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DESIGN OF IOT BASED TRICYCLE

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Abstract - The rapid advancement in Internet of Things (IoT) technology has opened up numerous opportunities for innovation across various industries. In the transportation sector, IoT has the potential to revolutionize conventional vehicles into smart, connected modes of transportation. This project focuses on the design of an IoT-based electric tricycle, aimed at providing a sustainable and efficient mode of personal transportation.The electric tricycle integrates IoT technology to enhance its functionality and user experience. Key features include real-time monitoring of vehicle parameters such as speed, battery status, and location, enabling remote tracking and management through a dedicated mobile application. Additionally, the tricycle incorporates smart safety features such as collision detection and automatic emergency braking, enhancing rider safety on the road.The design phase involves the selection of appropriate components and the integration of IoT modules, sensors, and actuators into the tricycle framework. The fabrication process encompasses building the chassis, integrating the electric propulsion system, and assembling the IoT components. Emphasis is placed on ensuring durability, reliability, and energy efficiency throughout the construction process.Overall, the project aims to contribute to the advancement of sustainable transportation solutions by leveraging IoT technology to create an innovative, eco-friendly electric tricycle. Through this endeavor, we envision promoting the adoption of electric vehicles and facilitating a more connected and efficient urban mobility ecosystem

Keywords: IoT-based electric tricycle, Sustainable transportation, Connected vehicles, Electric vehicle innovation, Real-time monitoring, Safety features, Fabrication process, Integration of IoT technology, User experience, Smart mobility solution

1.INTRODUCTION

1.1 Background and Motivation:

1.1.1 Environmental Concerns and Transportation Challenges:

The transportation sector is a significant contributor to greenhouse gas emissions, air pollution, and energy consumption worldwide. With rapid urbanization and population growth, cities are facing increasing challenges related to traffic congestion, noise pollution, and environmental degradation. Traditional gasoline-powered vehicles exacerbate these issues, leading to adverse effects on public health and the environment. Recognizing the urgency of mitigating these challenges, there is a growing global emphasis on transitioning towards sustainable transportation alternatives.

1.1.2 Emergence of Electric Vehicles (EVs):

Electric vehicles (EVs) have emerged as a promising solution to address the environmental and energy challenges associated with conventional automobiles. By replacing internal combustion engines with electric motors powered by rechargeable batteries, EVs offer significant reductions in greenhouse gas emissions and dependence on fossil fuels. Furthermore, advancements in battery technology, electric drivetrains, and charging infrastructure have accelerated the adoption of EVs, making them increasingly viable for mainstream consumers.

1.1.3 The Need for Sustainable Urban Mobility Solutions:

Urban areas, in particular, face pressing challenges related to traffic congestion, air quality, and public health. In densely populated cities, the demand for efficient, affordable, and environmentally sustainable modes of transportation is paramount. Conventional automobiles, while providing mobility and convenience, contribute to traffic congestion and pollution. Therefore, there is a critical need to explore innovative transportation solutions that prioritize sustainability, efficiency, and accessibility, especially in urban environments.

1.1.4 Role of Electric Tricycles in Urban Mobility:

Electric tricycles represent a niche segment within the broader electric vehicle market, offering a compact, maneuverable, and cost-effective mode of personal transportation. Unlike traditional bicycles, electric tricycles provide added stability, cargo capacity, and comfort, making them suitable for a wide range of users, including commuters, delivery services, and senior citizens. Electric tricycles are particularly well-suited for urban environments, where they can navigate congested streets, narrow alleyways, and pedestrian zones with ease.

1.1.5 Integration of IoT Technology for Enhanced Functionality:

The Internet of Things (IoT) presents an opportunity to enhance the functionality, connectivity, and intelligence of electric tricycles. By integrating IoT sensors, actuators, and communication modules into the vehicle's design, it is possible to enable real-time monitoring, remote control, and data-driven optimization. IoT-enabled electric tricycles can provide valuable insights into vehicle performance, battery health, and user behavior, leading to improved efficiency, safety, and user experience. Moreover, IoT connectivity facilitates seamless integration with smart infrastructure, traffic management systems, and other IoT-enabled devices, further enhancing the potential of electric tricycles as sustainable urban mobility solutions.

1.2 Overview of Electric Vehicles and IoT Technology:
Electric vehicles utilize electric motors powered by rechargeable batteries, offering a cleaner and more efficient alternative to internal combustion engines. In recent years, advancements in battery technology and electric drivetrains have significantly improved the performance and affordability of EVs, driving their widespread adoption. Concurrently, the Internet of Things (IoT) has emerged as a transformative technology, enabling the connectivity and smart functionality of devices and systems. IoT facilitates real-time data monitoring, remote control, and autonomous decision-making, making it particularly well-suited for enhancing the functionality and efficiency of electric vehicles. By integrating IoT technology into the design of electric tricycles, this project aims to create a smarter, more connected mode of personal transportation that addresses the limitations of traditional EVs and improves the overall user experience.

1.2 Objectives of the Project:

Against this backdrop, the primary objective of this project is to design and fabricate an IoT-based electric tricycle that addresses the need for sustainable, efficient, and connected urban mobility solutions. By leveraging advancements in electric propulsion, battery technology, and IoT integration, the project aims to develop a prototype electric tricycle that demonstrates enhanced functionality, safety, and user experience. Through practical experimentation, performance testing, and user feedback, the project seeks to validate the feasibility and potential impact of IoT-enabled electric tricycles in real-world urban environments. Ultimately, the project aspires to contribute to the ongoing transition towards sustainable transportation systems and foster innovation in the field of electric mobility.

3.1 Selection of Components:

3.1.1 Electric Propulsion System:

The selection of the electric propulsion system is a critical aspect of the design phase. Factors to consider include the type and power rating of the electric motor, the voltage and capacity of the battery pack, and the overall efficiency of the drivetrain. Depending on the desired performance characteristics of the electric tricycle, options such as hub motors, mid-drive motors, or pedal-assist systems may be evaluated. Additionally, consideration must be given to the compatibility of the propulsion system components and their integration with other subsystems such as the braking system and electrical controls.

3.1.2 IoT Modules and Sensors:

Integrating IoT technology into the electric tricycle requires careful selection of IoT modules and sensors. Key considerations include the functionality, compatibility, and communication protocols supported by the IoT modules. Common sensors to consider include GPS modules for location tracking, accelerometer and gyroscope sensors for motion detection, temperature sensors for battery monitoring, and proximity sensors for collision detection. The selection of IoT modules should also take into account power consumption, data transmission rates, and scalability for future upgrades or expansions.

3.1.3 Mechanical Components and Materials:
The mechanical design of the electric tricycle involves selecting appropriate materials and components for the chassis, frame, suspension, and wheels. Factors such as weight, strength, durability, and cost must be carefully balanced to ensure optimal performance and reliability. Depending on the intended use and operating conditions, materials such as steel, aluminum, or composite materials may be chosen for the chassis and frame. Suspension systems, brakes, and wheel assemblies should be selected based on their compatibility with the overall design and performance requirements of the electric tricycle.

3.2 System Architecture Design:

3.2.1 Functional Requirements and Use Cases:

The system architecture design begins with defining the functional requirements and use cases of the electric tricycle. This includes identifying the primary use cases such as commuting, cargo transport, or recreational riding, as well as secondary use cases such as remote monitoring, anti-theft protection, and emergency response. Use case scenarios are developed to illustrate how users interact with the electric tricycle and its IoT-enabled features in various situations.

3.2.2 Component Interconnections and Data Flow:

The system architecture defines the interconnections and data flow between different subsystems and components of the electric tricycle. This includes establishing communication protocols, data formats, and interfaces between the electric propulsion system, IoT modules, sensors, actuators, and user interfaces. For example, data collected from sensors such as GPS, accelerometer, and battery monitor are transmitted to the IoT module for processing and analysis. The processed data is then communicated to the user interface, mobile application, or cloud platform for visualization and action.

3.3 Integration of IoT Technology:

3.3.1 Hardware Integration:

Integrating IoT technology into the electric tricycle involves physically mounting IoT modules, sensors, and actuators onto the chassis or frame of the vehicle. Care must be taken to ensure proper positioning, orientation, and protection of IoT components from environmental factors such as moisture, vibration, and temperature extremes. Wiring harnesses and connectors are used to establish electrical connections between IoT modules, sensors, and the central processing unit.

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3.3.2 Software Integration:

Software integration encompasses developing firmware for IoT modules, sensor calibration, data processing algorithms, and communication protocols. The firmware controls the operation of IoT modules, sensor data acquisition, and transmission of data to external devices or cloud platforms. Additionally, software interfaces are developed for user interaction, configuration settings, and remote monitoring/control via mobile applications or web interfaces. The software integration phase involves extensive testing and validation to ensure compatibility, reliability, and security of the IoT-enabled features.
Chassis is a major component of a vehicle system. It consists of part of the vehicle which consists of frame and running gear like motor, transmission system, suspension system etc. This type of chassis used for electric vehicle it consists of internal framework that supports man-made object. Design and analysis of the chassis is done through a advanced CAD (fusion 360, & Analysis software). The design and analysis of the chassis is done for stress distribution criteria .This type of chassis is mostly used in light weight vehicles like electric vehicles. It provides a good beam resistance because of its continuous rail from front to rear. As a result chassis has been designed in a way to reduce vibration, increase strength and optimize the weight of the chassis

3.4 Design of Parts in CAD software:

The software used for the design of the the parts is NX 12.

Front Wheel:

1. Used revolve function to create the tyre and rim.
2. Created one spoke and using circular pattern feature the other spokes were patterned.

Fig -1

Back Wheel:

1. Used revolve function to create the tyre and rim.
2. Created one spoke and using circular pattern feature the other spokes were patterned.

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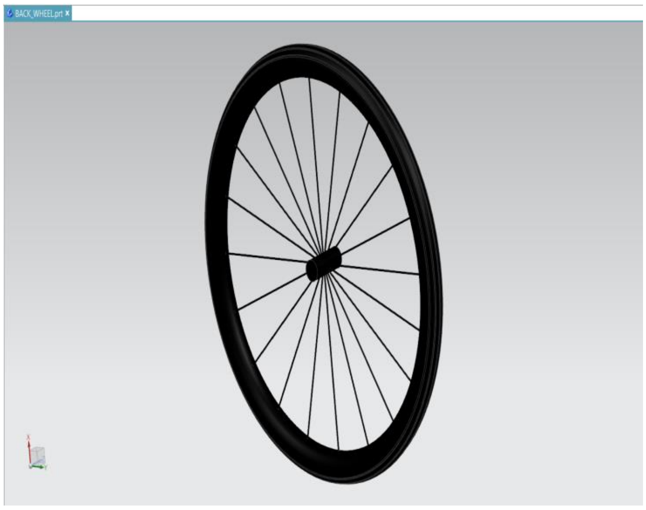

Body:

The body is made using extrusion, blend, sweep through guide tools.

Assembly:

Assembled the parts using assembly constraints like Touch align, Distance align to align the wheels to the body

Fig -1.1

IOT INTEGRATION

5.1 Hardware Integration:

5.1.1 IoT Module Installation:

IoT modules, including microcontrollers, communication devices (such as Wi-Fi or Bluetooth modules), and sensors, are integrated into the electric tricycle's electronics system. The modules are securely mounted within the chassis or frame, ensuring protection from environmental factors such as moisture, vibration, and temperature extremes. Wiring harnesses are routed and connected to establish electrical connections between IoT modules, sensors, actuators, and power sources.

5.1.2 Sensor Calibration:

Sensors such as GPS modules, accelerometers, temperature sensors, and proximity sensors are calibrated to ensure accurate data acquisition and reliable operation. Calibration procedures involve adjusting sensor parameters, such as sensitivity, bias, and offset, to match expected values under various operating conditions. Calibration tests are conducted to validate sensor accuracy and consistency, accounting for factors such as temperature variations, motion dynamics, and environmental interference.

5.2 Software Integration:

5.2.1 Firmware Development:

Firmware development involves programming the microcontrollers and IoT modules to perform specific tasks such as data acquisition, processing, and communication. Firmware algorithms are developed to control sensor readings, execute safety protocols, and transmit data to external devices or cloud platforms. Programming languages such as C, C++, or Python are commonly used to develop firmware for IoT-enabled devices, ensuring efficient resource utilization and real-time responsiveness.

5.2.2 Communication Protocols:

Communication protocols such as MQTT (Message Queuing Telemetry Transport), HTTP (Hypertext Transfer Protocol), or CoAP (Constrained Application Protocol) are implemented to facilitate data exchange between the electric tricycle and external devices or cloud platforms. Protocol selection is based on factors such as data throughput, reliability, latency, and power consumption. Secure communication protocols, such as SSL/TLS (Secure Sockets Layer/Transport Layer Security), may be employed to encrypt data transmissions and prevent unauthorized access.

5.3 Real-Time Monitoring:

5.3.1 Vehicle Parameter Monitoring:

IoT technology enables real-time monitoring of vehicle parameters such as speed, battery status, temperature, and location. Sensor data is collected continuously and transmitted to a centralized monitoring system or mobile application for visualization and analysis. Real-time monitoring allows users to track the performance and status of the electric tricycle, enabling proactive maintenance, troubleshooting, and optimization of operational efficiency.

5.3.2 Remote Diagnostics and Alerts:

In addition to real-time monitoring, IoT-enabled electric tricycles can perform remote diagnostics and generate alerts for critical events or abnormalities. Anomalies such as battery voltage fluctuations, motor overheating, or collision detection trigger alerts that are transmitted to users or service providers via email, SMS, or push notifications. Remote diagnostics enable timely intervention and preventive maintenance, minimizing downtime and ensuring the safety and reliability of the electric tricycle.

5.4 Mobile Application Development:

5.4.1 User Interface Design:

A mobile application is developed to provide users with a graphical interface for interacting with the electric tricycle's IoT features. The user interface design focuses on intuitive navigation, visual feedback, and accessibility across different mobile devices and operating systems. User interface elements such as dashboards, charts, maps, and notifications are designed to present relevant information and enable user interactions such as remote tracking, status monitoring, and settings configuration.

5.4.2 Feature Implementation:

The mobile application implements features such as real-time vehicle tracking, battery status monitoring, trip history logging, and remote control functionalities. Users can view the current location of the electric tricycle on a map, check battery charge levels, and receive notifications for events such as low battery or maintenance reminders. Remote control features allow users to remotely lock/unlock the tricycle, adjust settings, or initiate emergency procedures such as disabling the motor in case of theft or unauthorized use.

CONCLUSION

The design of an IoT-based electric tricycle represent a significant step towards addressing the growing need for sustainable, efficient, and connected urban mobility solutions. Through this project, we have successfully integrated IoT technology into the design of an electric tricycle, creating a smart and innovative mode of personal transportation. By leveraging advancements in electric propulsion, battery technology, and IoT integration, we have developed a prototype electric tricycle that offers enhanced functionality, safety, and user experience.The integration of IoT technology enables real-time monitoring of vehicle parameters, remote tracking, and management through a dedicated mobile application. Users can monitor battery status, track the tricycle's location, and receive alerts for critical events such as collisions or theft attempts. Additionally, safety features such as collision detection and automatic emergency braking enhance rider safety on the road, while anti-theft protection measures provide peace of mind to users.In conclusion, the IoT-based electric tricycle represents a promising solution for sustainable urban mobility, offering environmental benefits, enhanced user experience, and improved safety. As we continue to refine and optimize the design, we envision wider adoption of electric tricycles as a viable alternative to traditional gasoline-powered vehicles. By embracing innovation and leveraging IoT technology, we can create a more connected, efficient, and environmentally sustainable transportation ecosystem for future generations.

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