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Research Article

Real-Time Rider Assistance and Vehicle Monitoring via IoT-Based Smart Motorcycle Dashboards

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ABSTRACT

Smart clusters of motorcycles with Internet of Things (IoT) components are ready to change the motorcyclist experience by including advanced IoT technology that improves drivers, vehicle performance and general operational efficiency. The system uses many IoT elements such as sensors, GPS modules, and communication devices to provide real-time with key metrics such as speed, fuel efficiency, braking performance, and environmental conditions. With the persistent tracking of these variables, the system provides immediate performance feedback, allowing drivers to improve their driving skills and minimize fuel consumption. Additionally, integrating other vehicles will improve traffic safety. The navigation functions included in the actual traffic update support the driver when dealing with overloaded areas and selection of safest routes. The Bike Mode feature allows the driver to switch between a variety of predefined riding modes, including: B. Eco mode with high fuel efficiency and performance-oriented sports mode. This has adapted the system to a variety of operating conditions. If the motorcycle is working, traffic safety is given priority by sending a preset message to incoming callers. Additionally, the system's accident awareness and emergency capabilities ensure that drivers are supported immediately in the event of a crash. Overall, the intelligent cluster for motorcycles with IoT components provides an overall approach to improving driver safety, optimizing vehicle performance, and promoting the development of intelligent and interconnected motorcycles.

Keywords: IoT, Two-wheeler Safety, BikeMode, Smart Cluster.

INTRODUCTION

The rapid growth of the Internet of Things (IoT) has transformed many industries, especially the automotive sector. The integration of the Internet of Things (IoT) in two wheels is a critical development to improve driver security, performance and overall experience. Two wheels, especially motorcycles, are one of the most common and convenient means of transportation in cities and villages. However, due to low visibility, low security standards and no immediate feedback from drivers, they are susceptible to accidents. Intelligent systems aim to close this gap by integrating IoT-based sensors, GPS, and communications modules to create an intelligent communication experience for passengers.

The system continuously monitors vehicle performance, provides navigation services, increases security by detecting dangers, and provides real-time driving feedback. Gives important information to both the driver and the vehicle. Additionally, security features such as collision warning, navigation instructions and vehicle diagnostics are integrated to make driving safer and more comfortable. This study aims to examine the design, implementation and potential benefits of such systems, creating a safer, more efficient and networked driving experience for motorcycle users.

LITERATURE REVIEW

In recent years, the integration of Internet of Things (IoT) technology with two-wheelers has attracted great attention due to its potential to increase safety and improve vehicle performance. Our main goal is to develop safety monitoring and alarm systems that can respond quickly to potential threats. Bawa et al. [1] developed two safety monitoring tires

that provide real-time alerts using IoT devices to help drivers avoid accidents by alerting them to critical paths or malfunctions. The study is of great importance for increasing research on reducing motorcycle accidents through technology. [2] adopted a data-driven approach to monitor and analyze critical events of two-wheelers. In their research, they analyze data from multiple sensors using machine learning algorithms, allowing the system to detect dangerous situations such as braking or collision and provide instant advice to the passenger. This combination of intelligent situational sensing can prevent accidents and thus increase safety, providing great potential for the safety of two-wheelers in the future.

S. Cui et al. [1] have reported "An Effective Motorcycle Helmet Object Detection Framework for Intelligent Traffic Safety,", in this study a standard computer vision model "Detectron2" which is a Facebook AI research library that provides advanced object detection and segmentation algorithms. They carried out multiple test runs on different data sets and have built a study using these tests on just the detection and methods that can improve detection.

S. Anjum et al. [2] have demonstrated "Artificial Intelligence-based Safety Helmet Recognition on Embedded Devices to Enhance Safety Monitoring Process," this study focuses on safety helmets at construction sites, not completely related to our methodology but uses a similar detection idea. They have used tensor flowlite libraries to make the detections effective and lighter on the devices. They have built an IOT system where if a construction worker is not wearing an appropriate helmet, the supervisor will receive a notification.

Saranya et al. Their system monitors the health and performance of the vehicle, providing updates to passengers on fuel levels, engine performance, and maintenance needs. Although this approach focuses on vehicle management, it also opens up a broader discussion on the use of IoT to make two-wheelers more efficient and effective, thus improving safety and maintenance efforts. [5] investigated the use of IoT to create a safety system for two-wheelers. Their system identifies safety risks by monitoring factors such as speed, riding style, and sudden changes in riding behavior. This real-time monitoring not only keeps riders safe, but also provides valuable information for improving overall motorcycle safety standards in the future. Nancharaiah et al. [7] proposed an IoT-assisted accident prevention system using logical sensors and tracking strategies to enhance road safety. Shankar et al. [8] introduced an IoT-enabled accident detection and rescue system, improving emergency response times. [9] conducted a survey on IoT applications for two-wheeler road safety, highlighting various emerging technologies. [10] designed an Industry IoT-based driver monitoring system to enhance road safety through behavioral analytics. [11] developed a deep learning-based cycling safety service system, predicting potential crash scenarios. Sabri et al. [12] explored IoT-based vehicle security and safety systems, emphasizing smart technology integration. Gurusamy et al. [13] analyzed clustering algorithms for electric two-wheeler driving cycles under Indian smart city conditions, optimizing vehicle efficiency. Liu et al. [14] proposed a multi-source data optimization strategy for rebalancing bike-sharing systems. Modwel et al. [15] introduced a smart navigation system for two-wheelers, integrating real-time object detection. Cirillo et al. [16] investigated IoT service creation through large-scale collaboration in smart cities. Fontes et al. [17] proposed a cluster-based approach using smartphone data to optimize bike-sharing docking stations. Patra et al. [18] introduced an architecture model for smart cities using Cognitive IoT, focusing on urban transportation.

Fugiglando et al. [19] analyzed driving behavior using CAN bus data, providing insights into vehicle dynamics and safety. Ortiz et al. [20] reviewed the intersection of IoT and social networks, outlining key research challenges. Bibri [21] proposed an analytical framework for sensor-based big data applications to enhance urban sustainability. Liu et al. [22] applied smart optimization techniques to bike-sharing systems, improving their efficiency. Haque et al. [24] discussed Singapore's transport policies, emphasizing sustainability, safety, and smart mobility solutions. Das et al. [25] assessed the electric two-wheeler ecosystem using multi-criteria decision-making techniques. Prashantkumar et al. [26] proposed a two-wheeler security system incorporating advanced tracking mechanisms. Chhabra et al. [27] developed a smart IoT framework for safe two-wheeler driving experiences. Gaba et al. [29] introduced B-SAFE, a blockchain-enabled security architecture for connected vehicle environments.

The aim of this research is the development of two smart wheels that use IoT technology to improve driving safety and vehicle performance. Unlike existing systems that focus on simple diagnosis or navigation, this research incorporates various IoT components such as sensors, GPS modules, and instant communication to create a connection point for passengers and vehicles. The system provides instant hazard warnings, monitors vehicle performance, tracks passenger behavior, and provides instant feedback in a seamless, user-friendly manner. good. The system also includes integrated collision detection and emergency operations, so that timely intervention can be made in the event of an accident. By combining these features, the proposed system offers a way to improve the safety, performance, and overall experience of two-wheelers.

We focus on:

- **Comprehensive IoT Integration:** Smart Cluster systems integrate several IoT technologies, such as sensors, GPS, and real-time communications, to create a complete network environment for motorcycles. The system

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Research Article

continuously monitors road conditions, recognizes obstacles, analyzes driver behavior and issues immediate warnings, preventing accidents before they are recognized. Vehicle and Driver

- **Power Monitoring:** Real-time tracking of engine power, fuel consumption and riding patterns provide drivers and manufacturers with valuable insights to improve efficiency and security. Send location data to emergency services and prompt support in critical situations. Warnings that allow for safer, more appropriately discovered travel decisions. Economic and ecological benefits: By optimizing fuel consumption and monitoring vehicle health, this system helps reduce maintenance costs, improve fuel efficiency and support environmental compatibility .

METHODOLOGY

The primary objective of this system is to provide real-time monitoring and feedback for both the rider and the vehicle. The system aims to achieve the following goals:

- **Rider Safety**: Real-time hazard detection and alerts, accident prevention, and emergency response.
- **Vehicle Performance Monitoring**: Continuous tracking of key performance metrics like speed, fuel consumption, braking patterns, and engine diagnostics.
- **User Experience**: Seamless integration of all features through a user-friendly dashboard that delivers real-time insights without overwhelming the rider.

To achieve these objectives, a set of core system requirements is identified. These include sensor accuracy, low-latency communication, real-time processing, data security, and an intuitive user interface (UI).

System Architecture Overview

The architecture of the system involves multiple interconnected components, including sensors, communication modules, and data processing units. The entire system is designed to ensure smooth data flow between the IoT components and provide actionable insights to the rider.

Component	Purpose
Sensors	Collect real-time data about vehicle performance (e.g., speed, fuel) and the rider's behavior (e.g., braking, acceleration).
GPS Module	Provides real-time location data for navigation, accident location detection, and route optimization.
Dash Camera	Records the road ahead and can trigger emergency recording in case of an accident or hazard.
Microcontroller/IoT Hub	Acts as the central processor for data collection and communication between sensors and external systems.
Communication Modules	Facilitates data transmission between the two-wheeler system and external devices, including cloud servers and emergency services.
Cloud or Edge Computing	Processes and stores the data, enabling remote access, analytics, and feedback to improve system performance.
User Interface (UI)	Displays data to the rider, such as performance metrics, navigation, and hazard alerts, in an intuitive manner.

This system architecture ensures that each component serves a specific purpose, contributing to the overall functionality of the smart cluster.

Sensor Selection and Integration

IoT-based systems integrate several sensors to collect important data from vehicles, drivers and environments. Speed sensors monitor the vehicle's speed, allowing real-time performance tracking and rapid acceleration or braking detection. Fuel sensors help optimize fuel consumption by providing real data, reducing unnecessary fuel waste and improving efficiency. Gyroscopes and accelerometers measure the movement of the bike and recognize sudden movements or sharp curves that can indicate unstable riding behavior or future accidents. Additionally, obstacle recognition sensors identify objects in the vehicle path, such as pedestrians, other vehicles, or street residues, that ensure timely hazard warnings. The GPS module plays a key role in providing location-based navigation, accident recognition and emergency response coordination.

Communication System and Data Flow

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Research Article

The system uses an advanced communications framework to promote real-world functionality. Internal communication within the vehicle ensures smooth interaction between sensors, microcontrollers and onboard dashboards. This means that drivers will provide immediate information about the vehicle's performance, fuel status and safety metrics. Additionally, external communications extend connectivity beyond the vehicle, allowing you to interact with cloud servers, emergency services and other vehicles via Wi-Fi or Bluetooth. This ability supports highly developed remote diagnostics for analysis, real-time hazard warnings, and data storage, significantly improving system reliability and overall effectiveness.

User Interface Design

A designed user interface guarantees that vital information is conveyed to the rider without unnecessary complexity. The show provides actual-time performance metrics, inclusive of velocity, petrol performance, and braking conduct, allowing informed selection-making. protection signals proactively warn approximately ability dangers, unstable driving patterns, and emergency situations, making sure on the spot corrective actions. The navigation device offers actual-time visitors' insights, alternative routes, and optimized path recommendations to enhance both protection and comfort. Designed with simplicity in thoughts, the interface ensures that riders receive crucial records without distraction, making the whole machine intuitive and clean to use.

BIKEMODE

The BikeMode function is an critical element of the proposed IoT-based system for 2-wheelers, designed to enhance rider protection and beautify communication management. this option robotically manages incoming calls when the rider is on the motorcycle, lowering distractions and allowing the rider to stay targeted on the street. The gadget detects whilst the rider is actively using the two-wheeler whether or not through motion sensors, GPS information, or Bluetooth connectivity and triggers the BikeMode. as soon as activated, the characteristic responds to incoming calls with automatic messages, thereby preventing the rider from being distracted through their phone at the same time as using.

One of the primary functions of BikeMode is to send a pre-configured message to the caller when an incoming call is detected. Common messages include:

- "I am riding and unable to answer right now, I will get back to you shortly."
- "I'm on my bike and can't take your call; please leave a message."

|These automatic responses make certain that the rider's consciousness remains solely on the street, thereby minimizing the hazard of injuries. furthermore, the machine may be customized through the rider to tailor those messages in step with their needs. for instance, the rider may want to set a selected message for own family contributors or emergency contacts, letting them understand they're at the motorbike and available for urgent topics.

Further to conventional computerized messages, the BikeMode characteristic includes an important override capability. If the system detects a name from a predefined set of priority contacts, including own family members, emergency services, or other crucial contacts, it bypasses the automated message reaction and lets in the decision to come back via. This ensures that urgent calls can be spoke back, even even as the rider is in BikeMode. once the rider has adequately stopped the bike, the gadget logs any neglected calls or messages and notifies the rider. this option presents a convenient way for riders to capture up on neglected communication after they've finished their adventure. It additionally ensures that the rider's protection is never compromised.

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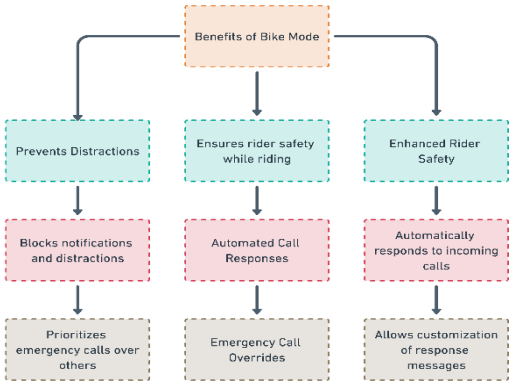

Figure 1. Benefits of BikeMode

The benefits of bike mode are summarized in figure 1.

FUTURE SCOPE

The future scope of the smart Cluster for 2-Wheeler using IoT components lies in further enhancing the system's abilties with the aid of integrating superior technology including synthetic intelligence and gadget mastering to expect and prevent potential hazards based totally on historic facts and real-time analysis. future improvements could include extra sophisticated coincidence detection algorithms, which could permit for computerized intervention or steerage in risky conditions, together with unexpected lane changes or emergency braking. moreover, the gadget ought to increase to include integration with different vehicles and infrastructure, facilitating car-to-vehicle and vehicle-to-infrastructure verbal exchange for stepped forward site visitors control and accident avoidance.

CONCLUSION

In conclusion, the smart Cluster for 2-Wheeler the usage of IoT components represents a substantial development in motorbike safety, performance, and rider revel in. by means of integrating an expansion of IoT technologies inclusive of sensors, GPS, and real-time communique modules, the machine affords riders with essential records on car overall performance, street conditions, and safety indicators. functions like the BikeMode offer customized driving reports, even as automated call control and emergency response skills ensure rider attention and safety. The studies and development of this device lay the muse for a future in which -wheelers are safer, smarter, and more related. With continuous improvements in sensor technology, verbal exchange networks, and AI-primarily based analytics, this gadget has the capability to transform how riders have interaction with their bikes, improving now not most effective protection and efficiency however also creating a greater fun and at ease driving environment. because the IoT surroundings evolves, the combination of greater superior features will in addition enlarge the talents of the clever Cluster, making it a vital tool for enhancing motorbike transportation worldwide.

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