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Speed Control & SMS Alert System for E-Bikes

Rakshak Sood¹, Prajeet Rathod², Aditya Bhandare³, Danish Ukaye⁴, Harshal Patil⁵

Assistant Professor, Department of Electronics and Computer Science, Vidyalankar Institute of Technology,
Mumbai, India¹

Student, Department of Electronics and Computer Science, Vidyalankar Institute of Technology, Mumbai, India²⁻⁵

ABSTRACT:- This document outlines the design and creation of a Smart E-Bike System, which aims to enhance rider safety and communication by utilizing modern technology. The system includes a 12W/120W e-bike motor, an ESP8288 microcontroller, and a SIM800L GSM module to facilitate SMS notifications, in addition to sensors for monitoring speed and vehicle status in real time. Driven by the growing popularity of e-bikes and the accompanying safety concerns at increased speeds, this initiative tackles the absence of effective speed monitoring and alerting systems in current models. The suggested solution offers a dual-mode functionality—safe and emergency modes—that automatically manages speed and relays alerts to both the rider and the owner through SMS during critical situations. A mobile app via the Blynk IoT platform and real-time speed and RPM monitoring on a 20x4 LCD are important features. Safety and usefulness are improved by extra parts including a relay for operational control and a buzzer for auditory notifications. Effective signal processing and communication between system components are guaranteed by the ESP8288 microcontroller. This research shows how smart technology may be used in personal mobility solutions to encourage safer riding habits by providing prompt visual and aural feedback. The research highlights the system's contribution to safer e-bike usage by examining its components, architecture, advantages, and limitations.

KEYWORDS: Smart E-Bike System, Rider Safety, ESP8288, SIM800L GSM, Real-Time Monitoring, Dual-Mode (Safe/Emergency), Blynk IoT App

I. INTRODUCTION

Urban transportation is experiencing a major change, with electric bikes (e-bikes) becoming a popular and eco-friendly option compared to traditional bicycles and motor vehicles. Especially in busy urban areas, e-bikes present a viable answer to issues related to traffic and pollution. Their increasing appeal is due to the ease they offer—enabling users to cover greater distances with reduced physical exertion compared to standard bicycles.

But there are also significant safety concerns associated with the increasing use of e-bikes. E-bikes, which may achieve speeds comparable to those of scooters or motorbikes, demand more steadiness and control from their riders. When motorcyclists are unaware of their speed or do not get timely warnings about dangerous conditions, the risks of traveling at high speeds are increased. By creating a smart e-bike system with sophisticated monitoring and alerting features to encourage safer riding habits, our project tackles these problems.

The primary aim of this system is to improve rider safety by allowing real-time tracking of speed and RPM, while also alerting when speed limits are exceeded. It features a dual-mode operation—safe and emergency modes—adapted to different riding conditions. In safe mode, the system triggers a buzzer to alert the rider when they exceed 60 km/h and limits the speed to 80 km/h to avoid unsafe driving. Emergency mode, on the other hand, permits unrestricted speed control and lifts some safety restrictions, providing flexibility during urgent scenarios.

To maintain ongoing communication and situational awareness, the system includes a GSM module that sends SMS notifications to the owner, particularly in emergency cases. A built-in LCD screen provides real-time visual updates, enabling riders to keep track of speed and vehicle status while riding.

A literature analysis that examines current technologies and pinpoints existing gaps in e-bike safety solutions opens this report. It then goes on to describe how the Smart E-Bike System was developed, going into great depth about its architecture and component parts. The performance of the system is further assessed, along with its benefits and drawbacks, and suggestions for future improvements are made.

This research enhances e-bike efficiency and safety while also advancing smart mobility more broadly by fusing intelligent systems with personal transportation. The ideas and insights offered are meant to stimulate more study into the integration of safety technologies into urban and personal transportation frameworks

II. LITERATURE SURVEY

The swift evolution of electric bike (e-bike) technology has attracted growing interest from researchers and manufacturers alike because of its ability to decrease environmental effects and promote sustainable urban transportation. A survey of the current literature reveals notable advancements in e-bike design but emphasizes the urgent requirement for improved safety features. This portion explores important research, technologies, and obstacles that characterize the present landscape of e-bike safety and innovation.

A. Advancements in E-Bike Technologies

E-bikes greatly lessen the physical strain on the user by using electric motors to help in pedalling. The range and efficiency of battery systems have significantly increased due to technological advancements, especially the use of lithium-ion batteries. Lithium-ion batteries perform better than conventional lead-acid batteries in terms of weight and energy density, making e-bikes more nimble and durable (Zhang et al., 2019).

The e-bike experience has been further revolutionized by the incorporation of smart technology, particularly Internet of Things (IoT) capability. These days, a lot of e-bikes have remote monitoring and control capabilities. IoT integration improves user experience by providing real-time performance data and facilitating intelligent system interactions, according to studies in the IEEE Xplore library.

B. E-Bike Safety Systems

Safety is a significant concern in the advancement of e-bike technologies. Several studies highlight the importance of proactive safety features, especially those that tackle risks linked to high-speed riding. According to Smith and Patel (2020), many e-bike accidents arise from excessive velocity and loss of control, particularly among inexperienced riders. Their research suggests the need for speed regulation systems that can cap and monitor maximum speeds. Although most e-bikes come equipped with basic safety elements such as lights, reflectors, and effective braking systems, these primarily serve as passive safety measures. Active safety solutions, like speed monitoring and real-time alerts, are less prevalent but are becoming increasingly vital. [1] recommend a dual-mode system that delivers instant notifications when safe speed thresholds are exceeded, thereby enhancing rider reaction times and decreasing the likelihood of accidents.

C. GSM-Based Communication and Monitoring

GSM technology has demonstrated remarkable efficacy in communication systems, namely in applications related to vehicle tracking and security. The successful usage of GSM modules in providing real-time location monitoring and alarm functionalities is highlighted in a thorough assessment by Kumar and Singh (2021). The SIM800L module, which sends the e-bike owner SMS notifications to keep them informed of the bike's condition, is used in this project in light of these findings.

GSM integration facilitates user interaction through mobile applications in addition to security. Data visualization and remote monitoring are made possible by platforms like Blynk, which are frequently utilized in IoT projects. By using such technologies, this initiative improves usability and safety awareness by giving riders real-time updates on system functioning and speed.

D. Gaps in Existing Systems

Despite recent progress, numerous commercial e-bikes still do not feature fully integrated monitoring and alert systems. Johnson et al. (2020) highlight significant shortcomings in current models, including the lack of real-time

speed tracking and alert mechanisms, which can result in hazardous riding situations when users are unaware of their speed or nearby dangers.

The research emphasizes the necessity for comprehensive systems that incorporate real-time data collection, user notifications, and external communication. This project aims to address those deficiencies by developing a Smart E-Bike System that combines speed monitoring, visual and audio alerts, and notifications to the owner—laying the groundwork for more intelligent and safer personal transport solutions.

III. METHODOLOGY



The goal of the project is to improve medication adherence for those with complicated drug schedules, long-term illnesses, or cognitive impairments by developing a smart pill container system. With the use of sensors and connectivity, this technology tracks and detects drug usage in real-time, sending out alerts and reminders on schedule.

Component Description:

The Smart E-Bike System is built upon a collection of integrated electronic components, each serving a specific purpose to ensure overall functionality, safety, and reliability. These components collectively enable real-time speed monitoring, alert generation, and continuous feedback to the rider. Below is a detailed explanation of the components used in this project.

1.E-Bike Motor (12V/120W)

The motor serves as the main power source for the e-bike, providing the necessary mechanical force to propel the vehicle. Operating at 12 volts and capable of a peak power output of 120 watts, it achieves speeds like those of conventional bicycles while greatly minimizing physical exertion. Tailored for urban commuting, the motor delivers excellent torque and energy efficiency to tackle diverse terrain conditions. It is controlled by a motor driver circuit that processes PWM (pulse-width modulation) signals from the microcontroller to facilitate smooth acceleration and braking.

2.Microcontroller (ESP8288)

The ESP8288 microcontroller, which oversees data processing and component coordination, is at the center of the system. It is perfect for Internet of Things applications due to its low power consumption and integrated Wi-Fi capabilities. The ESP8288 is programmed in C++ using the Arduino IDE and reads throttle input, calculates speed, and

manages outputs like the GSM module and LCD display. Convenient remote monitoring is ensured by its wireless connectivity, which enables interaction with mobile applications.

3. GSM Module (SIM800L)

The e-bike owner can receive SMS warnings thanks to the SIM800L GSM module, which facilitates communication. It operates between 3.7V and 4.2V, needs steady voltage regulation, and has a serial interface that communicates to the microcontroller. By alerting the owner to any unusual occurrences, such speed limit infractions or emergencies, it significantly improves the system's safety and remote monitoring capabilities.

4. Throttle

The throttle acts as a key control mechanism, enabling cyclists to manage the speed of the e-bike. It operates as a variable resistor, producing an analog voltage signal in relation to the user's input. The microcontroller processes this signal and modifies the motor's speed output as needed. Created for user-friendliness, the throttle allows cyclists to swiftly adapt to varying riding situations.

5. Power Supply (12V, 3A SMPS)

A dependable power source is crucial for ensuring the system functions consistently. The 12V, 3A Switching Mode Power Supply (SMPS) implemented in this project provides a stable power supply for all components. Renowned for its compact design and efficiency, the SMPS integrates smoothly into the e-bike's structure and ensures that every module operates within its specified voltage and current limits.

6. Display (20x4 LCD with I2C)

A 20x4 character LCD screen is used to give the cyclist real-time feedback. Important information including the current speed, RPM, and operating mode (emergency or safe) are displayed. Communication with the microcontroller is made easier and wiring complexity is decreased by using the I2C protocol. The rider's awareness is improved by the screen's constant updating of important performance indicators.

7. Relay and Buzzer

This subsystem is tasked with providing audible warnings when speed limits are surpassed. The microcontroller emits a control signal that triggers the relay, which subsequently activates the buzzer. This immediate auditory feedback assists the rider in modifying their behavior before achieving unsafe speed thresholds. The combination of the relay and buzzer bolsters the system's active safety features.

8. Voltage Regulator (7805 IC)

To ensure stable voltage across components, the system incorporates a 7805-voltage regulator. This integrated circuit reduces the 12V supply to a consistent 5V output, necessary for the microcontroller and other low-voltage devices. Adequate voltage regulation is crucial to avert potential damage and guarantee the system's long-term reliability.

9. Toggle Buttons

Toggle buttons are incorporated to facilitate manual control over specific features, including motor direction changes and toggling between safe and emergency modes. These buttons are strategically placed for easy accessibility, enabling the rider to make quick adjustments during operation. This improves user adaptability and system responsiveness in various riding situations.

IV. WORKING

The Smart E-Bike System is designed to provide real-time monitoring of performance and intelligent control, with the goal of enhancing safety and ride efficiency. This section describes the operation of the system, including its structure, signal processing, alert mechanisms, and features for user interaction.

1.System Architecture

At the core of the system lies the ESP8288 microcontroller, which oversees the functions of all associated modules. The design utilizes a modular strategy, where each component serves a specific purpose and connects to the microcontroller. The throttle generates an analog input that the ESP8288 uses to adjust motor speed. Simultaneously, it refreshes the LCD with performance information and manages the GSM module to send alerts as necessary.

2.Input Processing

When the rider engages the throttle, it produces an analog voltage signal directed to the ESP8288. The microcontroller processes this signal and translates it into a digital value, which reflects the desired speed. A PWM signal is then generated based on this value and sent to the motor driver to regulate motor output. This feedback control system guarantees accurate speed management, resulting in smooth acceleration and deceleration.

3.Speed Monitoring and Alerts

The system continuously computes the e-bike's speed based on the throttle input. If the speed exceeds 60 km/h, the ESP8288 initiates an audible alert by activating the buzzer through the relay. When the speed reaches 80 km/h, the microcontroller halts further acceleration by locking the motor's output. At the same time, the GSM module (SIM800L) dispatches an SMS alert to the bike owner, informing them of the overspeed occurrence.

4.Mode Switching

A 20x4 LCD provides real-time data such as speed, RPM, and the current operational mode. Utilizing the I2C protocol, the ESP8288 transmits this information efficiently to the display. Furthermore, the system interfaces with the Blynk IoT platform, enabling users to monitor performance metrics remotely through a mobile application. This integration enhances user experience by facilitating off-bike tracking and interaction.

5.Data Display and Mobile Integration

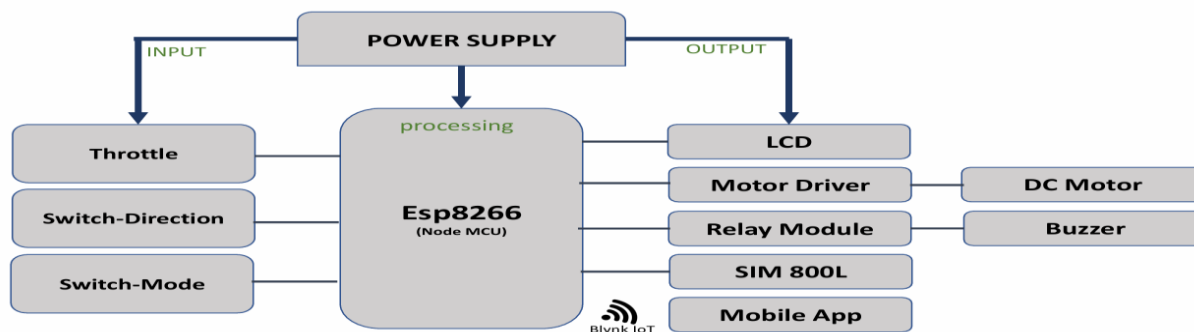
There are two operational settings: safety and emergency. In safe mode, the system enforces speed limits and activates warning systems as necessary. Emergency mode, accessible via a toggle button, removes speed restrictions while maintaining alert functions. This adaptability proves beneficial in situations that require rapid acceleration, such as navigating through crowded traffic.

6.User Interactions

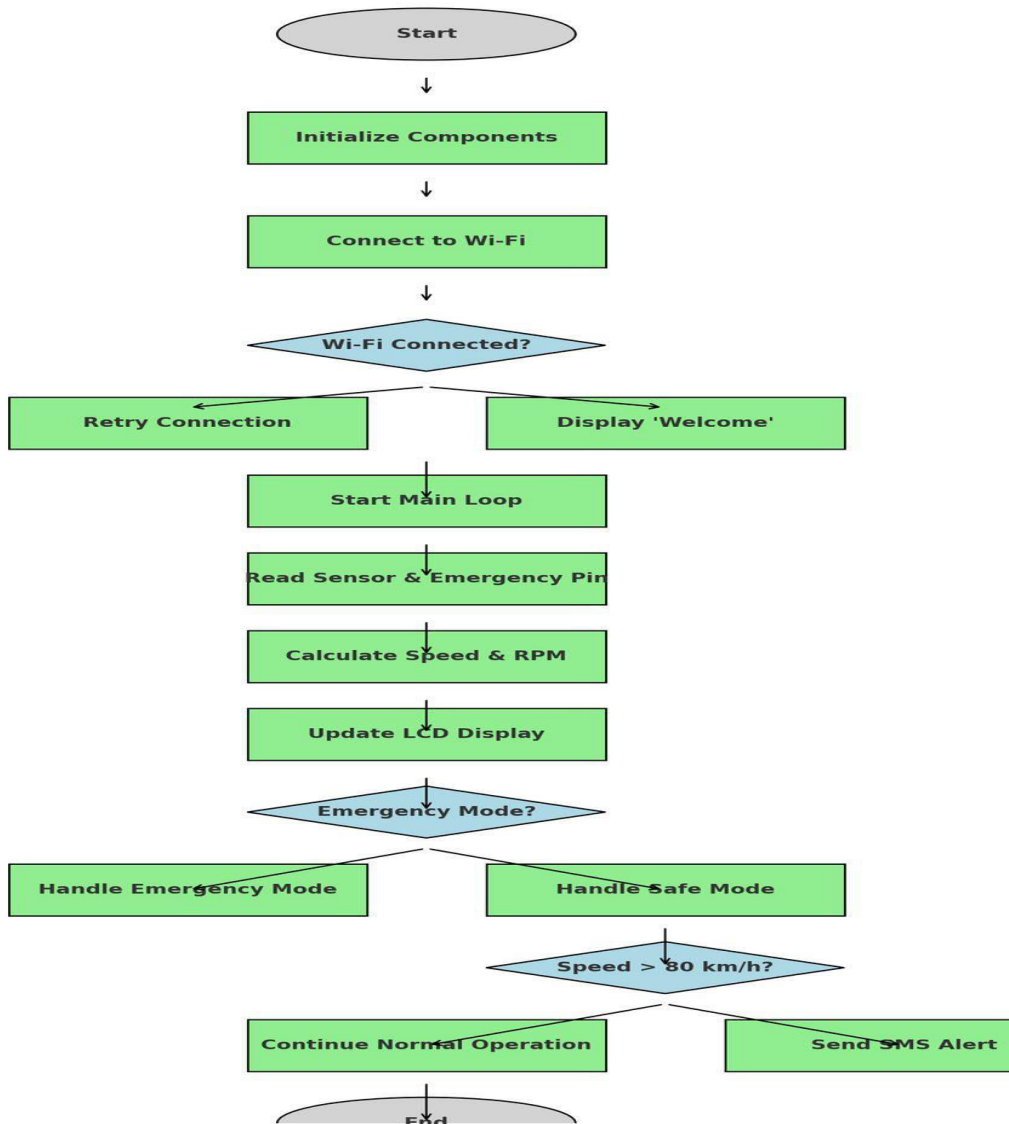
The system is designed for user convenience. Riders can manage speed by adjusting the throttle and utilize toggle buttons to switch operational modes or alter motor direction. Immediate feedback is available via the LCD and mobile app, allowing riders to remain informed and make timely decisions for a safer ride.

7.System Workflow

The operational sequence of the system unfolds as follows: The rider modifies the throttle, generating an analog signal to the ESP8288. The microcontroller analyzes the input and produces a PWM signal to manage the motor. Speed is monitored continuously, and alerts are activated upon exceeding established limits. System data appears on the LCD and is concurrently updated in the Blynk mobile application. Users can interact with toggle buttons to switch modes or reverse the motor direction. This cohesive system enables riders to uphold safety practices while enjoying a streamlined, technology-enhanced biking experience.



V. FLOW CHART



VI. CONCLUSION

The Smart E-Bike System presents a significant step forward in enhancing personal mobility with an emphasis on rider safety and smart communication. By incorporating the ESP8288 microcontroller and SIM800L GSM module, the system enables real-time monitoring of speed and vehicle status while providing instant SMS alerts in emergency situations. The integration of dual operational modes—safe and emergency—ensures that the bike can automatically adapt to critical scenarios, thereby minimizing the risk of accidents. Additional components like the 20x4 LCD display, buzzer, and relay contribute to a more interactive and responsive user experience. The use of the Blynk IoT platform for mobile app integration adds convenience and remote accessibility, making the system user-friendly and technologically advanced. Overall, the project demonstrates how smart technology can be effectively utilized to create safer, smarter, and more efficient e-bike solutions for modern transportation needs.

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