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Fabrication of IoT Based E-Vehicle for Physically Challenged People

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Abstract- The Mobility is essential for everyone, yet physically challenged individuals often face limited options. While hand-operated tricycles and retrofitted scooters are commonly used, they come with drawbacks-manual bikes require significant effort, while IC engine-powered scooters are costly and need regular maintenance. To address these challenges, our project focuses on designing an eco-friendly bike powered by a BLDC motor, providing a convenient and affordable mobility solution for disabled individuals, especially those from economically weaker backgrounds. Additionally, IoT-based modules, including Arduino and a GSM module, enhance the bike's functionality. These components collect real-time sensor data, enabling efficient monitoring and control via an Android app. By integrating IoT technology, this smart vehicle ensures greater safety, reliability, and ease of use. The system allows users to track and manage vehicle parameters remotely, offering a seamless riding experience. This innovative approach bridges the gap between technology and accessibility, promoting sustainable and inclusive mobility solutions.

Keywords- BLDC motor, IoT, Arduino, GSM module, Eco-Friendly Bike, Smart vehicle, Android app, Accessibility.

I. INTRODUCTION

Mobility plays a crucial role in our everyday lives, allowing us to move freely, work, and participate in social activities. However, for individuals with physical disabilities and elderly people, transportation can be a major challenge. Many traditional vehicles, such as motorcycles, bicycles, and cars, are not designed to accommodate their needs, limiting their independence. While some mobility aids, like hand-operated tricycles and retrofitted scooters, offer partial solutions, they come with their own set of problems. Hand-operated tricycles require a lot of physical effort, making long-distance travel exhausting, while modified scooters, which run on internal combustion engines (ICEs), are expensive and require regular maintenance. These limitations highlight the need for a better alternative.

Conventional vehicles that rely on internal combustion engines burn fossil fuels like petrol and diesel to generate power. Unfortunately, this process releases harmful pollutants such as carbon monoxide, nitrogen oxides, and unburnt hydrocarbons, contributing to air pollution and various health problems. Additionally, greenhouse gases like carbon dioxide and methane accelerate global warming, leading to climate change. With growing concerns about environmental degradation, it is crucial to explore sustainable transportation solutions that reduce carbon footprints while ensuring accessibility for all.

Electric vehicles (EVs) have emerged as a promising alternative, providing an eco-friendly and efficient mode of transport. Unlike fuel-powered vehicles, EVs produce zero emissions, significantly reducing air pollution and environmental harm. They also operate more quietly, making them ideal for use in public spaces such as hospitals, shopping malls, bus stops, and railway stations, where pollution-free mobility is essential. However, while electric bikes and motorized mobility solutions exist for disabled individuals, many of them still face design challenges. Issues such as low ground clearance, difficulty in manoeuvrings tight spaces, and instability on uneven surfaces make these vehicles less practical and comfortable.

To address these challenges, this project introduces Electro-Handy, a specially designed electric vehicle for physically challenged individuals and the elderly. Unlike conventional electric bikes, Electro-Handy focuses on comfort, safety, and ease of use while being affordable and requiring minimal maintenance. The design tackles key concerns such as stability, smooth operation, and adaptability to different terrains, ensuring a hassle-free experience for users. By integrating advanced technologies like battery-powered motors and intelligent control systems, Electro-Handy enhances mobility while promoting sustainability.

Beyond personal convenience, it carries a much deeper significance. As the world moves towards cleaner and greener transportation, it is essential to create solutions that cater to everyone, including vulnerable populations. Electro-Handy represents a step towards a more inclusive and sustainable future, empowering individuals with physical limitations to reclaim their independence while reducing environmental impact. By shifting towards electric mobility, we can contribute to a cleaner, healthier planet while improving the quality of life for those who need it most.

The mobility is a necessity, not a luxury. With advancements in technology, there is no reason why physically challenged individuals and the elderly should be left behind. The Electro-Handy project aims to bridge this gap by providing a practical, comfortable, and efficient electric vehicle that enhances freedom, confidence, and well-being. Through this innovation, we take a step closer to making transportation accessible for all while contributing to a sustainable future.

II. LITERATURE REVIEW

Asadi et al to explored the design and development of a hybrid electric motorcycle that combines both a fuel-powered engine and an electric motor. Unlike traditional hybrids, this through-the-road parallel hybrid system allows the two power sources to work independently on different wheels, improving efficiency and flexibility. The researchers used Simulink simulations to analyse energy use, fuel savings, and emissions before building a working prototype [1].

Chang et al to introduced the how to make pedal-assisted electric bikes smoother and more efficient by improving their speed control system. In real-world riding, factors like road slopes, wind resistance, and rider effort can cause speed fluctuations. To tackle this, researchers developed a disturbance observer-based control system that detects and adjusts for these changes in real time. Using mathematical modelling and simulations, they tested how well this system improves speed stability and energy efficiency [3].

Gupta et al to the development of a hybrid tricycle that combines both electric power and human pedalling to create a more efficient and sustainable mode of transport. The goal is to design a system that optimizes energy use, improves performance, and reduces rider fatigue. Researchers used simulations and prototype testing to analyse factors like battery efficiency, motor performance, and pedalling effort to find the right balance between power sources. The results showed that the hybrid tricycle offers better energy efficiency, longer travel range, and a more comfortable riding experience compared to traditional pedal-powered tricycles [5]. Mehra et al to explored the development of a three-wheel electric car designed to enhance mobility for physically disabled individuals. The goal is to create a compact, lightweight, and energy-

efficient vehicle that is easy to use in urban environments. Special focus is given to ergonomic design, accessibility, and user-friendly controls, ensuring a comfortable and safe driving experience. Powered by electric propulsion, the vehicle offers a clean and cost-effective alternative to traditional mobility aids while reducing carbon emissions [10].
Tong et al This study explores the development of an assist mode hybrid electric motorcycle that improves performance and fuel efficiency. Unlike traditional hybrids, this motorcycle features an assist mode, where the electric motor provides extra power during acceleration and high-load conditions, reducing strain on the internal combustion engine (ICE). Researchers used simulations and prototype testing to optimize the balance between engine and electric motor power [14].

Zhang et al to improve the travel planning for fully electric vehicles (EVs) in ever-changing traffic conditions using a multi-objective optimization approach. Since EVs have limited battery range and rely on charging stations, planning an efficient route is crucial. The research focuses on finding the best balance between travel time, energy consumption, and charging needs [15].

III. DESCRIPTION OF EXISTING SYSTEM

The physically challenged individuals mainly depend on wheelchairs for mobility. While these wheelchairs help them move around, they come with several challenges. Manual wheelchairs require the user to push the wheels using their hands, which can be exhausting, especially for those with limited upper body strength. Some people rely on caregivers to push them, reducing their independence. Electric wheelchairs, though more convenient, still have their drawbacks. They are expensive, need frequent charging, and often lack smart features that could make mobility easier. Navigating them in tight spaces or rough terrain can also be difficult. Most traditional wheelchairs, whether manual or electric, don't come with essential safety features like obstacle detection, automatic braking, or emergency alerts, increasing the risk of accidents. Additionally, for individuals with severe disabilities who cannot use a joystick or buttons, even an electric wheelchair may not be a practical solution.

Figure.1. Existing System of Electrical wheel chair

These challenges highlight the need for a smarter, more advanced mobility option. An IoT-based e-vehicle designed specifically for physically challenged individuals could provide features like voice control, mobile app operation, GPS tracking, and smart obstacle detection. This kind of innovation would not only make movement easier but also enhance safety and independence, giving users a greater sense of freedom in their daily lives. For many physically challenged individuals, moving around on their own can be a daily struggle.

While wheelchairs have been a crucial tool for mobility, they still come with several challenges. Manual wheelchairs require constant effort to push, which can be exhausting, especially for those with limited upper body strength. Some users have to rely on caregivers for movement, making them feel less independent. Electric wheelchairs offer a more convenient alternative, allowing users to control them with a joystick or buttons. However, they are expensive, need frequent charging, and don't always provide the level of comfort and ease that users need.

IV. COMPONENTS OF EXISTING SYSTEM

The IoT-Based E-Vehicle for Physically Challenged People is designed to provide enhanced mobility, safety, and independence. This system brings together several key components to create a smart, user-friendly solution for individuals with physical disabilities. At the heart of the system is the Arduino Uno, which acts as the brain, processing inputs and controlling various components. It is powered by a battery, ensuring a steady energy supply for smooth operation. To make the vehicle more sustainable, a solar panel is included, allowing the battery to recharge using sunlight, reducing reliance on external power sources.

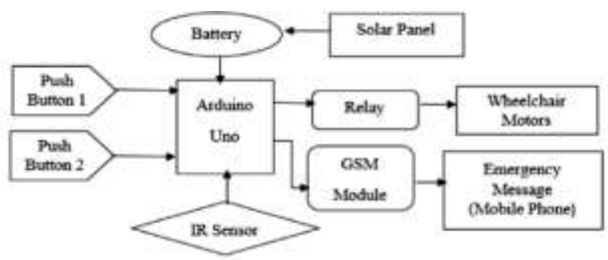

Figure 2. Block Diagram of Existing System

For movement, the wheelchair motors provide efficient and controlled motion, making it easy for users to navigate different terrains. A push button is integrated to offer a simple control mechanism, allowing users to operate the vehicle effortlessly. Safety is a top priority, so an IR sensor is added to detect obstacles and help prevent collisions, ensuring a secure ride. In case of emergencies, the system features a GSM module, which sends emergency messages to phones, alerting caregivers or family members if the user needs assistance.

A relay module is also incorporated to manage power distribution between different components, ensuring smooth and reliable functionality. Together, these components create an intelligent and accessible e-vehicle, empowering physically challenged individuals with greater freedom and security. By combining renewable energy, automation, and real-time communication, this system makes transportation more convenient and safer for those who need it most.

It is designed to provide greater mobility, safety, and independence. At its core, the Arduino Uno acts as the brain, seamlessly managing signals from various components. A battery powers the vehicle, while a solar panel harnesses sunlight to recharge it, making the system eco-friendlier and more efficient. For smooth movement, wheelchair motors are integrated, allowing users to navigate effortlessly. A push button offers simple and intuitive control. To ensure safety, an IR sensor detects obstacles, preventing collisions and ensuring a secure ride. In case of emergencies, a GSM module automatically sends alert messages to phones, ensuring that help is always within reach.

V. PROPOSED SYSTEM

It is designed to provide a safe, efficient, and smart mobility solution for physically challenged individuals. By integrating IoT technology, automation, and reliable power management, this e-vehicle enhances independence and ease of movement. At the core of the system is an Arduino microcontroller, which acts as the central unit, ensuring smooth coordination between all components. To power the vehicle, a 48V lithium battery is used, offering a stable and long-lasting energy source. This battery supplies power to a 48V brushless DC (BLDC) motor, which provides smooth and efficient movement.

The motor driver plays a key role in controlling the motor's speed and direction based on input commands, allowing the user to navigate effortlessly. Since different components require varying voltage levels, a 48V to 12V DC converter is included to step down the voltage, ensuring safe and efficient power distribution to the Arduino, lights, and sensors. Safety is a top priority in this system. A GSM module is integrated to enable emergency communication, allowing the vehicle to send alert messages to predefined phone numbers if the user needs assistance. This feature ensures that help is always within reach, providing peace of mind to both the user and their caregivers. Additionally, lights and switches are included to improve visibility and make the vehicle easier to operate. The lights enhance safety during low-light conditions, while the switch allows the user to turn the system on and off conveniently.

Block Diagram

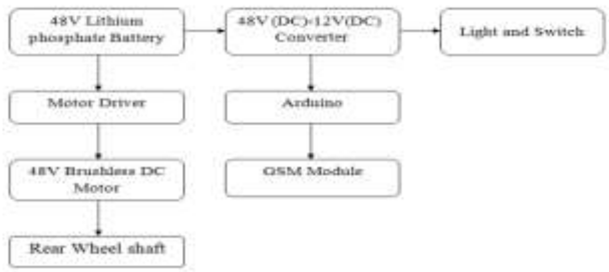

Figure 3. Block Diagram of Proposed System

The Arduino microcontroller acts as the brain of the system, processing input signals and managing various components. The BLDC motor ensures efficient operation with lower maintenance compared to traditional brushed motors, making the vehicle more durable and reliable. The motor driver facilitates precise control, ensuring smooth acceleration and braking for a comfortable riding experience. This IoT-based e-vehicle is designed to be a user-friendly and smart mobility solution that empowers physically challenged individuals. With features like emergency messaging, energy-efficient motor control, and seamless automation, the system provides both convenience and safety.

Material Specification

S.No	SPECIFICATION	VEHICLE
1	Battery Capacity	48V,30Ah
2	Charging time	50Minutes
3	Maximum speed	40km/hr
4	Wheels & Tiers	3wheels(Front-1 & Back-2)
5	IoT kit	GSM module, Arduino
6	Weight	90kg
7	Load capacity	200kg
8	Watts	750W
9	Motors	BLDC Motor

Figure 4. Material Specification

Proposed System Methodology

Planning

- The first step is to identify the key mobility challenges faced by physically challenged individuals and design a solution that meets their needs.
- This involves defining the objectives and scope of the project while ensuring it aligns with accessibility standards.
- A detailed project plan is created, outlining the required workforce, budget, and estimated expenses for development and implementation.
- A feasibility study is conducted to assess how well the selected components such as the 48V lithium battery, brushless DC motor, motor driver, and GSM module perform in real-world conditions.
- Collaboration with engineering experts and IoT professionals helps validate the design and ensures the project is both practical and efficient

Development

- Once planning is complete, the next step is assembling the necessary components.
- The Arduino microcontroller is programmed to manage inputs from push buttons, sensors, and power controls.
- The 48V brushless DC motor is integrated with a motor driver, ensuring smooth acceleration and control.
- Since different components require different power levels, a 48V to 12V DC converter is installed to supply stable power to the lights, GSM module, and Arduino.
- For safety and convenience, a GSM module is added to enable emergency alerts, allowing users to send distress messages if needed.
- The lights and switches are also included to enhance visibility and make operation easier.
- Pilot testing is then conducted to analyse the motor's efficiency, battery performance, and emergency response system before finalizing the design.

Implementation

- With all components in place, the assembly process begins. The vehicle frame is built, ensuring durability and stability for easy manoeuvrability.
- The motor driver and DC motor are fine-tuned for smooth motion, including acceleration, braking, and direction control.

- The lights and switches are installed for improved user control, and all systems are connected and calibrated for optimal performance.
- Users and operators are trained on how to operate the vehicle, handle emergencies, and maintain the system.
- The e-vehicle is then tested in different environments and terrains to ensure it functions effectively in real-world conditions.
- Additionally, an IoT-based monitoring system is integrated to remotely track performance and gather data for analysis.

Evaluation

- After implementation, feedback from users is collected to assess comfort, ease of use, and reliability.
- Performance data such as battery life, motor efficiency, and GSM alert accuracy is analysed to ensure the vehicle operates at peak efficiency.
- Regular inspections and software updates help maintain the system's reliability over time.
- By comparing real-world performance data with initial feasibility studies, improvements and upgrades can be made to enhance the e-vehicle further.
- The goal is to ensure that the IoT-based e-vehicle remains a safe, reliable, and accessible mobility solution for physically challenged individuals, giving them greater independence and freedom in their daily lives.

Working Of Proposed System

The IoT-based e-vehicle is designed to offer a safe, stable, and user-friendly mobility solution for physically challenged individuals. It features a three-wheel structure with one front wheel and two rear wheels, ensuring better balance and support. The rear wheels are equipped with motor hubs that drive the vehicle, while the front wheel is connected to a steering handle, making navigation smooth and effortless.

The power supply system is a crucial part of this vehicle. It includes a rechargeable battery, a charger, and a simple plug-in/plug-out system, allowing users to charge the vehicle conveniently. The electric motor is attached to the centre shaft, which transmits power to the wheels, enabling smooth movement. To provide additional stability and security, extra support wheels have been added, ensuring a safer ride. One of the most important aspects of this system is its IoT integration.

The vehicle is equipped with an Arduino board, a GSM module, and a 9V battery, allowing real-time tracking and smart monitoring. The Arduino board acts as the brain of the system, processing inputs and managing controls. The GSM module functions as a GPS, enabling users and caregivers to track the vehicle’s location. This ensures better safety, especially for individuals who require assistance, while also adding an extra layer of convenience to mobility.

Applications of Proposed System

The IoT-based e-vehicle is designed to empower physically challenged individuals by providing them with a safe, reliable, and user-friendly mobility solution. One of its key applications is personal transportation, enabling users to move independently without relying on caregivers or traditional wheelchairs. With its intuitive hand-operated controls and stable three-wheel design, it offers a comfortable and effortless riding experience.

Additionally, the integration of smart IoT features, such as GPS tracking and remote monitoring, ensures that caregivers and family members can track the vehicle’s location in real time, enhancing safety and allowing for immediate assistance when needed. Beyond personal mobility, this e-vehicle is highly adaptable to various environments, including hospitals, shopping malls, office spaces, and residential areas. It allows users to navigate both indoor and outdoor spaces with ease, reducing the physical strain of movement.

Another major advantage is its eco-friendly nature. Since it runs on electricity, it eliminates the need for fossil fuels, contributing to a cleaner and greener environment. The design also allows for further customization, with options to integrate features like voice control, automated braking, and smart sensors, making it even more accessible and user-friendly. By combining technology with mobility, this e-vehicle promotes independence, safety, and sustainability, making daily life easier and more inclusive for physically challenged individuals.

VI. RESULTS AND DISCUSSIONS

- The development of an IoT-based e-vehicle for physically challenged individuals has shown promising results in terms of accessibility, efficiency, and overall ease of use. The main goal was to create a vehicle that provides independence while incorporating modern technology to enhance safety and convenience. After testing and evaluating its performance, several key observations were made.
- Performance and Efficiency: The e-vehicle operates using a BLDC (Brushless DC) motor and a LiFePO4 battery, which provide smooth and reliable performance. During testing, it demonstrated excellent acceleration, stable speed control, and efficient energy consumption. One of the most notable advantages is the fast-charging time, which allows users to quickly recharge and continue their daily activities without long waiting periods. Additionally, the lightweight design improves maneuverability, making it easier for users to navigate different terrains with minimal effort.

Figure 5. Proposed Experimental Setup

- Smart Features and IoT Integration: One of the standout aspects of this project is the integration of IoT-based features, which make the vehicle more intuitive and user-friendly. The ability to control the vehicle using voice commands, a mobile application, or a joystick offers multiple options, ensuring that individuals with different levels of mobility can operate it comfortably. GPS tracking adds an extra layer of safety, allowing caregivers or family members to monitor the vehicle's location in real time.
- Accessibility and Comfort: Getting in and out of traditional electric wheelchairs can often be a struggle for physically challenged individuals. To address this, the e-vehicle is designed with a movable seat, making it easier for users to enter and exit without assistance. The hand-operated control system further simplifies navigation, ensuring that users can comfortably operate the vehicle without the need for external help.
- Eco-Friendly and Sustainable Solution: Since the vehicle is fully electric, it contributes to a cleaner environment by eliminating the need for fossil fuels. The use of a LiFePO4 battery, known for its long lifespan and efficiency, ensures sustainability while reducing waste. By promoting electric mobility solutions, this project aligns with global efforts to minimize air pollution and carbon emissions, making transportation both efficient and eco-friendly.
- Safety and User Experience: Safety is one of the top priorities when designing mobility solutions for physically challenged individuals. The e-vehicle includes multiple safety features such as emergency braking, real-time monitoring, and an intelligent obstacle detection system. During testing, users expressed confidence in the vehicle's ability to provide a secure and stable ride. The smooth operation, combined with the responsive control system, makes it easy to navigate even in crowded or uneven environments.

VII. CONCLUSION & RECOMMENDATIONS

To provide a better mobility solution for physically challenged individuals, we have designed and fabricated a special electric bike that can be operated entirely by hand. This single-person vehicle is not only cost-effective but also environmentally friendly, helping to reduce air pollution by eliminating the need for fossil fuels. The bike is powered by a BLDC motor and a LiFePO4 battery, ensuring high efficiency and quick charging compared to conventional vehicles. It is designed to be lightweight, making it easier to handle and manoeuvre.

One of its key features is a movable seat, allowing easy entry and exit for physically challenged users, making the ride more accessible and comfortable. With electric vehicles becoming an essential part of our future, this innovation aims to enhance mobility while promoting sustainability. By providing a safe, efficient, and user-friendly transportation option, this bike empowers individuals with disabilities to move independently, improving their quality of life while contributing to a cleaner environment.

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