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AI Assisted Electric Tricycle for Paraplegic Individuals

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Abstract: In today's rapidly developing world, transportation has become an essential requirement for individuals to travel independently and perform daily activities efficiently. Mobility plays a vital role in education, employment, healthcare, and social interaction. However, paraplegic individuals often face significant challenges in commuting due to limited accessibility, dependence on caregivers, and the high cost of advanced assistive mobility devices. Difficulties such as *maneuvering* ***vehicles, reversing, parking, travelling during unfavourable conditions, and maintaining physical stability reduce their independence and confidence. To address these issues, this project introduces an "AI Assisted Electric Tricycle for Paraplegic Individuals", an intelligent, eco-friendly, and cost-effective mobility solution designed to enhance independent transportation for differently abled users. The proposed tricycle is powered by an electric drive system integrated with rechargeable battery technology, providing smooth and efficient transportation with minimal operational cost. The system incorporates Artificial Intelligence-assisted features for safer and smarter mobility assistance. The tricycle is designed with advanced functionalities such as motorized reverse driving assistance, obstacle awareness support, intelligent control assistance, lighting system, horn, and user safety features to ensure reliable operation under different travelling conditions. The reverse driving mechanism eliminates the need for manual vehicle movement, which is often difficult for paraplegic users. In addition, the vehicle structure is designed to provide comfort, stability, and ease of access for long-distance travel. The proposed vehicle also promotes sustainable transportation by reducing dependence on conventional fossil fuels and minimizing environmental pollution. Compared to conventional mobility aids and modified scooters, the proposed tricycle offers lower maintenance cost, improved user independence, and enhanced accessibility at an affordable price. A working prototype of the AI Assisted Electric Tricycle was developed to demonstrate the practical implementation of the system. The project mainly aims to empower paraplegic individuals by providing a reliable, intelligent, and self-sustaining mobility solution that improves their quality of life while encouraging inclusive and environmentally responsible transportation technology.***

Keywords: Artificial Intelligence (AI), Electric Tricycle, Paraplegic Individuals, Smart Mobility, Assistive Technology, Sustainable Transportation, Motorized Reverse System, Battery Powered Vehicle, Intelligent Mobility Assistance, Eco-Friendly Vehicle.

I. INTRODUCTION

Mobility is one of the fundamental necessities of human life, enabling individuals to access education, employment, healthcare, and social interaction. For paraplegic individuals, independent transportation remains a major challenge due to physical limitations, inaccessible public infrastructure, and the high cost of advanced assistive mobility systems. Most conventional mobility aids require external assistance for operation, reversing, parking, and maneuvering in difficult environments, thereby reducing the independence and confidence of differently abled individuals.

With the rapid advancement of electric vehicle technology and artificial intelligence, there is a growing opportunity to develop intelligent mobility solutions that are affordable, efficient, and user-friendly. Electric tricycles have emerged as a promising alternative to conventional mobility vehicles because of their stability, low operational cost, and eco-friendly nature. However, many existing systems lack intelligent assistance and adaptive features specifically designed for paraplegic users. The proposed project, "AI Assisted Electric Tricycle for Paraplegic Individuals," aims to develop an advanced electric mobility system integrated with AI-assisted functionalities to improve user safety, comfort, and independence. The vehicle is powered by a rechargeable battery-operated electric drive system and incorporates smart assistance features such as obstacle awareness support, motorized reverse driving, intelligent control assistance, lighting systems, and safety mechanisms. These features help users operate the vehicle more effectively without depending on others.

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The tricycle is designed to provide enhanced stability, ease of operation, and reliable transportation for short and medium distance travel. The integration of AI assistance improves decision support and user interaction, making the vehicle more adaptive to real-world conditions. In addition, the use of electric power contributes toward sustainable transportation by reducing fuel consumption, environmental pollution, and maintenance cost.This project mainly focuses on empowering paraplegic individuals by providing a self-sustaining, affordable, and intelligent mobility solution that enhances their quality of life and promotes inclusive transportation technology. A functional prototype was developed to validate the practical implementation and performance of the proposed system.

Fig. 1 Conventional Vehicle for Paraplegia Persons

II. LITERATURE SURVEY

Several research studies and technological developments have been carried out in the field of assistive electric mobility systems for differently abled individuals. Existing works mainly focus on improving mobility, safety, comfort, energy efficiency, and intelligent assistance for paraplegic users through electric propulsion and smart control technologies.

R. Kumar and S. Anand (2018) presented an Assistive Mobility Technologies for Differently Abled Individuals, discussed the importance of electric mobility solutions for paraplegic individuals. It strongly demonstrate that conventional wheelchairs have limitations in terms of speed, outdoor usability, and physical effort. Electric tricycles were identified as a better alternative due to improved stability, higher load capacity, and ease of balance control. However, the systems mainly depended on manual operation and lacked intelligent assistance features.

M. Priya, K. Jayanthi, and S. Dhivya (2020) proposed Design and Development of Electric Tricycles for Rehabilitation Applications, focused on the ergonomic and rehabilitation aspects of electric tricycles. The authors emphasized the importance of comfortable seating, proper weight distribution, and vibration reduction for user safety and comfort. Brushless DC (BLDC) motors and lithium-ion batteries were widely recommended because of their high efficiency, low maintenance, and reliable performance. The study concluded that although these systems improved mobility, they still required significant manual user control.

A. Sharma and D. Pant (2021) elaborated Applications of Artificial Intelligence in Assistive Transportation, highlighted the growing role of Artificial Intelligence in mobility systems. The study explained how AI technologies such as machine learning, computer vision, and sensor fusion improve obstacle detection, intelligent navigation, adaptive control, and user safety. The authors also discussed the use of ultrasonic sensors, accelerometers, IoT communication modules, and cloud-based monitoring systems for real-time decision-making and remote monitoring.

S. Deori and R. A. Rajesh (2022) proposed a Smart Sensor Integration in Electric Assistive Vehicles, explained the integration of smart sensors and IoT technology in electric vehicles. It concentrates on how ultrasonic sensors, gyroscopes, accelerometers, and monitoring systems can continuously track vehicle conditions such as speed, tilt, battery health, and obstacle distance. IoT platforms allow real-time data transmission and remote monitoring, improving safety and emergency response for paraplegic users.

R. Shamsini and W. Iskak (2023) developed Intelligent Safety Systems for Electric Mobility Devices, proposed AI-based obstacle detection systems using ultrasonic sensors, cameras, and intelligent algorithms. These systems help detect static and dynamic obstacles and provide preventive actions such as alerts, automatic braking, or speed reduction. The study concluded that intelligent safety systems significantly improve user confidence, safety, and independent navigation.

J. Lee and M. Karthik (2023) discussed Energy-Efficient Electric Drive Systems, energy management and efficiency optimization in electric tricycles. The study explained that intelligent motor control, adaptive speed regulation, and optimized power management improve vehicle efficiency and battery performance. Efficient energy management techniques help increase driving range and reduce energy consumption in assistive electric vehicles.

T. A. Kumar and R. Gupta (2024), demonstrated Human–Machine Interaction in Assistive Electric Vehicles, discussed the importance of Human–Machine Interface (HMI) systems in assistive transportation. The authors highlighted voice-controlled systems, mobile application interfaces, and AI-assisted interaction methods that simplify vehicle operation for paraplegic individuals. The study concluded that intelligent HMI systems improve accessibility, user comfort, safety, and overall user experience.

From the literature reviewed, it is observed that many existing systems focus individually on electric mobility, IoT monitoring, AI assistance, safety systems, or energy management. However, very few systems integrate all these technologies into a single intelligent electric tricycle specifically designed for paraplegic individuals. Therefore, the proposed AI Assisted Electric Tricycle aims to combine electric mobility, AI-assisted monitoring, ultrasonic obstacle detection, MPU6050-based stability monitoring, Blynk IoT communication, and an AI-assisted mobile application into one integrated system to provide safer, smarter, and more independent mobility assistance.

III.PROPOSED METHODOLOGY

A. Mechanical Design

The mechanical design of the proposed AI Assisted Electric Tricycle was developed by considering stability, user comfort, load carrying capacity, and operational safety for paraplegic individuals. The total load capacity of the vehicle, including the rider, battery system, and supporting components, was estimated during the design process. Various mechanical parameters and forces acting on the tricycle such as traction force, rolling resistance, braking force, and load distribution were analysed to ensure safe and efficient operation under different road conditions.

The drivetrain mechanism of the vehicle was designed using a chain and sprocket arrangement to achieve reliable power transmission from the electric motor to the rear wheel. Appropriate gear ratio selection was carried out to provide better torque, smooth acceleration, and efficient vehicle movement. The braking system was also analysed to determine the required braking torque for safe stopping and improved rider control.

A 3D model of the tricycle was designed using Blender software to visualize the structural arrangement and component placement of the vehicle. Proper consideration was given to the centre of gravity to improve stability during movement on horizontal surfaces, turning conditions, and inclined roads. Stability analysis was performed to ensure safe operation of the tricycle without risk of imbalance or overturning during practical usage.

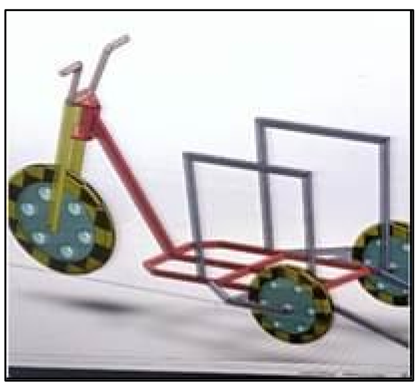

Fig. 2 Prototype 3D Model

B. Electrical Design

The electrical design of the proposed AI Assisted Electric Tricycle was developed by considering performance, energy efficiency, safety, and reliability for paraplegic mobility applications. A Brushless DC (BLDC) motor was selected as the drive unit due to its high efficiency, low maintenance, compact size, and smooth electronic speed control.

A lithium-ion battery was used as the main energy storage system because of its lightweight structure, high energy density, and longer life cycle. The battery system includes a Battery Management System (BMS) for protection against overcharging, overheating, over-discharging, and short-circuit conditions. An MCB (Miniature Circuit Breaker) was also incorporated to provide additional electrical protection against overload and fault conditions, ensuring safe operation of the vehicle.

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The electrical system was integrated with safety and intelligent assistance features such as ultrasonic sensors for obstacle detection, MPU6050 sensor for motion and tilt monitoring, relay modules for electrical control, and a buzzer for warning indications. The sensor data is transmitted through the Blynk IoT platform for real-time monitoring and smart control. An AI-assisted mobile application was also developed for intelligent detection and user assistance, thereby improving safety, accessibility, and independent mobility for paraplegic individuals.

C. Electronic Design

The block diagram of the proposed AI Assisted Electric Tricycle for Paraplegic Individuals illustrates the integration of mechanical, electrical, electronic, and IoT-based subsystems to achieve intelligent and safe mobility. The system is powered by a lithium-ion battery pack, which supplies energy to the entire vehicle. An MCB (Miniature Circuit Breaker) is connected in series with the battery to ensure protection against overload and short-circuit conditions. The Battery Management System (BMS) is used to monitor and protect the battery from overcharging, over-discharging, and thermal issues.

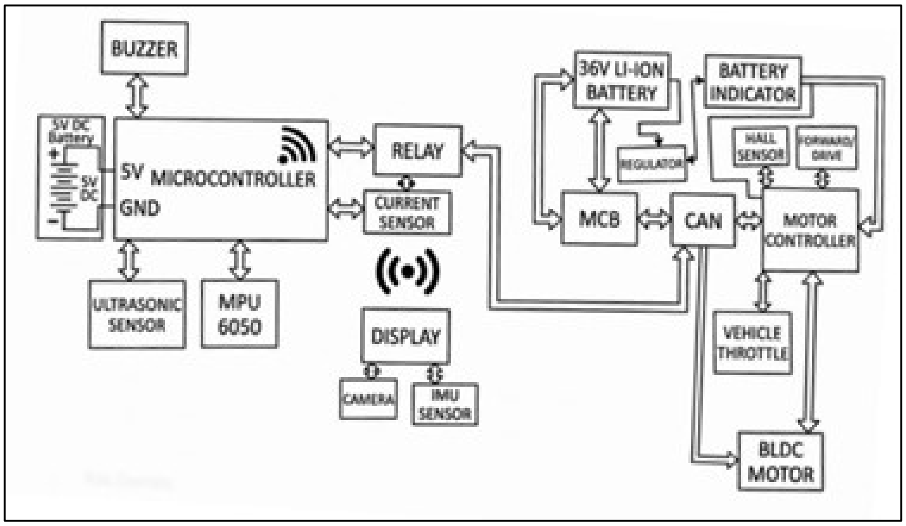

Fig. 3 Block Diagram of the Proposed Tricycle for Paraplegia Persons

The energy from the battery is supplied to a Brushless DC (BLDC) motor through a motor controller, which regulates speed and direction of the tricycle. The drivetrain system converts motor power into mechanical motion to drive the rear wheel using a chain and sprocket mechanism. The Brain of the IoT System is ESP8266. For safety and intelligent assistance, an ultrasonic sensor is used for obstacle detection, while the MPU6050 sensor monitors tilt, motion, and stability of the vehicle. The sensor signals are processed through a microcontroller unit, which acts as the central control system. A relay module is used for switching and controlling different electrical loads such as lighting, horn, and auxiliary systems. A buzzer is integrated to provide real-time warning alerts during obstacle detection or unsafe operating conditions. The processed data from sensors is transmitted to the Blynk IoT platform for real-time monitoring and control.

In addition, an AI-assisted mobile application is developed to support intelligent decision-making, enhance user interaction, and improve safety features for paraplegic users. Overall, the block diagram represents a smart mobility system that combines electrical propulsion, sensor-based safety, and IoT connectivity to provide an efficient and independent transportation solution.

D. Working of the AI Assisted Electric Tricycle

The proposed AI Assisted Electric Tricycle for Paraplegic Individuals operates as an integrated smart mobility system combining electrical propulsion, sensor-based safety, IoT connectivity, and AI-assisted monitoring. The system is powered by a lithium-ion battery, which supplies regulated energy to the entire tricycle through an MCB (Miniature Circuit Breaker) for protection against overload and short circuits. The Battery Management System (BMS) ensures safe charging and discharging by monitoring voltage, current, and temperature conditions. The energy from the battery is supplied to a BLDC motor through a motor controller, which regulates speed and direction of movement. The drivetrain converts this rotational energy into mechanical motion using a chain and sprocket mechanism, enabling smooth vehicle operation. For safety and intelligent assistance, an ultrasonic sensor continuously detects obstacles in front of the vehicle. When an object is detected within a predefined distance, the system triggers a buzzer to provide an immediate warning to the user. At the same time, relay modules are activated to control or isolate specific electrical loads such as motor cut-off, lighting, or auxiliary systems for safety purposes.

The MPU6050 sensor is used to monitor tilt angle, acceleration, and overall vehicle stability. If abnormal tilting or unsafe motion is detected, the system generates alerts and can assist in preventive control actions to avoid instability or accidents. All sensor data including ultrasonic readings, motion parameters, and system status are transmitted to the Blynk IoT platform, enabling real-time monitoring and remote visualization of vehicle conditions through a mobile interface.

The ESP8266 microcontroller was used as the main control unit in the proposed AI Assisted Electric Tricycle system. The ESP8266 is a low-cost and high-performance Wi-Fi enabled microcontroller used widely in IoT and embedded system applications. It is powered by a Tensilica L106 32-bit RISC processor and operates at a clock frequency of 80 MHz, which can be extended up to 160 MHz for higher processing speed. The controller operates at 3.3V and supports built-in Wi-Fi communication based on the IEEE 802.11 b/g/n standard, enabling wireless data transmission and remote monitoring applications. The ESP8266 supports multiple communication protocols such as UART, SPI, I2C, and PWM, allowing easy interfacing with sensors, relays, and other peripheral devices.

The controller acts as the central processing unit of the system by receiving input data from various sensors such as the ultrasonic sensor and MPU6050 sensor. Based on the sensor readings, the ESP8266 processes the data and controls the corresponding outputs including buzzer alerts, relay operations, and safety indications. The ultrasonic sensor was interfaced using Trigger and Echo pins connected to the GPIO pins of the ESP8266 for obstacle detection. The MPU6050 sensor was connected through the I2C communication protocol using SDA and SCL pins for motion and tilt monitoring. Relay modules and the buzzer were connected to digital output pins for controlling electrical operations and warning alerts. The ESP8266 also communicated with the Blynk IoT platform through its built-in Wi-Fi module for real-time monitoring and data transmission.

In addition, an AI-assisted mobile application was developed using MIT App Inventor, where an AI camera module is integrated for basic visual detection and user assistance. This application provides an interactive interface for monitoring sensor data, receiving alerts, and assisting the user in understanding surrounding conditions. Overall, the system operates as a smart mobility platform where sensor inputs, IoT communication, and AI-based application support work together to ensure safe, efficient, and independent transportation for paraplegic individuals.

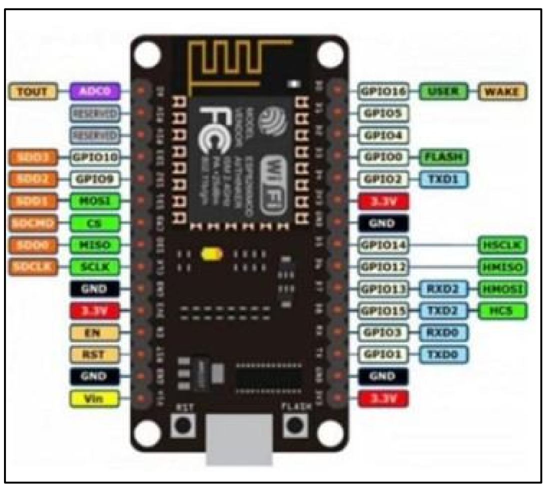

Fig. 4 ESP8266 Pinout

IV. RESULTS AND DISCUSION

The tricycle was successfully developed based on the Proposed design and was thoroughly tested to evaluate its performance, efficiency, and braking effectiveness. Testing was conducted under warm environmental conditions to ensure safe operation and stable performance of the system. The vehicle was tested on normal road conditions with standard traffic flow to verify smooth functioning and user comfort during regular usage. Additionally, it was evaluated in heavy traffic conditions to ensure the reliability and effectiveness of the braking system, as well as to confirm safe stopping performance under sudden or frequent stop situations. These test conditions helped in validating the overall stability, safety, and real-time operational capability of the AI Assisted Electric Tricycle for practical use.

Fig. 5 Fabricated Tricycle

Table 1 – Condition Verification

Road condition	Flat roads with small slopes
Weather condition	Warm weather
Weight of test person seated	85 kg
Distance covered in one full run	19 km
Maximum speed obtained	41 km/h
Brakes	Working accurately
Seating	perfect
Hand pedaling	Not Possible

A. Output Observations with Ultrasonic Sensor

Case 1: No Obstacle Detection

When the vehicle was operated under normal conditions with no obstacle within the predefined safety range, the system functioned smoothly without interruption. The ultrasonic based sensor continuously measured distance and transmitted safe readings greater than the threshold value. Since no obstacle was detected, the motor controller allowed normal BLDC motor operation. The vehicle accelerated and decelerated smoothly according to throttle input. There was no buzzer activation and no warning indication on the display. Current consumption remained stable within rated limits.

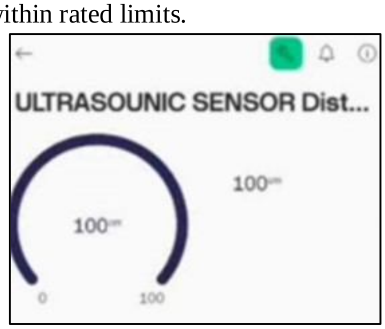

Fig. 6 No Obstacle Detected

Case 2: Obstacle Detection

When an obstacle was introduced in front of the vehicle, the system immediately responded based on the measured distance. As the object entered the safety threshold range, the motor speed reduced gradually, ensuring controlled deceleration.

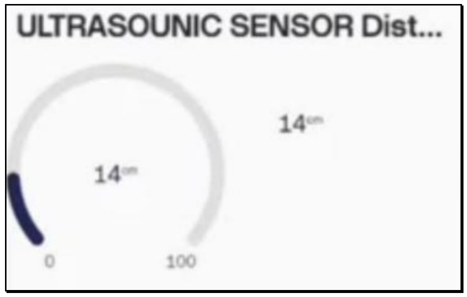

Fig. 7 Object Detected

B. Output Observations using Camera

In this system, object recognition is used to identify obstacles in front of the vehicle and assist in safe navigation. It is a part of Artificial Intelligence, where the system detects and recognizes objects using sensor data. Instead of using a camera-based system, this project utilizes an ultrasonic sensor to recognize the presence of objects by measuring distance. When an object is detected within a predefined threshold range, the system triggers a buzzer alert to warn the user and prevent collisions. This approach provides a simple and cost-effective method of object recognition, improving safety and reliability in the electric vehicle system.

Fig. 8 Object detection using Camera

C. Output Observation using MPU6050

To test stability protection, the vehicle was intentionally tilted beyond the preset safe angle. The MPU6050 sensor detected abnormal tilt instantly. As soon as the tilt exceeded the safety limit, the motor controller output was cut off and the vehicle stopped immediately. The buzzer was activated to alert the rider to the unsafe condition. The response was rapid and consistent in repeated tests. The system effectively prevented potential fall conditions by stopping the vehicle without delay

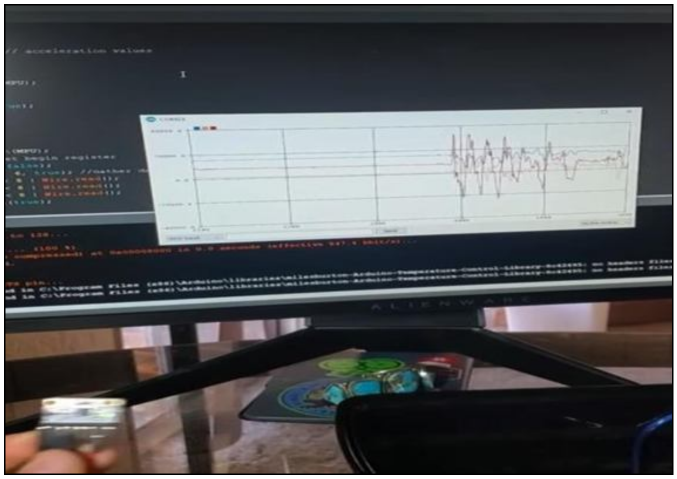

Fig. 9 MPU6050 output

D. Dashboard Output

The EV dashboard unit provided continuous real-time information during all operating conditions. Under normal movement, it showed speed, battery level, and system parameters accurately. When obstacle detection, tilt condition, or high current occurred, the display immediately reflected the warning status. Speed updates were smooth and responsive during acceleration and deceleration. The display remained stable without flickering or *delay*

Fig. 10 Dash board Display

E. Current Sensing

The current sensor plays a vital role in maintaining the overall safety and efficiency of the system by continuously tracking the flow of current in real time. It provides accurate analog signals corresponding to the load conditions, which are processed by the microcontroller for decision-making. During normal operating conditions, the sensor readings remained stable and within the predefined safe threshold, indicating that the motor was functioning efficiently without any overload. As the load on the motor increased, a proportional rise in current was observed, demonstrating the sensor's sensitivity and responsiveness. When the current exceeded the preset safety limit, the system responded immediately by triggering protective actions such as activating the relay to disconnect the motor supply.

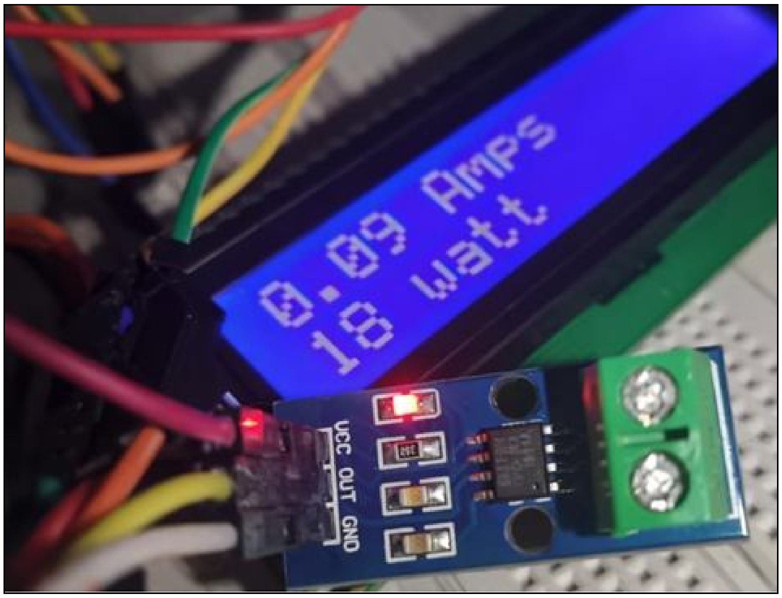

Fig. 11 Sensing the Current Rating

F. Battery Level Determination

The battery level indicator is an essential component in an electric vehicle, as it provides real-time information about the remaining energy in the battery. This helps the user monitor the charge level and plan vehicle operation accordingly, preventing unexpected power loss. From a hardware perspective, the battery level indicator system consists of a voltage sensing circuit, microcontroller, and display unit. The battery voltage is measured using a voltage divider circuit, which reduces the high battery voltage to a safe level suitable for the microcontroller. This measured voltage is then processed to estimate the state of charge (SoC) of the battery. A display device, such as an LCD, LED indicators, or a tablet interface, is used to present the battery status to the user

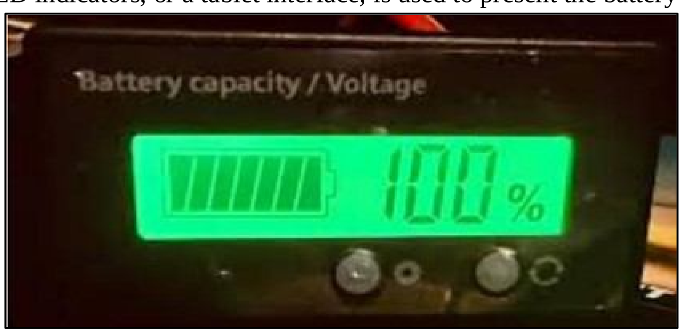

Fig. 12 Battery Level Indication

In this system, object recognition is used to identify obstacles in front of the vehicle and assist in safe navigation. It is a part of Artificial Intelligence, where the system detects and recognizes objects using sensor data. Instead of using a camera-based system, this project utilizes an ultrasonic sensor to recognize the presence of objects by measuring distance. When an object is detected within a predefined threshold range, the system triggers a buzzer alert to warn the user and prevent collisions. This approach provides a simple and cost-effective method of object recognition, improving safety and reliability in the electric vehicle system

V. CONCLUSION

The development of a personalized electric tricycle for individuals with disabilities enhances inclusive and accessible mobility by combining user-centred design with advanced technologies. Features such as a flat platform, secure locking mechanisms, and ramps ensure easy wheelchair access and safe travel. Systems like obstacle detection, along with components such as LiDAR, ToF sensors, GPS, and lithium-ion batteries, improve performance, control, and navigation. The project can be further enhanced with smart control options like voice, mobile app, and joystick operation, along with health monitoring sensors for emergency alerts.

Additional safety features such as automatic braking, tilt detection, and lighting systems, combined with intelligent driving capabilities, improve overall reliability. Power efficiency can be increased through solar support and battery management, while GPS tracking, geo-fencing, and anti-theft systems strengthen navigation and security. User comfort is improved with adjustable seating and protection features, and communication systems enable emergency messaging. Overall, the project promotes independence, safety, and equality, redefining mobility through innovation and accessibility

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