhances crop health. It can also plan irrigation according to weather predictions, saving water by preventing needless watering prior to precipitation. The system adapts to shifting soil conditions through ongoing monitoring and feedback loops, increasing efficiency. The sprinkler system promotes smart irrigation innovations and sustainable farming methods by optimising yields and decreasing water waste.

7) Adaptive Interface and Customization

The weather station, which provides real-time information on temperature, humidity, wind speed, and rainfall, is essential to smart irrigation. By using this data to forecast weather patterns, irrigation can be optimised by postponing watering when rain is predicted. It guarantees that irrigation takes place in the best possible conditions, minimising water loss due to wind or evaporation. Furthermore, monitoring long-term climate trends helps farmers efficiently plan their irrigation plans. The system adjusts to weather variations by evaluating both previous and current data, guaranteeing accurate water use. This proactive strategy promotes sustainable farming, reduces over-irrigation, and increases crop resilience. Incorporating a weather station into modern agriculture enhances production, climate adaption, and resource efficiency.

8) Power Supply via 5V Adapter

The system operates through a 5V adapter, providing continuous power to the Raspberry Pi Zero 2W. This ensures uninterrupted functionality and avoids the need for frequent recharging. The power supply is stable and reliable, making the system ready for use at all times.

9) Wireless Connectivity and Future Scalability

With Wi-Fi and Bluetooth support, the system enables future enhancements such as remote monitoring, cloud-based storage, and AI-driven improvements. The modular design allows for additional features like voice recognition, mobile app integration, and remote caregiver alerts. These capabilities ensure that the system remains scalable and adaptable to evolving assistive technology advancements.

VI. RESULT

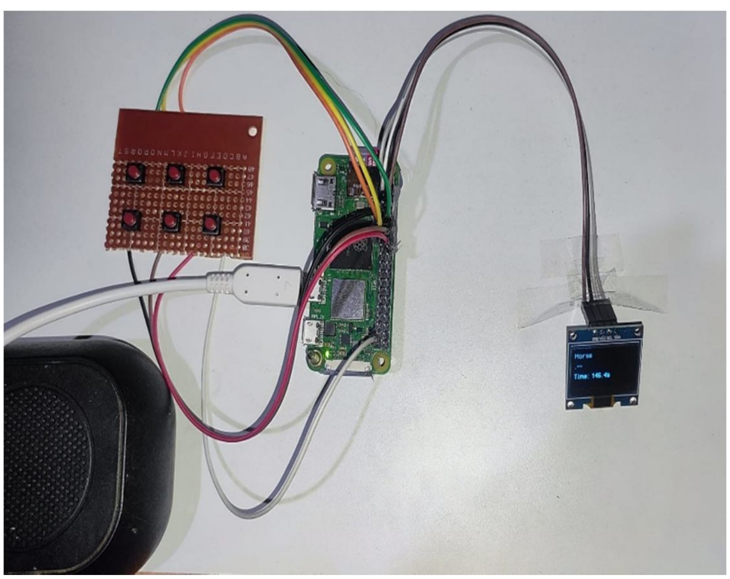

Fig 2.Kit prototype

Fig 3. OLED Output

VII. CONCLUSION

By integrating Morse code communication, predictive text, and speech synthesis, the proposed assistive communication system significantly enhances the quality of life for individuals with partial paralysis. The use of the Raspberry Pi Zero 2W as the central controller ensures efficient processing, while the six-button interface offers a simple and intuitive way for users to input Morse code. The OLED screen provides real-time visual feedback, allowing users to easily navigate and select words, reducing the effort required for communication. The Bluetooth-enabled audio output system ensures that the text is converted into speech, enabling users to interact vocally with caregivers and others in their environment. The system's predictive text feature improves communication efficiency by suggesting commonly used words and phrases, further minimizing the time spent on input. Additionally, real-time health monitoring ensures that users' well-being is continuously tracked, triggering alerts for timely intervention in case of any health anomalies. Customizability is a key feature of the system, allowing users to adjust the interface and settings according to their needs. The 5V adapter power supply ensures continuous operation, and the low-power consumption of the Raspberry Pi Zero 2W extends the system's usability. Future scalability through wireless connectivity and potential integration of AI and machine learning could enhance predictive capabilities, making the system adaptable to evolving assistive technology needs. This assistive communication system combines accessibility, efficiency, and sustainability, offering individuals with severe mobility impairments an improved way to interact with the world around them. Through its integration of advanced technologies and ease of use, the system not only provides an effective solution for communication but also empowers users with greater independence, ultimately contributing to the advancement of assistive technologies in healthcare and personal care.

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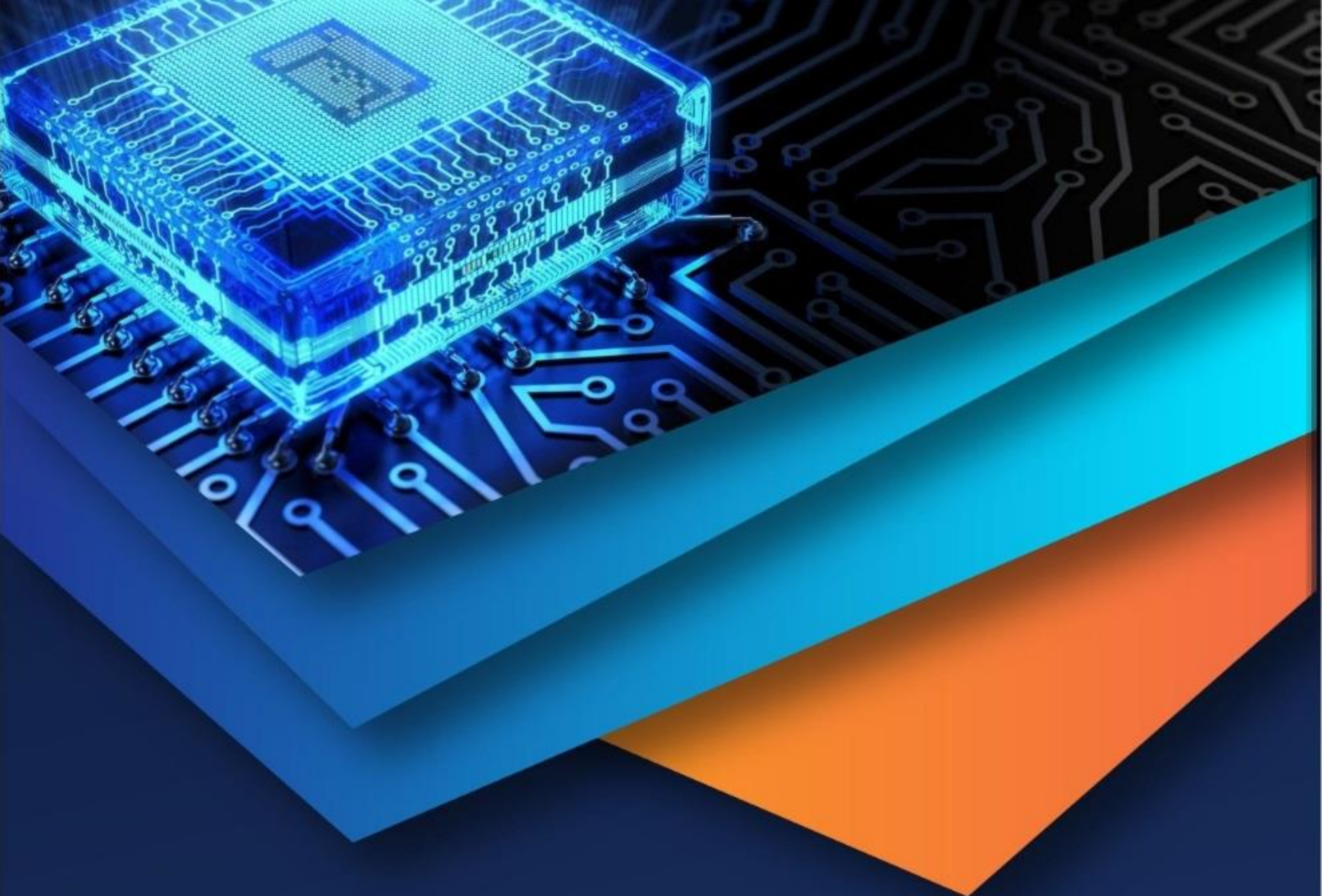

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