JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AUTOMATION and CUSTOMIZATION OF WHEELCHAIR BASE FOR MULTI-PURPOSE APPLICATIONS

I.V.S.Yeswanth[1],G.HariBabu[2] D.Mohan Manideep[3], N.GanethSai[4], S.Chaitanya[5], T.Manoj[6], V.V.S.Pavan Kalyan[7]
[1] Assistant Professor, Department of Mechanical Engineering, Nellore, AP
[2,3,4,5,6,] UG Students, Narayana Engineering College, Nellore, AP

Abstract: *Electric wheelchairs, sometimes referred to as power chairs, are mobility aids made to help the elderly and those with limited movement. A joystick or other control devices, like as smartphones, are used to operate the wheels of electric wheelchairs, which are propelled by a battery-powered motor. The project's primary goal is to improve wheelchair functionality by using a customized base and joystick control mechanism. Patients can use the wheelchair more easily and conveniently by adding a joystick control device. In order to provide individualized care for each user, the base may be customized to include spaces for food, medication, and other necessities. The electric wheelchair's automation also makes it simple for those with disabilities to use. A sliding door that opens by hand detection and shuts automatically after a predetermined amount of time is automated. The system is made to operate a wheelchair through the use of an Android mobile device. This project's primary goal is to facilitate the mobility of the elderly who are unable to move well as well as those who are disabled or handicapped. The unique people will be able to live a life less dependent on other people as a result of this design. We are integrating wheelchair control based on Arduino in this system.*
Keywords: *Electric wheel chair; Arduino; Customization of wheel chair base*

I. INTRODUCTION

Millions of people have lost their ability to walk independently as a result of illnesses, car crashes, natural disasters, and other events. Concurrently, the aging of the population and advancements in medical technology have made an aging society one of the most significant concerns that many nations need to give careful thought to. Wheelchairs are the ONLY means of transportation for these persons to interact with people and situations outside of their homes. As Baby Boomers age over the next few decades, the number of Americans over the age of 15 who rely on wheelchairs is predicted to rise to nearly 3.3 million [1-3]. People with disabilities are growing more and more keen to integrate current technologies into their wheelchairs in order to enhance their quality of life, both socially and independently. Regretfully, the only significant advancement in wheelchair technology in the past century has been the development of battery-powered motorized wheelchairs in the 1950s. The rest of society has not changed at the same rate as performance and functionality have improved throughout time. Nonetheless, the majority of electric wheelchairs on the market are still large, heavy, and poorly designed, with poor energy efficiency, a short travel range, and few communication and navigational features.

II. DESIGN

2.1 DESIGN CONSIDERATIONS AND REQUIREMENTS OF ELECTRIC WHEEL CHAIR

2.1.1 Control System:

Arduino Uno: The Arduino Uno microcontroller acts as the central processing unit of the wheelchair. It is responsible for receiving inputs from the joystick and smartphone, processing these inputs, and controlling the output devices such as the motor, LCD display, and automated sliding door. The Arduino's flexibility allows for easy integration of additional sensors and modules as needed.

HC-05 Bluetooth Module: This module enables wireless communication between the Arduino and an Android smartphone. It allows the user to control the wheelchair remotely via a dedicated smartphone app, enhancing user convenience and accessibility. The HC-05 module connects to the Arduino using standard serial communication protocols.

2.1.2 User Interface:

Joystick Control: A joystick provides a simple and intuitive method for users to control the wheelchair's movement. It sends directional commands to the Arduino, which then translates these commands into motor actions. The joystick is typically mounted in an easily accessible location on the wheelchair armrest. An Android app is developed to provide an alternative control method. The app communicates with Arduino via Bluetooth, offering features such as directional control, speed adjustments, and status monitoring. This adds a layer of versatility for users who prefer a touch interface. The LCD screen is used to display real-time information to the user. This includes operational status, battery level, and error messages. The LCD is connected to the Arduino, which sends the necessary data to be displayed.

2.1.3 Mechanical Design:

Automated Sliding Door: The wheelchair incorporates an automated sliding door that operates based on hand detection. Sensors are placed near the door to detect when a hand is approaching, triggering the door to open. After a predefined period, the door automatically closes. This feature enhances ease of access and user independence. The wheelchair base is designed to be modular and customizable. Users can adjust the base to accommodate personal items like medicines, food, and other essentials. This customization is facilitated through modular compartments that can be rearranged or resized according to user needs.

2.1.4. Motor and Power Supply:

Motors: High-efficiency DC motors are used to drive the wheelchair's wheels. These motors are controlled by the Arduino through motor driver circuits, which manage the direction and speed of the motors based on input commands from the joystick or smartphone. The wheelchair is powered by a rechargeable battery, ensuring reliable and consistent power for extended use. The power supply system includes voltage regulation components to maintain stable operation of the electronic circuits and motors.

2.1.5. Safety and Reliability:

Various sensors are integrated into the system to ensure safe operation. For instance, obstacle detection sensors can be added to prevent collisions, and battery level sensors monitor the charge status to alert users when recharging is needed. Critical components such as the power supply and control circuits are designed with redundancy in mind. Backup systems or fail-safes are included to ensure the wheelchair remains operational even if a primary component fails.

2.1.6. Software Requirements:

The Arduino is programmed using the Arduino IDE. The software includes code for reading inputs from the joystick and Bluetooth module, processing these inputs, and controlling the motors and display. The program also handles the logic for the automated sliding door and other custom features. The Android app is developed using a platform such as Android Studio. It provides a user-friendly interface for controlling the wheelchair and receiving feedback from the Arduino. The app communicates with Arduino through the Bluetooth module, sending control commands and receiving status updates.

The design of the electric wheelchair focuses on providing enhanced functionality, ease of use, and customization for users. By integrating advanced control systems, user-friendly interfaces, and robust mechanical and electronic components, the wheelchair aims to significantly improve the mobility and independence of individuals with mobility challenges.

2.2 CALCUTIONS FOR FRABRICATION OF ELECTRIC WHEELCHAIR

Case 1: Motor

The diameter of the back wheel of the wheelchair(D) is 600mm.

We are calculating for the person whose weight(PW) is 80kgs.

The wheelchair alone weight 20kgs(WW) ,

So the total weight (TW) = PW+WW

= 80kgs+20kgs

=100kgs

The coefficient of friction between the rubber and concrete(μ) is 0.15(The value of the coefficient of friction is taken from the engineeringedge.com website). Converting the total weight which is in kilograms into Newton by using the formula 1Kg = 9.81N

Therefore, Weight(100kg)(W) = 981N.

Now the torque required is Calculated by using the formula.

The torque required(T) = product of the coefficient of friction(μ), Weight(W), and Radius of the Wheel in meters(R).

i.e., T = μ*W*R

T= 0.15*981*0.3

T= 44.145Nm

Now let us assume the maximum speed required for the wheelchair is 0.5m/sec.

The formula for the linear speed of the wheelchair is D*π*N/60.

Therefore, D*π*N/60 = 0.5

N = 0.5*60/0.6*π

= 15.915 rpm

= 16 rpm

Now calculate the power required for the wheelchair in HP (horsepower) using the formula.

P = 2*π*N*T/4500

P = 2*π*16*4.414/4500

P = 0.0926 hp

Converting HP(horsepower) into watts using the equation

1 HP = 745.7 W

Therefore, 0.0926 hp = 69.05W

i.e., P = 69.05W

P = 70W

Therefore, the power required for the wheelchair for carrying an 80kg person is 70W.

Case 2: Inclined path

When traveling on an incline, wheelchairs encounter a force known as gradient resistance. This resistance arises from gravity acting on the wheelchair as it travels up the slope. The formula for gradient resistance is "g sin α", where g is the acceleration due to gravity and α is the angle of the incline. Since gradient resistance opposes the motion of the wheelchair, it causes the velocity to decrease and the acceleration to approach zero. As a consequence, the force required to push the wheelchair uphill (push force) becomes significantly reduced.

Therefore:

Torque = (Rolling Resistance + Gradient Resistance) * Radius

= [(umgcos α) + (mgsin α)] *r

= [(0.01*145*9.81*cos7.1) + (145*9.81*Sin7.1)] *0.254

Torque = 48.24Nm

Considering FOS = 1.5; Torque = 72.36Nm i.e.,

36.18Nm at one wheel

Power at one wheel = Torque * (v/r) = 36.18* (5.905) = 213.64 Watts

Since Case 2 requires more power, therefore designing for Sloped Path. Hence, selecting lorry wiper motor that has a power capacity of 250W, 12V and can run at 60 rpm. The maximum torque that can be achieved is 50 Nm. This motor can be powered by a 12V Lithium-ion battery.

2.3 CONVERSION OF EXISTING WHEELCHAIR INTO ELECTRICAL WHEELCHAIR

2.3.1 Choosing Motors and Power Source:

Two brushed DC motors with gearboxes for each driven will is chosen for better climbing

2.3.2 Mounting Motors and Sprockets: The motor brackets to the wheelchair frame near the wheels and sprockets are fixed to the motor shafts and wheelchair axles.

2.3.3 Chain Drive System:

Connect the motor sprockets to the wheelchair axle sprockets with chains. Ensure proper chain tension and alignment.

2.3.3 Electrical Control System:

This is the most critical part. You'll need a motor controller to regulate power to the motors based on user input (joystick or toggle switch).

Safety features like fuses and emergency stops are crucial.

III. CUSTOMIZATION OF WHEELCHAIR BASE USING IOT

3.1 Working of the Electric Wheelchair Project

The Arduino Uno microcontroller is the brain of the wheelchair, processing inputs and controlling outputs. It operates based on a program uploaded via the Arduino IDE. The program includes code to handle input from the joystick and Bluetooth module, process these inputs, and control various actuators and displays. The joystick is an analog input device connected to the Arduino. It typically has two potentiometers that provide variable resistance based on the joystick's position. The Arduino reads the voltage levels from these potentiometers through its analog input pins and converts these analog signals to digital values using an Analog-to-Digital Converter (ADC). These digital values represent the direction and speed of movement: Forward/Backward: Moving the joystick forward or backward changes the resistance, causing a variation in the voltage level read by the Arduino. This value is mapped to control the speed and direction of the wheelchair's motors. Left/Right: Moving the joystick left or right similarly changes the resistance, altering the voltage level read by the Arduino, which is mapped to control the differential speed of the motors for turning. The HC-05 Bluetooth module enables wireless communication between the Arduino and an Android smartphone. The Bluetooth module is configured in slave mode and connected to the Arduino via serial communication (TX and RX pins). The smartphone app sends control commands over Bluetooth, which are received by the HC-05 module and transmitted to Arduino. The Arduino processes these commands and translates them into motor control signals: Directional commands (e.g., forward, backward, left, right) are sent as specific data packets from the smartphone. The Arduino interprets these packets and adjusts motor speeds accordingly. Status updates, such as battery level or operational mode, can be sent from the Arduino to the smartphone for display in the app. The LCD is typically a 16x2 character display connected to the Arduino. It uses digital pins to communicate via either 4-bit or 8-bit mode. The Arduino sends text strings to the LCD to display information. The display shows real-time data such as battery status, error messages, and mode of operation (e.g., manual joystick control or Bluetooth control). Custom messages or prompts can also be displayed to guide the user through various functions or alert them to important conditions (e.g., low battery warning).

The automated sliding door operates based on input from a hand detection sensor, such as an infrared (IR) sensor. The sensor detects the presence of a hand by measuring the reflected IR light. When a hand is detected. The sensor sends a signal to the Arduino, triggering the door to open. The Arduino activates a motor or actuator connected to the door mechanism, causing it to slide open. After a predefined duration, the Arduino deactivates the motor or actuator, allowing the door to close automatically. This duration is set in Arduino's program.

The wheelchair base is designed to be modular, with compartments and mounting points for various accessories. Users can adjust the layout to accommodate personal items Modular compartments can be added or removed based on the user's needs. Custom mounts or holders can be 3D-printed or fabricated to fit specific items, such as medicine bottles or food containers.

Motors: The wheelchair uses high-efficiency DC motors to drive its wheels. Each motor is controlled by an H-bridge motor driver circuit connected to the Arduino. The H-bridge allows for bidirectional control of the motors (forward and reverse) and speed control via Pulse Width Modulation (PWM) The Arduino sends PWM signals to the motor driver to control the speed of the motors. Directional control is achieved by switching the polarity of the voltage applied to the motors through the H-bridge.

Power Supply: The wheelchair is powered by a rechargeable battery, providing a stable voltage to the Arduino, motors, and other electronic components. The power supply system includes A battery management system (BMS) to monitor the charge and health of the battery. Voltage regulators to ensure the Arduino and sensors receive a consistent voltage level. Charging circuitry to safely recharge the battery when connected to a power source.

Sensor Integration: Various sensors are integrated to enhance safety and reliability Obstacle detection sensors (e.g., ultrasonic sensors) can be mounted on the wheelchair to prevent collisions. These sensors send distance measurements to the Arduino, which can stop or slow down the wheelchair if an obstacle is detected within a predefined range. Battery level sensors monitor the state of charge and send alerts to the user when the battery is low, ensuring the wheelchair does not run out of power unexpectedly. Critical systems have redundant components to ensure reliability. Dual motor drivers can be used to provide backup in case of a failure. The control system may have a fail-safe mode that stops the wheelchair safely if a critical fault is detected.

Smartphone App Development: The Android app is developed using a platform like Android Studio, providing a graphical user interface for controlling the wheelchair. The app sends control commands via Bluetooth to the Arduino, such as direction, speed, and mode changes. It receives status updates from the Arduino and displays relevant information to the user, such as battery level and operational status. The app may also include additional features like logging usage data or providing remote diagnostics.

3.2 CIRCUIT DIAGRAM OF ELECTRIC WHEELCHAIR

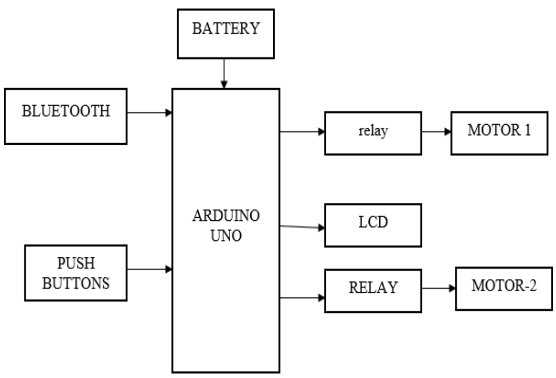


Figure 1: Block diagram of assembly

Arduino Uno: The Arduino Uno is a microcontroller board that acts as the brain of this circuit. It will provide power and ground connections to various components and interpret signals between them.

Servo motor: A servo motor is a type of motor that can rotate a specific angle. The wiring diagram shows the servo motor connected to pin 9 of the Arduino Uno. This suggests the Arduino Uno will control the angular position of the servo motor. Ultrasonic sensor: An ultrasonic sensor uses sound waves to detect objects at a distance. The diagram shows the ultrasonic sensor connected to the Arduino's trig pin (pin 11) and echo pin (pin 12). By sending a signal through the trig pin and measuring the return time on the echo pin, the Arduino can determine the distance of an object in front of the sensor.The text labels on the diagram further specify the power connections. The positive power supply (typically around 5 volts) is labeled "5v" and connects to the Arduino's "5V" pin. Ground (typically 0 volts) is labeled "GND" and connects to the Arduino's "GND" pin.

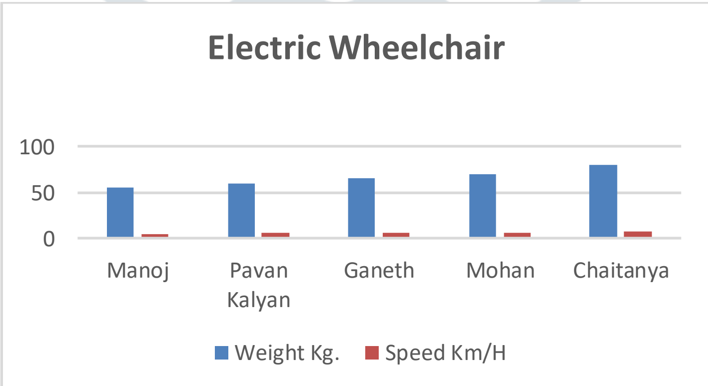
The exact functionality of this circuit would depend on the code uploaded to the Arduino Uno. However, given the components used, it is likely designed to be a basic robotic system that can detect and respond to its environment using the ultrasonic sensor and servo motor.

Figure 2: Finished wheelchair with customization

IV. RESULT

In this project a working model of electric wheel chair is done by programming Arduino using Arduino IDE, and the program is loaded into the Arduino board. The joystick gives facilitated control over the wheelchair. After interfacing all components according to the circuit diagram, we get the desired output. We have completed our project. In our project, we have used a joystick, an Arduino ATMega328P Controller, an L293D IC, two DC motors, and a Battery. The heart of the propulsion system is the battery and the motor to be fitted in the basement. The whole system is tested by driving the chair with the help of the joystick position. We succeeded in making the wheelchair successful in reclining for better mobility for the user with the manual mechanism that we placed in this wheelchair. Mainly the wheelchair can also be controlled by mobile control with the Bluetooth module. Wheelchairs are mobility devices with wheels, used by people who have difficulty walking or who cannot walk at all. Wheelchairs come in many different types, including manual wheelchairs, electric wheelchairs, and standing wheelchairs.

GRAPH:



Wheelchairs can be customized with various accessories, such as ramps, lifts, and hand controls. Many famous people use wheelchairs, including Stephen Hawking, FDR, and Frida Kahlo. The Paralympics is a sporting event for athletes with disabilities, including wheelchair athletes. Wheelchairs are an important tool for people with disabilities to live independently. The first wheelchairs were invented in China around 600 AD. The modern wheelchair was invented in the 18th century by John Joseph Merlin. Wheelchairs can be used for recreation, such as wheelchair racing and wheelchair basketball. Many famous people use wheelchairs, including Stephen Hawking and Frida Kahlo. Wheelchairs are an important tool for people with disabilities to live independently.

V. CONCLUSION

In conclusion, we completely designed this wheelchair specifically for individuals with physical disabilities who are unable to walk, allowing them to easily control it using a joystick. For those who cannot move their legs or hands, the reclining feature offers a practical solution, enhancing comfort and usability. The construction of this wheelchair incorporates several key components, including DC motors, an Arduino microcontroller, and a power distribution board to evenly distribute power from the battery. These components work together to ensure smooth and reliable operation. Electrical Wheelchair surely will be the best choice for disabled people as it enables them to lead a normal life like others. The technology mentioned here in this paper is simple, efficient, and cost-effective. We have completed our project within Twenty Thousand, but in the market, its price is above Seventy Thousand. Further studies on smart wheelchairs, may help us to a great extent in the future for the greater benefit of humankind. Our objective of creating a strong, lightweight wheelchair was successfully achieved. All design elements have been rigorously validated for safety through simulations, ensuring the highest standards of user protection. The bill of materials confirms that the product is more affordable compared to other wheelchairs on the market, making it accessible to a wider range of users. This design simplifies the process of transferring patients from wheelchairs to stretchers by combining both functions into one versatile device. The electric wheel chair is designed to carry a weight of 80kgs and battery capacity is arranged for a life of 30min.

VI. REFERENCES

[1] Design And Analysis of Electric Wheelchair Cum Stretcher by Siddhant Pawar1, Yogesh Kanade2, Hemant Singh3

[2] Design And Construction of Electric Wheelchair with Mecanum Wheel by NuntachaiThongpance 1, PhichitphonChotikunnan 2

[3] Design of Motorised Wheelchair for Paraplegic by Sangeetha 1, Shreeshayana 2

[4] Joystick Controlled Wheelchair by Trinayan Saharia1, Jyotika Bauri2, Mrs. Chayanika Bhagabati

[5] Electric Wheelchair for Physically Challenged by P. Swapna 1, Dr. B. Sharmila2, Y. Dhan3