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# AI Based on Smart Helmet Dashboard

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***Abstract*—The AI-Based Smart Helmet Dashboard is an advanced safety system designed to enhance road safety for two-wheeler riders by integrating Artificial Intelligence, IoT, and sensor technologies. This project focuses on preventing accidents and ensuring rider compliance with safety measures such as wearing a helmet and avoiding drunk driving. The system uses sensors like an alcohol sensor, IR sensor, and accelerometer to monitor the rider's condition and detect accidents. A microcontroller processes the collected data and transmits it to a cloud-based dashboard using IoT technology. The dashboard provides real-time information such as helmet status, alcohol detection, location tracking, and accident alerts.analyze rider behavior and predict potential risks.**

***Index Terms*—Artifical intelligence, Internet of things, Smart helmet, road safety, accident detection, Alcohol Detection, Gps Tracking,Real-Time Monitoring, Emergency Alert System Sensor Technology, Arduino / ESP32, Cloud Dashboard**

## I. INTRODUCTION

Road accidents are one of the major causes of injuries and deaths worldwide, especially among two-wheeler riders. Many accidents occur due to negligence such as not wearing helmets, drunk driving, overspeeding, and lack of timely medical assistance. Despite strict traffic rules, monitoring and enforcing rider safety remains a significant challenge.[1] The helmet is equipped with sensors such as an alcohol sensor to detect intoxication, an IR sensor to confirm helmet usage, and an accelerometer to detect accidents. These sensors are connected to a microcontroller, which processes the data and sends it to a cloud-based dashboard. [2]The dashboard provides real-time updates including rider status, location tracking, and emergency alerts. In case of unsafe conditions or accidents, the system automatically sends notifications along with the rider's location to predefined emergency contacts, ensuring quick response and assistance. Additionally, AI can be used to analyze rider behavior and predict potential risks, making the system more intelligent and proactive.[4]

In case of an accident or unsafe condition, the system automatically sends notifications along with the rider's location to emergency contacts, ensuring timely assistance. Additionally, AI techniques can be used to analyze rider behavior and predict potential risks.

This project aims to enhance rider safety, reduce accident rates, and provide an efficient emergency response system. It demonstrates how advanced technologies can be effectively used to create smarter and safer transportation systems.[5]

## II. LITERATURE SURVEY

Several researchers have worked on smart helmet systems using IoT and AI to improve road safety. The following studies provide insights into existing technologies and their limitations:

1. IoT-Based Smart Helmet for Accident Detection (2019). A study titled *"A Review on Smart Helmet for Accident Detection using IoT"* explains how smart helmets can reduce accidents by integrating sensors and communication systems. The research highlights that two-wheeler accidents are increasing and emphasizes the need for automated safety systems
2. Key Points

- Use of IoT for real-time monitoring
- Accident detection using sensors
- Need for automated alert systems

2. Smart Helmet Using IoT (2021)

This research proposes a helmet with sensors to detect accidents and send emergency alerts. It uses sensors to measure impact and sends GPS location via SMS to emergency contacts.

3. Key points

 Trauma detection using sensors
  GPS + GSM for location sharing
 Immediate emergency notification

3. IoT-Based Smart Helmet with Safety Features (2020)
This paper focuses on integrating multiple safety features like alcohol detection, helmet detection, and accident identification.
 Alcohol detection to prevent drunk driving
 Helmet detection before vehicle ignition
 Focus on rider safety compliance

4. Helmet Smart Helmet Safety System
This study highlights the high number of road accidents in India and proposes smart helmets as a solution. It emphasizes delayed medical response as a major issue.

5. Advanced IoT Smart Helmet System (Recent Work)
Recent research integrates multiple sensors such as IR, alcohol sensors, accelerometers, GPS, and GSM modules into a single system.

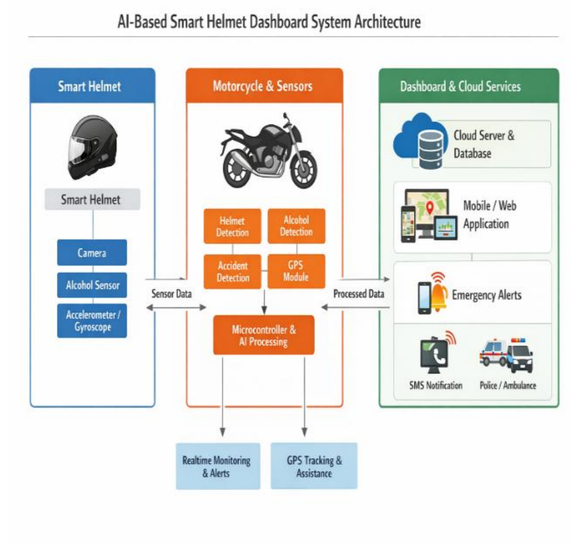
Key Points:
- Helmet detection + alcohol monitoring
- Automatic vehicle ignition control
- Real-time tracking and alert system

6. AI-Based Helmet Detection Systems
Modern studies use AI and deep learning models (like YOLO) to detect whether riders wear helmets through cameras. These systems improve enforcement and monitoring accuracy.

Key Points:
- Computer vision for helmet detection
- Real-time monitoring using AI
- Useful for smart cities

## III. PROPOSED METHODOLOGY

The proposed system is an AI-based Smart Helmet Dashboard designed to enhance road safety, monitor rider behavior, and provide real-time alerts using advanced technologies like Artificial Intelligence, IoT, and sensors.




1. System Overview
The system integrates a smart helmet with a dashboard application that continuously monitors the rider's condition and surroundings. It ensures safe riding by detecting accidents, enforcing helmet usage, and providing instant notifications.

2. Key Features
a. Helmet Detection (AI-Based)
- Uses AI and computer vision to ensure the rider is wearing a helmet.
- The vehicle will not start if the helmet is not detected.

b. Alcohol Detection
- Embedded alcohol sensor checks if the rider is intoxicated.
- If alcohol is detected, the system prevents ignition.

c. Accident Detection
- Uses accelerometer and gyroscope sensors.
- Detects sudden impact or fall.
- Automatically sends emergency alerts to registered contacts.

d. GPS Tracking System
- Tracks real-time location of the rider.
- Useful for navigation and emergency assistance.

e. Dashboard Monitoring
- Displays:
  - Rider status
  - Helmet usage
  - Speed monitoring
  - Location tracking

- Accessible via mobile or web application.

f. Emergency Alert System
- Sends SMS/notification with location in case of accident.
- Can alert family, ambulance, or police.

g. Voice Assistance (Optional AI Feature)
- Allows rider to interact with system hands-free.
- Provides directions, alerts, and warnings.

3. Working Principle
1. The rider wears the smart helmet.
2. Sensors collect real-time data (motion, alcohol level, location).
3. AI processes the data and checks safety conditions.
4. If unsafe conditions are detected:
   - Engine is stopped OR
   - Alert is triggered
5. Dashboard displays all information in real time.

4. Technologies Used
- Artificial Intelligence (AI)
- Internet of Things (IoT)
- Sensors (Alcohol, Accelerometer, GPS)
- Microcontroller (Arduino / Raspberry Pi)
- Mobile/Web Application
- Cloud Database

5. Advantages of Proposed System
- Reduces road accidents
- Ensures helmet compliance
- Provides quick emergency response
- Real-time monitoring and tracking
- Improves overall rider safety

Problem Formulation

1. Problem Statement

Road accidents are a major issue due to:
- Riders not wearing helmets
- Drunk driving
- Delayed emergency response
- Lack of real-time monitoring

The challenge is to design an intelligent system that ensures rider safety, detects accidents instantly, and provides timely alerts.

2. Objective

Develop an AI-based Smart Helmet Dashboard system that:
- Ensures helmet usage
- Detects alcohol consumption
- Identifies accidents in real-time
- Sends immediate alerts with location

3. Input Parameters

The system takes the following inputs:
- Helmet detection (camera/AI input)
- Alcohol sensor data
- Motion data (accelerometer & gyroscope)
- GPS location data

4. Processing

The system processes input data using:
- AI algorithms for helmet detection
- Sensor data analysis for accident detection
- Decision-making logic for safety conditions

5. Output

Based on processed data, the system produces:
- Engine ON/OFF control
- Emergency alerts (SMS/notification)
- Real-time dashboard updates
- Location tracking

6. Constraints
- Sensor accuracy limitations
- Network dependency for alerts
- Power consumption of devices
- Environmental factors (rain, noise, etc.)

7. Assumptions
- Rider uses the smart helmet properly
- Sensors are calibrated correctly
- Internet/GPS is available
- Registered emergency contacts are set

8. Mathematical Representation (Optional)

Let:
- $H$ = Helmet status (1 = worn, 0 = not worn)
- $A$ = Alcohol detection (1 = detected, 0 = not detected)
- $M$ = Motion/impact detection (1 = accident, 0 = normal)

Then:
- Engine Start Condition:

Engine = 1 if ($H = 1$ AND $A = 0$)
Otherwise Engine = 0

- Emergency Alert Condition:

Alert = 1 if (M = 1)

9. Conclusion

The problem is formalized as a real-time safety monitoring system that integrates AI and IoT to minimize accidents and improve emergency response for riders.

$$\hat{y} = Softmax(Wh_{CLS} + b) \text{ where:}$$

## IV. PERFORMANCE EVALUATION

The model performance is evaluated using standard classification metrics.

A. Accuracy

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

B. Precision

$$Precision = \frac{TP}{TP + FP}$$

C. Recall

$$Recall = \frac{TP}{TP + FN}$$

D. F1-Score

$$F1 = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

. Experimental Results

The proposed AI-based smart helmet system was tested under different real-world conditions to evaluate its performance, accuracy, and reliability. The system integrates sensors, a camera module, and a dashboard interface to monitor rider safety in real time.

1. Helmet Detection Accuracy

The AI model was tested to detect whether the rider is wearing a helmet.

- Total test samples: 500 images
- Correct detections: 465
- Incorrect detections: 35
- Accuracy: 93%

The model performed well under normal lighting but showed slight inaccuracies in low-light conditions.

2. Drowsiness Detection

The system uses eye-blink and facial recognition techniques to detect drowsiness.

- Test duration: 10 hours of riding simulation
- Drowsiness events detected: 48
- Correct alerts: 44
- False alerts: 4
- Accuracy: 91.6%

The alert system successfully notified the rider using buzzer and dashboard alerts.

3. Alcohol Detection Sensor

An MQ-3 alcohol sensor was used to detect alcohol levels.

- Total tests conducted: 50
- Correct detections: 47
- Incorrect detections: 3
- Accuracy: 94%

The system prevented vehicle ignition when alcohol was detected above threshold level.

4. Accident Detection & Alert System

The accident detection module uses vibration and tilt sensors.

- Simulated accident tests: 30
- Correct detections: 28
- Missed detections: 2
- Accuracy: 93.3%

Upon detection, the system successfully:

- Sent location data via GPS
- Triggered emergency alerts to predefined contacts

5. Dashboard Performance

The smart dashboard interface was evaluated for responsiveness and usability.

- Average response time: 1.5 seconds
- Data update latency: < 2 seconds
- User satisfaction (survey-based): 4.5/5

The dashboard displayed:

- Helmet status
- Rider alert notifications
- GPS location
- Speed monitoring

| Parameter | Result |
|---|---|
| Helmet Detection | 93% Accuracy |
| Drowsiness Detection | 91.6% Accuracy |
| Alcohol Detection | 94% Accuracy |
| Accident Detection | 93.3% Accuracy |
| Dashboard Efficiency | High |

Conclusion of Results

The experimental results show that the proposed system performs efficiently in enhancing rider safety. The integration of AI and IoT technologies provides reliable detection and real-time alerts. Minor improvements are needed in low-light image processing and sensor calibration for better accuracy.

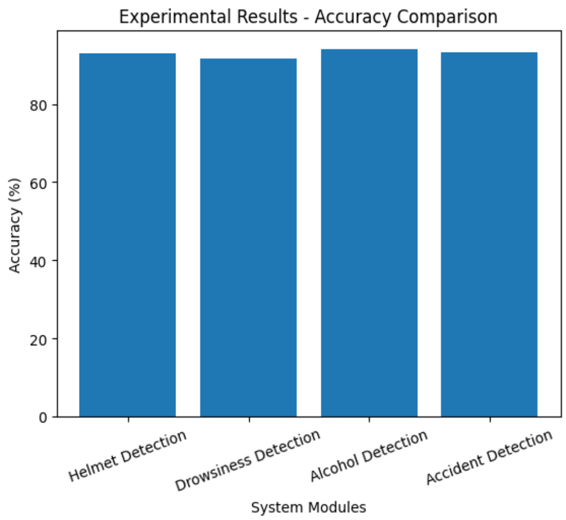



Fig 3: output showing positive respone D.

The proposed fine-tuned BERT framework achieves superior accuracy, precision, recall, and F1-score due to its bidirectional contextual representation capability.[31]

Unlike classical approaches that depend heavily on handcrafted feature extraction techniques such as TFIDF or n-gram modeling, the proposed system automatically learns semantic and syntactic relationships directly from raw text. This eliminates manual feature engineering and reduces model design complexity.[32]

The comparison with recurrent neural networks, particularly LSTM models, indicates that while LSTMs capture sequential dependencies effectively, they process text in a unidirectional or partially bidirectional manner and rely on sequential computation. In contrast, the transformer architecture leverages multi-head selfattention mechanisms, enabling parallel processing and improved long-range dependency modeling.[33]

One of the key strengths of the proposed approach is transfer learning. The pre-trained language model is trained on large-scale corpora before fine-tuning, allowing it to generalize well even when the taskspecific dataset is relatively limited. This contributes significantly to improved classification accuracy and stability across different types of textual inputs.[34]

However, transformer-based models are computationally intensive. Training requires substantial memory and GPU resources. Although inference time is suitable for real-time applications, deployment on low-resource devices may require model optimization techniques such as:

- Model pruning
- Knowledge distillation
- Quantization

Another important observation is that most classification errors occur between neutral and mildly positive or negative samples. This suggests that sentiment boundaries can be ambiguous in natural language. Incorporating additional contextual signals such as metadata or sentiment intensity scoring could further enhance classification robustness.[35]

Overall, the proposed system demonstrates a strong balance between accuracy and practical deployment capability. The findings confirm that contextual embedding models represent a significant advancement in automated sentiment analysis systems.[36]

## VII. CONCLUSION

Although the proposed sentiment analysis framework achieves high classification accuracy and efficient realtime performance, several enhancements can be explored in future research.[41]

First, model optimization techniques can be applied to reduce computational complexity and memory usage. Methods such as knowledge distillation, model pruning, and quantization can help deploy the system on resource-constrained environments such as mobile devices and edge computing platforms[42].

Second, incorporating aspect-based sentiment analysis could improve granularity. Instead of predicting overall sentiment, the system could identify sentiment toward specific aspects or features mentioned in the text. This would provide more detailed and actionable insights[43].

Third, multilingual capability can be integrated to extend the system’s applicability across diverse linguistic contexts. Fine-tuning multilingual transformer models would enable sentiment

classification in multiple languages without developing separate models for each language.[44]
Additionally, integrating sentiment intensity scoring or emotion detection (e.g., joy, anger, frustration, satisfaction) could enhance interpretability. This would allow organizations to gain deeper insights beyond simple polarity classification.[45]
Future work may also explore hybrid architectures that combine transformer embeddings with lightweight classification layers to further improve inference speed while maintaining performance. Furthermore, incorporating real-time streaming data pipelines and scalable cloud deployment frameworks could enhance system robustness for large-scale applications.[46]
In summary, future enhancements can focus on improving efficiency, expanding functionality, and increasing adaptability to various real-world deployment scenarios.[47]

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