Stand-N-Move Chair: "Empowering Mobility and Independence"

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011192029, 011192018, 011192024, 011192017, 011163056

***Abstract*—The goal is to build an automated wheelchair that enables users to stand and navigate around their environment with safety, comfort, and convenience. The wheelchair will have a joystick to control speed and sensors to detect obstacles in front of the user. The standing mechanism can be activated with a button, and the system can detect if the user falls from the wheelchair**

***Index Terms*—Automated WheelChair, Joystick, and Sensors.**

I. Introduction

The "Stand-N-Move Chair" is an innovative electric wheelchair designed to revolutionize the mobility experience for users with limited mobility. This project aims to empower individuals with mobility challenges, particularly those who wish to stand and control their movement using intuitive head movements. By combining cutting-edge technology and thoughtful design, this wheelchair seeks to provide users with the freedom to stand up and interact with their environment at eye level, fostering a sense of inclusion and independence. With a strong focus on user safety, comfort, and ease of use, the Stand-N-Move Chair aspires to bridge the gap between seated and standing mobility, opening up new possibilities for users to engage with the world around them in a more natural and intuitive manner. Through this project, we hope to enhance the quality of life for wheelchair users, enabling them to navigate their surroundings with confidence and dignity, breaking barriers, and fostering a more inclusive society for all.

A. Obejectives of Our Project

- Develop a Safe and Reliable Standing Mechanism: Design and implement a robust standing mechanism that allows the user to safely transition from a seated to a standing position and vice versa, ensuring stability and minimizing any risk of accidents or falls
- Integrate Joystick-Controlled Directional System: Develop an intuitive and accurate joystick-controlled system that enables the user to maneuver the electric wheelchair in the desired direction by detecting and interpreting joystick movements effectively.
- Automatic Fall Detection System: Develop an accurate fall detection system that will detect fall and notify the nearby hospital and emergency contacts.
- Enhance Safety Features: Implement a comprehensive safety system that includes obstacle detection, collision avoidance, and emergency braking to protect the user from potential hazards and ensure a secure riding experience.

Identify applicable funding agency here. If none, delete this.

II. Proposed System

Our system will operate simultaneously after all the functionalities have been implemented. Our goal is to build an automated wheelchair with user safety, comfort, and convenience of use that enables wheelchair users to stand and navigate around in their environment. The user may control the speed of the wheelchair by using the joystick which helps the person to move anywhere. Additionally, if there are any objects in front of their road within a certain distance, the wheelchair can detect the obstacle through the sensors. The user just needs to click a button to activate the standing mechanism if they are required to stand. If the user falls from the wheelchair, the system can detect the fall occurrence which facilitates timely response and assistance when needed.
The final structure of our system is shown in figure 1

III. Project Overview

A. Features of Our system

The goal of this research is to provide people with mobility issues more control over their own bodies, especially those who want to stand and move by using their fingers. The system has the following features:

I Develop a Safe and Reliable Standing Mechanism
II Integrate a Joystick-Controlled Directional System
III Automatic Fall Detection System
IV Obstacle avoidance

B. Hardware and Software Requirements

We require specific hardware and software tools in order to complete the project. We make use of Arduino IDE as a software tool and the other hardware tools are:

1. Microcontroller Arduino Uno R3 :
The Arduino Uno R3 is a widely used microcontroller board designed for beginners and hobbyists. It features an Atmel ATmega328P microcontroller, 14 digital I/O pins, 6 analog input pins, USB connectivity, a 16MHz clock speed, and is compatible with a wide range of sensors

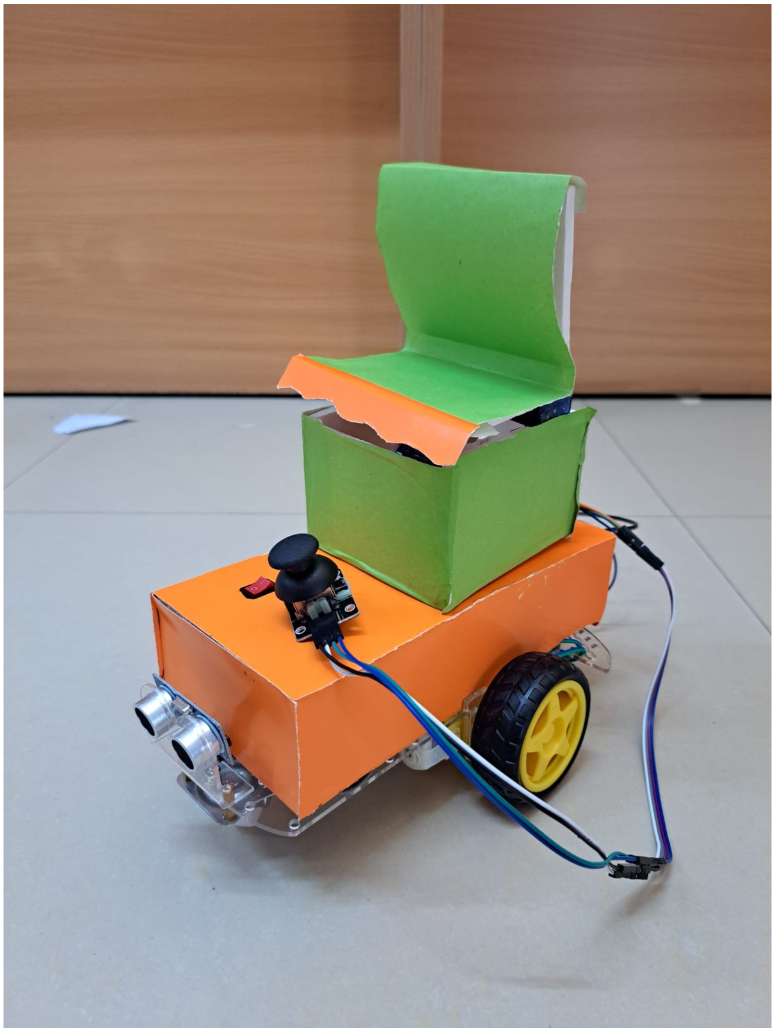

Fig. 1. The Architecture of Standing WheelChair

and shields. It's known for its versatility and ease of use, making it suitable for various electronic projects.

2. GSM :
   The SIM800L GSM module is a compact communication module that facilitates GSM network connectivity, including SMS, voice calls, and GPRS data connections. It operates on a range of voltages, communicates via UART, and requires a standard SIM card.

3. Joystick:
   A joystick is a manual input device used for controlling the movement of objects in various applications. It consists of a handle that can be moved in different directions for input. Joysticks can provide two-dimensional or three-dimensional control depending on the application.

4. L298N Motor driver:
   The L298N motor driver is an IC used to control DC motors and stepper motors. It employs an H-bridge configuration for direction and speed control and can handle two motors independently in many applications.

5. Servo Motor:
   A servo motor is a precise rotary actuator that maintains a specific angle of rotation. It relies on feedback mechanisms for accuracy and finds applications in robotics, CNC machines, and other systems requiring controlled motion. Control is often achieved using PWM (Pulse Width Modulation) signals.

6. MPU6050:
   The MPU6050 is a motion-tracking sensor (IMU) that combines an accelerometer and a gyroscope in a single package. It offers six degrees of freedom (6DoF) for measuring motion in three dimensions and communicates via digital interfaces like I2C or SPI. It is commonly used in applications involving motion and orientation tracking.

7. Ultrasonic sensors:

An ultrasonic sensor measures distance by emitting high-frequency sound waves and timing how long it takes for them to bounce back, making it suitable for applications like obstacle detection and distance measurement.

Also, Mechanical Actuators, Breadboard, and wheels are needed.

C. The Overall Workflow of Our Different Modules

In this section, We outline the process for each feature of our system.

1) Wheel Control Movement: Figure 2 shows the overall wheel control system.

2) Collision Avoidance: Figure 3 represents how the system detects objects in the forward direction.

3) Standing Mechanism: Figure 4 demonstrates the standing mechanism of our system.

IV. Overall Implementation Process of Our System

We have progressed through various phases of the implementation, each of which is described below:

A. Design and Prototyping

During the design and prototyping phase, we developed a Tinkercad prototype of the project, integrating the necessary components and testing their functionality with associated code. Furthermore, we carefully selected the sensors essential for the successful completion of the project.

B. Electronics and Hardware Integration

In this phase, we conducted the hardware integration process to ensure the seamless functionality of all components and hardware elements when working together. Additionally, we explored alternative hardware configurations, such as experimenting with gyro sensors as a control mechanism for the wheels instead of the joystick.

Moreover, during this phase, we explored different approaches for the standing mechanism. Initially, we attempted to implement it using a single servo, but this proved unsuccessful. Consequently, we adapted our design by integrating two servos, which proved to be effective in achieving the desired outcome.

C. Obstacle Avoidance Algorithm

For obstacle avoidance, we incorporated a sonar sensor into our project. The sonar sensor is capable of detecting the presence of objects within a specified range. In our implementation, we utilized this sensor to identify obstacles within a 20 cm range. If the sensor detects an obstacle within this range, the wheelchair halts its forward movement, regardless of any forward commands issued. However, it retains the ability to move in other directions, effectively serving as an obstacle-avoidance mechanism.

D. Standing Mechanism Implementation

To implement the standing mechanism, we incorporated two servos into the chair's design. One servo is attached to the chair's legs, allowing it to tilt the seating position to a maximum of 60 degrees from its initial orientation. The other servo is connected to the seatback, enabling it to tilt to the same 60-degree angle from its initial position. By controlling both servos simultaneously, we achieve the chair's standing configuration.

The operation of the standing feature is controlled by a toggle switch. When the switch is in the ”on” position, the chair transitions into the standing position, with both servos adjusting the seat and backrest accordingly. Conversely, when the switch is turned ”off,” the chair returns to its initial seating position. This toggle switch provides users with a straightforward and convenient means of activating and deactivating the standing feature as needed.

E. Wheel control using joystick

To facilitate wheelchair control, we've integrated a joystick, offering users a convenient and intuitive means of steering. We've leveraged the PWM (Pulse Width Modulation) pins of the Arduino to manage the wheelchair's wheel speed dynamically. Specifically, we've linked the enable pins of the wheel motor controllers to these PWM pins. This configuration allows us to vary the speed of the wheels, making it responsive to the joystick's movements.

As the joystick is manipulated, the PWM signals to the motor controllers change in real time, resulting in the corresponding acceleration or deceleration of the wheelchair's wheels. This responsive control system ensures a smoother and more adaptable driving experience for the user.

F. Fall Detection

For fall detection, we've employed the MPU6050, a 6-axis gyroscope and accelerometer sensor. This versatile sensor enables us to monitor abrupt alterations in both rotation and acceleration. By analyzing the sensor's data, we've established a predefined threshold. This threshold serves as a reference point to distinguish between the wheelchair's normal state and a potential fall event.

When the sensor readings surpass the established threshold, it triggers a fall detection event. This mechanism allows us to promptly identify if the wheelchair has experienced a fall, facilitating timely response and assistance when needed.

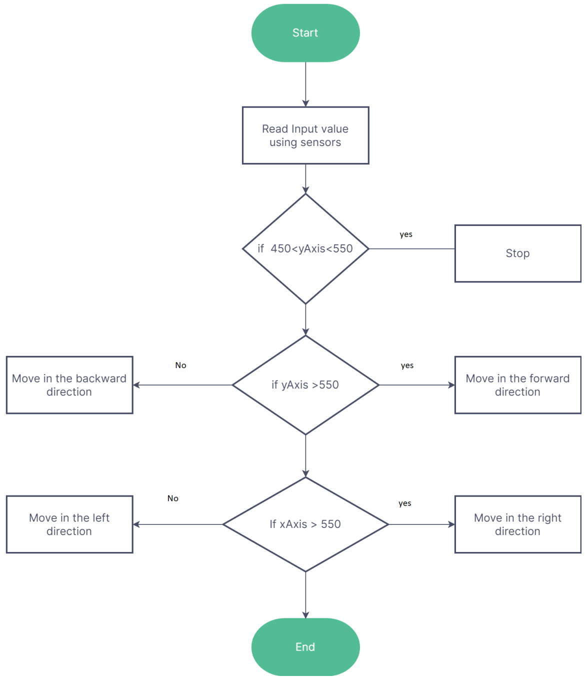

Fig. 2. Wheel Control System.

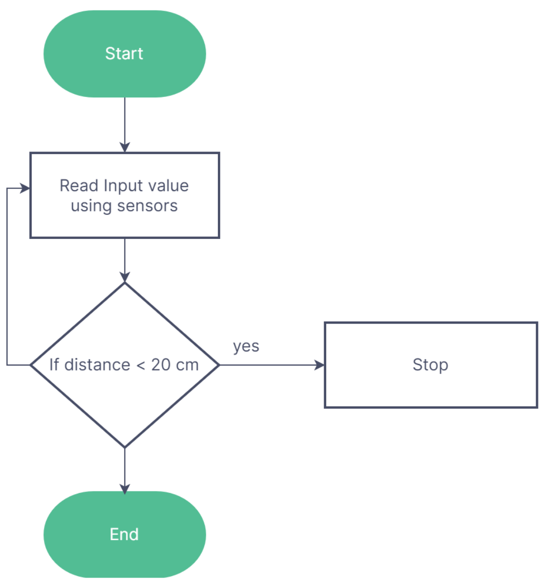

Fig. 3. Avoidance of Obstacle Mechanism.

Fig. 4. Standing Mechanism of the System.

G. *Project Demonstration and Code*

We can see the code implementation part and project demonstration from the below links.
Github:(https://github.com/Anamjafar/StandingWheelChairWithObstacleAvoidance.git)
Drive:(https://drive.google.com/file/d/1ugu7eE2SNxTHlK5opat558Xth4gw9G2J/view?usp=sharing)

V. Conclusion

Our innovative wheelchair design empowers users with enhanced mobility and independence. By integrating a safe standing mechanism and an intuitive joystick-controlled directional system, we offer a comfortable and accessible solution. With a focus on user feedback and safety, our project aims to create a transformative experience, breaking barriers for a more inclusive future. In future work, we will try to implement the fall detection module by sending an emergency message and live location.