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Multifunctional Smart Assistance System

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ABSTRACT

In the current generation, individuals suffering from paralysis often face significant challenges in performing daily activities, making them highly dependent on caregivers. This project aims to enhance the independence of paralysis patients by integrating a smart assistive system that incorporates three major functionalities: wheelchair movement control, health monitoring, and home automation. The wheelchair movement system is designed to operate using an accelerometer sensor, which detects the head gestures of the patient. Based on the direction of head movements, corresponding signals are sent to the motor drivers, allowing the wheelchair to move accordingly. This hands- free control mechanism ensures ease of mobility for patients who have limited or no hand movement, significantly improving their independence. For health monitoring, the system employs a MAX30102 heart rate sensor, which continuously tracks the patient's heart rate and SpO_2 (oxygen saturation) levels. This real-time health data helps in early detection of medical conditions, ensuring timely intervention and improved patient safety. The home automation module is designed to provide effortless control over electrical appliances such as lights and fans. Through Bluetooth connectivity, the patient can turn appliances on and off using a simple interface, eliminating the need for physical assistance. This feature enhances comfort and accessibility, allowing patients to manage their surroundings with ease. By integrating these three key features, the proposed system offers a comprehensive assistive solution for paralysis patients, promoting self- reliance, improving healthcare monitoring, and enhancing overall convenience in daily life.

Keywords—*Paralysis Assistive System, Head Gesture Control, Accelerometer-Based Wheelchair, Health Monitoring, MAX30102, Bluetooth Home Automation, Independent Living.*

I. INTRODUCTION

For individuals living with paralysis, everyday tasks that many take for granted—moving from one room to another, turning on a light, or keeping track of their health—can become overwhelming challenges. Many rely entirely on caregivers for assistance, which can limit their independence and affect their overall well-being. While assistive technologies have made progress in addressing some of these challenges, most solutions either focus on just one aspect of patient care or require complex controls that may be difficult to use for those with severe mobility impairments. This often leaves patients with limited options, forcing them to compromise on comfort and self-sufficiency.

To change this, we propose a Smart Assistive System that seamlessly integrates three essential features: wheelchair control, health monitoring, and home automation. The goal is to make independent living as effortless as possible. Instead of relying on manual controls, the wheelchair can be operated through simple head movements, giving users the freedom to move without using their hands. A built-in health monitoring module continuously tracks vital signs like heart rate and oxygen levels using the MAX30102 sensor, providing real-time updates to help detect potential health risks before they become serious. Additionally, a Bluetooth-enabled home automation system allows users to control household appliances—such as lights and fans—at the touch of a button, making daily life more convenient and reducing dependence on others.

Unlike traditional assistive devices that only solve one problem at a time, this system takes a comprehensive approach, ensuring that mobility, health, and home accessibility work together in harmony. By combining lightweight sensors, wireless communication, and an intuitive user interface, the system not only empowers patients but also eases the burden on caregivers, creating a better living environment for both. More than just a piece of technology, it represents a step toward true independence, allowing individuals with paralysis to regain control over their daily lives with confidence and dignity.

Beyond functionality, accessibility should not be limited to those who can afford costly medical devices. Our system is designed with affordability and ease of use in mind, making it a practical option for a wider audience, including individuals in low-resource settings. By utilizing cost-effective hardware and open-source software, we ensure that this solution remains scalable, adaptable, and inclusive.

II. LITERATURE REVIEW

By decreasing manual intervention and increasing healthcare efficiency, an Internet of Things (IoT) health monitoring system based on microcontrollers enhances real- time patient tracking [1]. Through decentralized processing, AI-driven automation, and privacy enhancement, an Edge AI- enabled IoT framework maximizes wearable health monitoring [2]. In order to help paralyzed patients, a head- gesture-controlled wheelchair incorporates health monitoring sensors, enhancing mobility and enabling continuous tracking [3]. With EEG-based control for greater independence, a brainwave sensor-based home automation system improves accessibility for people with disabilities [4]. Real-time health monitoring is made possible by IoT and biomedical sensors, which send critical data to cloud platforms for prompt intervention [5]. By detecting abnormalities and tracking heart health in real time, an AI-powered wearable ECG system lowers the risk of cardiovascular disease [6]. By identifying anomalous health patterns, a motion-sensing Internet of Things healthcare system reduces false alarms and maximizes real-time monitoring [7]. AI-powered smart home automation benefits the elderly and disabled by enhancing emergency response and environmental control [8]. Quadriplegic patients' mobility is improved by an IoT-based smart wheelchair system that uses head movements and AI-based real-time monitoring [9]. Accessibility is increased, control over household appliances is enhanced, and independent living is encouraged with a voice-activated and smartphone-integrated home automation system [10].

III. METHODOLOGY

This system is designed to give individuals with severe mobility impairments greater independence by combining wheelchair control,home automation, and health monitoring into one seamless solution.At its core, the wheelchair responds to simple head movements, making it easy to operate without requiring hand control. A lightweight headband fitted with an ADXL345 accelerometer detects these movements and sends signals to an Arduino, which processes them and directs the L298N motor driver to move the wheelchair in the desired direction. This hands-free approach ensures that users can navigate their surroundings effortlessly, giving them a new sense of freedom.

Beyond mobility, the system also helps users manage their daily activities through a built-in home automation feature. Using a Bluetooth-enabled HC-05 module, patients can control household appliances like lights and fans with just a few taps on a smartphone app.

In addition to providing mobility and convenience, the system prioritizes health monitoring. The headband continuously tracks vital signs, including heart rate using a pulse sensor, body temperature through a DS18B20 sensor, and oxygen saturation (SpO_2) with a MAX30100 sensor. The collected health data is displayed on an OLED or LCD screen, allowing users to monitor their well-being in real time without relying on external medical devices.

To further improve safety, the system is IoT-enabled, meaning that all health data is transmitted to a cloud platform like Thing Speak or Firebase. This allows caregivers and doctors to access the patient's vitals remotely, ensuring continuous monitoring. If any readings indicate a potential health risk, automatic alerts are sent out so that timely medical intervention can take place. This real-time connectivity gives both users and their families peace of mind, knowing that help is just a notification away.

IV. COMPONENTS

A. Arduino UNO:

Based on the ATmega328P, the Arduino Uno is an open- source microcontroller board that finds extensive application in embedded systems, automation, and electronics. It is one of the most widely used development boards because it is easy for beginners to use while still having enough power for experts.It can be powered by a 7–12V external source or by USB, and it runs at 5V. It can run C/C++ programs using the Arduino IDE and has 14 digital I/O pins, 6 of which support PWM, 6 analog inputs, and a clock speed of 16 MHz.It is perfect for small to medium-sized projects because it has 32 KB of flash memory (0.5 KB bootloader), 2 KB of SRAM, and 1 KB of EEPROM. It also supports sensors, motors, displays, and communication modules like WiFi, Bluetooth, and RFID.

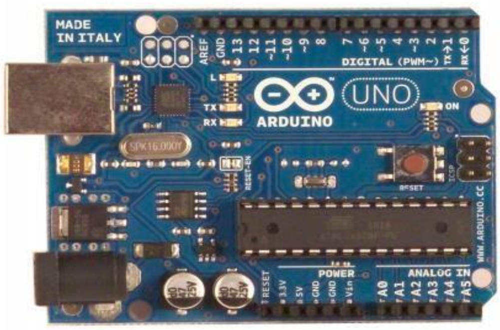

Fig. 1. Arduino UNO

Because of its versatility, the Arduino Uno is used in many different applications, including robotics, home automation, IoT solutions, and industrial automation. It is a key platform for developing interactive systems, enabling users to create innovative projects ranging from autonomous robots to smart home devices. With a robust global community and a wealth of open-source resources, the Arduino Uno remains a popular choice for embedded systems prototyping and learning.

B. ADXL345:

The ADXL345 is an advanced three-axis accelerometer designed for applications requiring precise motion detection and low power consumption. It operates on a voltage range of 2.0V to 3.6V and is often powered by 3.3V in embedded systems. With a high-resolution 13-bit output, it provides accurate acceleration measurements even at low g-forces, making it ideal for applications such as tilt sensing, gesture recognition, and shock detection.One of its key features is its ability to detect free fall and tap/double-tap gestures, which are useful in security systems, step counters, and interactive user interfaces. It includes an integrated FIFO buffer that helps reduce the processing load on the microcontroller by storing motion data temporarily before transmission. The ADXL345 can communicate via both I2C and SPI protocols, offering flexibility in different hardware setups.In addition, the sensor provides real-time acceleration data at output data rates ranging from 0.1 Hz to 3200 Hz, allowing developers to optimize performance for either power efficiency or high- speed motion tracking. Due to its small size and lightweight nature, it is widely used in wearable technology, robotics, drones, automotive systems, and medical devices

Fig. 2. ADLX345 hardware layout

C. Heart rate pulse oximeter:

The MAX30102 heart rate pulse oximeter sensor measures blood oxygen (SpO_2) levels and heart rate with high accuracy using optical technology. According to the photoplethysmography (PPG) principle, it emits red and infrared light through the skin, usually at the earlobe or fingertip. Blood vessels absorb these wavelengths differently depending on oxygenation levels. The modulated signal from pulsatile blood flow is captured by a photodiode and subsequently processed through circuits for amplification and filtering to minimize noise from motion artifacts and ambient light.

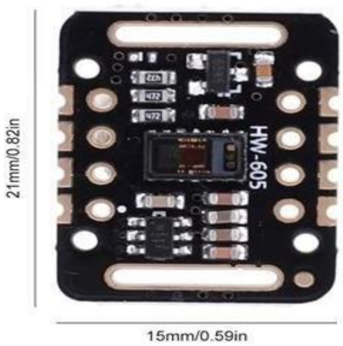

Fig 3. MAX30102

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V. IMPLEMENTATION

A. Block Diagram

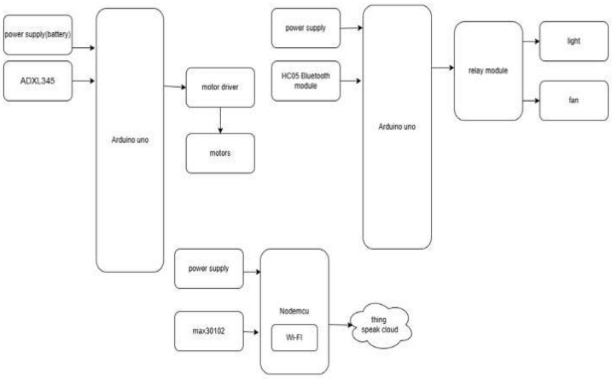

Fig. 4. Block Diagram.

The Smart Headband System is a comprehensive assistive technology that combines home automation, health monitoring, and gesture-based wheelchair control to enhance independence and well-being of paralyzed patients. To guarantee improved patient care and accessibility, the system makes use of IoT-based real-time tracking and monitoring.The Arduino Uno is the central component of the system, processing input from multiple sensors and modules to facilitate seamless operation. Patients can easily maneuver their wheelchair thanks to an ADXL345 accelerometer that recognizes head movements.Arduino processes the accelerometer data before sending it to the motor driver, which regulates the motors and guarantees accurate movement in response to the patient's head movements.The MAX30102 pulse oximeter sensor continuously measures oxygen and heart rate for real-time health monitoring. A NodeMCU ESP8266 transmits critical data to ThingSpeak Cloud for remote health monitoring.In addition,the system has an LCD display for real-time updates,a relay module for home automation,and a motor driver for wheelchair movement. When an emergency arises,a buzzer ensures prompt assistance.Through the integration of IoT-driven health tracking,home automation,and gesture-based mobility,this system improves paralysis patients' independence and medical supervision.

This data is transmitted to a NodeMCU ESP8266 module, which uploads the patient's health parameters to the ThingSpeak cloud platform for remote monitoring by caregivers and medical professionals. This ensures timely alerts and intervention in case of abnormalities. Additionally, a temperature sensor can be integrated to monitor body temperature, providing a comprehensive health tracking system.An HC-05 Bluetooth module allows voice control of electrical appliances, including fans and lights, for home automation. The patient's surroundings can be controlled with basic voice commands, increasing comfort and lowering reliance on caregivers. After processing these commands, the Arduino turns on the relay module, which turns the appliances on and off.

B. Hardware:

The Smart Headband System for Paralysis Patients uses Internet of Things-based automation to improve health monitoring and mobility. An ADXL345 accelerometer for head-controlled wheelchair navigation and a MAX30102 sensor for real-time oxygen and heart rate monitoring send data to an Arduino Uno. An HC-05 Bluetooth module allows voice- activated home automation to control fans and lights, and a temperature sensor monitors changes in body temperature.

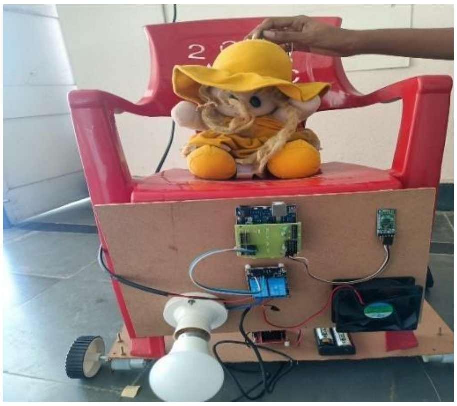

Fig. 5. Hardware setup

C. Software:

The Arduino IDE is the foundation of the Smart Headband system's software implementation. It is used to program the microcontroller to perform a variety of tasks, including home automation, health monitoring, and wheelchair control. Because the software is written in C, commands are executed effectively and sensor data is processed in real time. By sending patient vitals to caregivers and medical professionals, cloud platforms such as ThingSpeak and Firebase are integrated to facilitate remote health monitoring. Mobile apps that are created with MIT App Inventor or Android Studio offer an easy-to-use interface for monitoring health metrics and managing household appliances. Bluetooth (HC-05) and WiFi (ESP8266) modules enable communication between system components, guaranteeing smooth data transfer.

VI. INTEGRATION AND WORKFLOW

When home automation, health monitoring, and wheelchair control are combined, an effective assistive system is produced that improves paralysis patients' independence and quality of life. Through head movements, the accelerometer-based wheelchair control ensures mobility without the need for manual labor. The health monitoring system simultaneously monitors vital signs such as heart rate and SpO_2 levels in real time, displaying the data locally and sending it to a cloud platform for remote monitoring. In the event of abnormal readings, automated alerts notify caregivers, guaranteeing prompt medical attention.

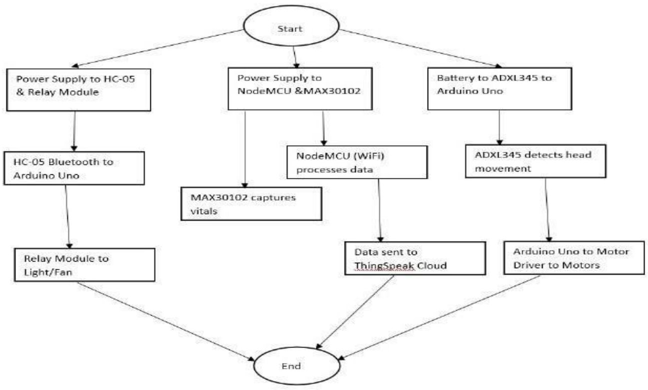

Fig. 6. Workflow.

By enabling Bluetooth appliance control, the home automation module further improves convenience and lessens reliance on caregivers. Smooth operation is ensured by IoT integration, which allows for seamless

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communication between these parts. The system fosters a more independent and dignified lifestyle by integrating smart mobility, real-time health tracking, and home automation. It also improves safety and daily comfort.

VII. RESULTS

A. Wheel chair movements:

Patients with paralysis can move around hands-free thanks to the wheelchair movement system. Head movements are precisely detected by the ADXL345 accelerometer, and the Arduino Uno processes them quickly. The L298N motor driver ensures smooth navigation, allowing precise control over movement directions. Testing demonstrated high accuracy and responsiveness, with users adapting easily to the system. Real- world trials confirmed its reliability, making it a practical solution for enhancing independence and mobility.

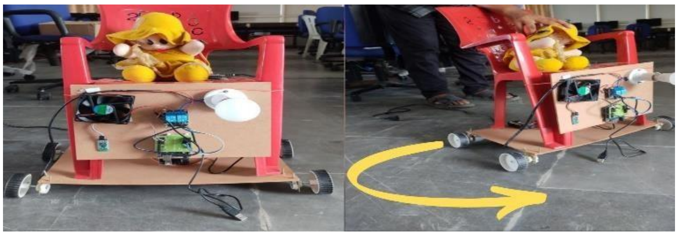

Fig 7.1 Wheel chair right movement

Fig 7.2 Wheel chair left movement

Fig 7.3 Wheel chair backward movement

Fig. 7.4 Wheel chair forward Movements

B. Home Automation:

The outcomes show how well the home automation system works to give paralyzed patients smooth control over their appliances.Testing verified that the Arduino Uno and the Bluetooth-based HC-05 module can effectively communicate,enabling users to control lights and fans with a smartphone app. The relay module ensured that connected devices were activated and deactivated instantly by accurately responding to commands.Real-world trial results showed that the system improves user convenience and independence by reducing the need for physical assistance.Furthermore, there were no noticeable delays or connectivity problems, and the system operated dependably both in ON and OFF modes.

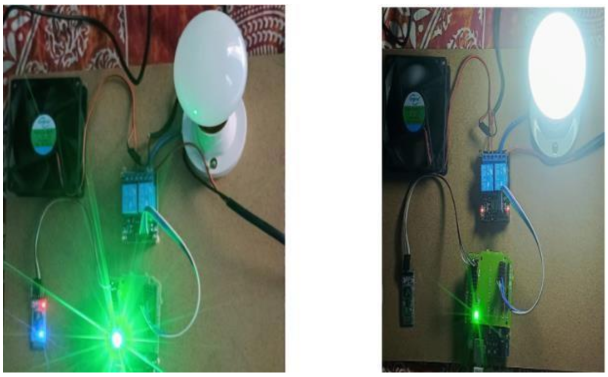

Fig. 7.5 Home automation.

C. Health Monitoring:

Health monitoring system tracks health in real time using the MAX30102 sensor, NodeMCU, and ThingSpeak Cloud. The MAX30102 uses red and infrared light to measure blood oxygen levels and heart rate. Remote monitoring is made possible by NodeMCU processing this data and sending it to ThingSpeak Cloud over Wi-Fi.This system is helpful for patient monitoring, elder care, and fitness tracking because it enables individuals or healthcare providers to track health parameters from any location. It improves preventive healthcare by offering prompt alerts for abnormal readings, guaranteeing proactive medical intervention, thanks to real time data availability.

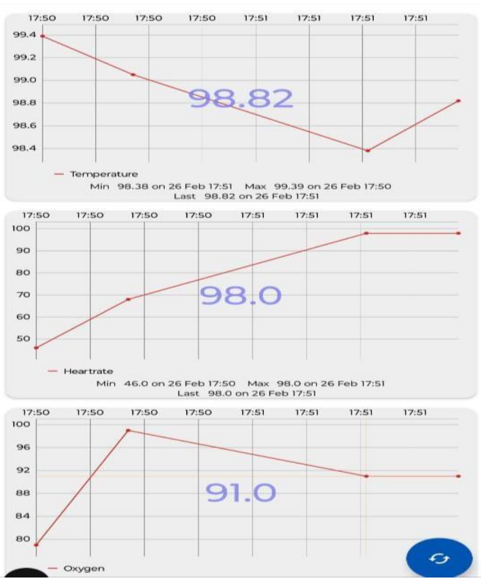

Fig. 8. Health Monitoring

CONCLUSION

Using Arduino, Bluetooth, and the Internet of Things, the Smart Headband for Paralysis Patients is a cutting-edge solution that improves mobility, home automation, and health monitoring. Patients' independence is increased by the system's integration of gesture-based wheelchair control, which enables hands-free wheelchair navigation. The home automation feature makes everyday life more convenient by allowing Bluetooth control of electrical appliances. Furthermore, the health monitoring system guarantees ongoing patient health assessment by tracking body temperature, heart rate, and SpO2 levels. IoT integration enables caregivers and medical professionals to remotely monitor a patient's condition by uploading real-time health data to the cloud. With increased autonomy, safety, and prompt medical intervention, this project offers paralysis patients a practical, affordable, and effective means of improving their quality of life.

DECLARATION

We would like to express our gratitude to all of the individuals who participated for their insightful suggestions, rapid support and help, all of which enabled us to finish the project on schedule. We would like to express our sincere gratitude to N.Gowthami, Associate Professor and Head of the Department of Internet of Things, for her crucial assistance, encouragement, and direction as well as her insightful criticism during the project's growth. Last but not least, we want to express our gratitude to each and every group member for their unwavering support in completing our project.

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