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DEVELOPMENT OF A MICROCONTROLLER-BASED SMART CONTROL SYSTEM FOR AN ELECTRIC WHEELCHAIR USING JOYSTICK AND MOBILE INTERFACE

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ABSTRACT- In this paper, an ESP32 microcontroller is used to develop and build a joystick-controlled electric wheelchair. Through simple joystick-based control, the technology is intended to give elderly or physically impaired people autonomous movement. Two geared DC motors coupled by a sprocket and chain transmission system power the wheelchair, which is constructed with a square tube frame. Each drive motor's speed and direction are managed by two BTS7960 high-current motor driver modules. The main input device is a joystick module, and control commands are also remotely sent via Wi-Fi using the Blynk program. The system is powered by a 12V 40A battery. To move the wheelchair forward, backward, left, and right, the ESP32 uses relay-controlled circuitry to detect joystick inputs and deliver the proper PWM signals to the BTS7960 motor drivers. For both home usage and rehabilitation facilities, the suggested system offers an inexpensive, dependable, and remotely controlled mobility option.

***Keywords*: -** ESP32, Electric Wheelchair, BTS7960 Motor Driver, Geared Motor, Joystick Control, Blynk App, Relay, Sprocket Chain Drive, 12V Battery, PWM Control, IoT Mobility

I. INTRODUCTION

For those with mobility disabilities, electric wheelchairs are a vital assistive device that promotes independence and enhances quality of life. People with severe limb problems cannot use conventional manual wheelchairs because they involve physical effort from the user or an attendant. In order to overcome this difficulty, motorized wheelchairs employ electric drive systems that are managed by the user via a variety of input interfaces.

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Low-cost and intelligent electric wheelchairs are now possible because to the quick development of embedded systems and Internet of Things technologyWith its dual-core CPU, integrated Wi-Fi and Bluetooth, and extensive GPIO and PWM capabilities, the ESP32 microcontroller offers the perfect foundation for managing motor-driven systems. A high-current H-bridge driver, the BTS7960 motor driver can manage up to 43a constant current, which makes it ideal for powering strong geared DC motors in wheelchair applications..

Using an ESP32 microcontroller, two geared DC motors, two BTS7960 motor drivers, a relay module, a joystick module, a Blynk mobile application, a sprocket-chain drive mechanism, and a 12V 40A battery, this project suggests a Joystick Controlled Electric Wheelchair. The square tube structure offers durability and structural rigidity. Both a physical joystick and the Blynk mobile app over a Wi-Fi network may be used by the user to operate the wheelchair..

II. OBJECTIVE

- To design and fabricate a joystick-controlled electric wheelchair using ESP32 microcontroller and BTS7960 motor drivers.
- To drive the wheelchair using two geared DC motors with a sprocket and chain transmission mechanism.
- To implement joystick-based directional control (forward, backward, left, right) using PWM signals.
- To integrate the Blynk mobile application for wireless remote control of the wheelchair via Wi-Fi.
- To use a 12V 40A battery as the power source and relay modules for circuit protection and switching.
- To build a sturdy and lightweight wheelchair frame using square tube structural members.
- To provide an affordable and accessible mobility solution for physically disabled individuals.

III. LITERATURE SURVEY

S. Tamura et al. claim that their research on electric wheelchair control systems emphasizes the significance of speed regulation in motorized mobility aids and shows how joystick interfaces may be used for intuitive directional control. In order to accomplish accurate and seamless wheelchair maneuvering, R. A. Ramlee and M. R. Arshad's study on microcontroller-based wheelchair control systems suggests using PWM motor control techniques.

The integration of the Blynk platform with ESP32 for wireless control of rehabilitation equipment, enabling remote operation via smartphones, as demonstrated by A. Kumar and P. Singh's work on IoT-enabled assistive devices. The BTS7960 H-bridge driver is a high-performance and reasonably priced option for powering high-current DC motors in mobility systems, according to B. Patel and N. Shah's article on motor driver selection for electric cars. The benefits of sprocket and chain drives in terms of torque transmission efficiency and dependability in low-speed, high-load applications like wheelchairs are discussed in V. Kumar et al.'s work on gear-driven electric vehicle chassis. M. Zubair and A. Hamid claim that their study on ESP32-based Internet of Things applications for assistive technology shows how

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successful the ESP32 is at wireless communication and real-time sensor data collecting, making it a perfect controller for smart wheelchair systems.

IV. BLOCK DIAGRAM

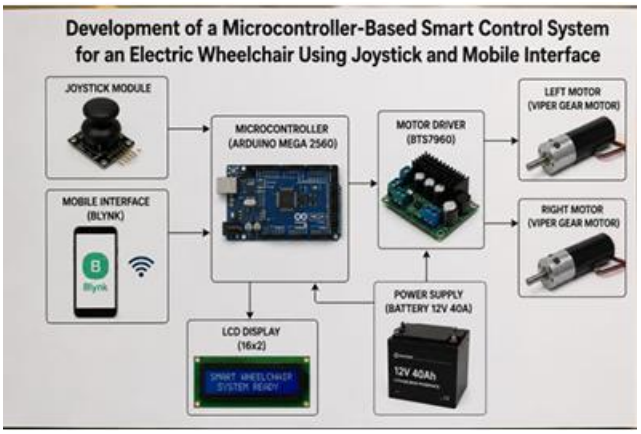

Fig.1 - Block diagram

The block diagram of the Joystick Controlled Electric Wheelchair consists of the following main blocks: 12V 40A Battery (Power Supply), ESP32 Microcontroller (Central Controller), Joystick Module (Primary Input), Blynk Mobile Application (Wireless Input via Wi-Fi), Relay Module (Circuit Switching), Two BTS7960 Motor Drivers (Motor Control), Two Geared DC Motors (Drive Mechanism), Sprocket and Chain Drive (Power Transmission), and Square Tube Frame (Mechanical Structure). The joystick and Blynk app provide directional commands to the ESP32, which processes the input and generates PWM signals to the BTS7960 motor drivers to control motor speed and direction.

V. WORKING

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Fig.2 - Working

Differential drive control is the basis for the operation of the Joystick Controlled Electric Wheelchair. The ESP32 initializes the joystick module, establishes a Wi-Fi connection, and initiates communication with the Blynk program upon power-up. Relay-controlled circuits allow the 12V 40A battery to power the complete system.

Two analog output signals that correspond to the joystick handle's X and Y axes are provided by the joystick module. The ESP32 uses its ADC channels to read these analog signals. The ESP32 decides whether to move forward, backward, left, or right based on the deflection of the joystick. The two BTS7960 motor driver modules receive corresponding PWM signals. One geared DC motor is controlled by each BTS7960 module. Differential steering is achieved by individually controlling the speed and direction of both motors by adjusting the PWM duty cycle and direction pins of the BTS7960 drivers. Smooth and effective torque distribution is made possible by the two geared motors' transmission of power to the back wheels via sprocket and chain drives.

The Blynk mobile application allows the user to simultaneously operate the wheelchair electronically. The ESP32 receives virtual button orders from the Blynk app over Wi-Fi, interprets them, and then activates the motors appropriately. In addition to controlling the primary power supply to the motor drivers, the relay module offers further circuit protection.

5.1 ESP32 Microcontroller

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Fig.3 - ESP32 Microcontroller

The ESP32 is a powerful, low-cost, dual-core microcontroller developed by Espressif Systems. It features a 240 MHz Xtensa LX6 dual-core processor, built-in Wi-Fi and Bluetooth connectivity, multiple ADC channels, PWM output capabilities, and a rich set of digital I/O pins. In this system, the ESP32 acts as the central controller, reading analog signals from the joystick, communicating with the Blynk server via Wi-Fi, and generating PWM control signals for the BTS7960 motor drivers.

5.2 BTS7960 Motor Driver (x2)

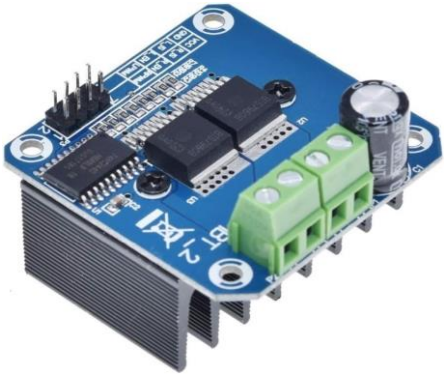

Fig. 4 - BTS7960 Motor Driver (x2)

A fully integrated H-bridge motor driver, the BTS7960 can continuously control DC motors with currents up to 43A. It has current sensing feedback, over-temperature protection, short-circuit protection, and PWM input control. In order to provide independent bidirectional speed control of both wheels, this project uses two BTS7960 modules, one for each geared drive motor. Each BTS7960 module's RPWM, LPWM, R_EN, and L_EN pins are driven by the ESP32 to regulate motor speed and direction.

5.3 Geared DC Motors (x2)

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Fig.5 - Geared DC Motors (x2)

The wheelchair's main driving actuators are two geared DC motors. Wheelchair users' weight must be supported on a variety of surfaces, and geared motors offer great torque at low speeds. These motors are rated to take the current provided by the 12V 40A battery via the BTS7960 drivers, and they run on 12V DC. Through the sprocket and chain drive arrangement, each motor powers one of the wheelchair's back wheels.

5.4 Relay Module

Fig.6 - Relay Module

The relay module functions as an electrically driven switch that enables the ESP32 to regulate the motor driver circuit's primary power source. The relay can switch high-current DC loads from the 12V 40A battery and runs on a low-power control signal from the ESP32. It guarantees that the motor circuit may be de-energized when necessary without removing the battery thanks to its safety disconnect mechanism.

5.6 Joystick Module

The joystick module is a dual-axis analog input device that produces voltage on the X and Y axes according to the direction and strength of the joystick deflection. Additionally, it has a push-button switch that is turned on by turning the joystick knob. The Y-axis output in this system regulates forward and backward motion, whereas the X-axis output controls lateral turning (left and right). The ESP32 ADC reads the analog outputs and converts them into PWM duty cycles for the motor drivers.

5.7 Blynk App

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Using a smartphone, the Blynk mobile application offers a wireless remote control interface for the wheelchair. The ESP32 receives directional commands (forward, backward, left, right, stop) via virtual buttons set up on the Blynk dashboard over a Wi-Fi network. In addition to the actual joystick, this capability enables the user or a caregiver to operate the wheelchair remotely. The ESP32 uses its built-in Wi-Fi to connect to the Blynk cloud server and reacts instantly to incoming virtual pin commands

5.8 Sprocket and Chain Drive

The wheelchair's back wheels get the rotational power of the geared motors through the sprocket and chain drive system. Compared to direct drive or belt drive systems, this drive method offers effective torque multiplication, mechanical dependability, and simple maintenance. In order to provide smooth and responsive motion during operation, the chain and sprocket are chosen depending on the motor torque, wheel size, and intended wheelchair speed.

5.9 Square Tube Structure

Square metal tubes (MS or aluminum) are used in the construction of the wheelchair frame because they offer great structural strength and stiffness while maintaining a tolerable overall weight. When compared to circular tubes of the same weight, the square tube cross-section provides better resistance to bending and torsional stresses. The structure is intended to fit the batteries, motor drivers, ESP32 controller, geared motors, and seating assembly in a small, comfortable space.

VI. CONCLUSION

The ESP32 microcontroller was used to create the Joystick Controlled Electric Wheelchair, which effectively illustrates a practical and reasonably priced motorized mobility option for those with physical disabilities. Using BTS7960 high-current motor drivers, the system efficiently combines a joystick module with the Blynk mobile application to offer dual-mode control of two geared DC motors.

The sprocket and chain drive mechanism ensures reliable power transmission to the drive wheels, while the square tube frame provides the necessary structural support.

The relay module offers circuit safety, and the usage of a 12V 40A battery provides enough energy for prolongedoperation. The ESP32's integrated Wi-Fi allows for easy connection with the Blynk platform, providing smartphone-based remote control features. The project may be made into a complete smart wheelchair solution for assistive technology applications by adding obstacle detection sensors, an automatic braking system, or voice control using the ESP32's Bluetooth functionality.

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