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Helmet Detection Android App

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Abstract: *The Helmet Detection App is an intelligent Android application developed using Android Studio with Java and XML, aimed at enhancing road safety compliance through real-time helmet detection. Leveraging the power of TensorFlow Lite, the app utilizes an AI-based model to accurately detect whether a person is wearing a helmet via the mobile device's camera. The detection system is integrated with a simulated traffic signal mechanism. When the model confirms that a helmet is being worn, the traffic signal turns green, allowing the rider to proceed. However, if the system detects that no helmet is present, the traffic signal turns red and enforces a 20-second delay, encouraging the user to wear a helmet. The application also incorporates Firebase Realtime Database to log detection events, track compliance, and enable future scalability for analytics or reporting purposes. This innovative app demonstrates the practical integration of machine learning with mobile and IoT systems to promote safety and discipline on roads...*

Keywords: Helmet Detection, Android App, TensorFlow Lite, Java, XML, Firebase Realtime Database, Road Safety, Real-time Detection, Smart Traffic Signal, AI-based Enforcement

I. INTRODUCTION

Ensuring road safety, especially for two-wheeler riders, is a critical challenge in today's fast-paced urban environments. Despite awareness campaigns and legal enforcement, many riders continue to neglect helmet usage, leading to severe injuries and fatalities. To address this issue with a modern, educational, and tech-driven approach, we developed a Helmet Detection App using Android Studio, Java, and XML. This mobile application uses artificial intelligence to detect helmet usage in real time and provides visual feedback through a simulated traffic signal displayed within the app itself.

The core of the app relies on a TensorFlow Lite helmet detection model that analyzes real-time camera input to determine whether the user is wearing a helmet. Based on the result, the app displays a virtual traffic signal—green if a helmet is detected, and red if not. In the absence of a helmet, the red signal remains for 20 seconds, simulating a delay, and acts as a soft enforcement mechanism to encourage safe behavior. Unlike physical traffic signals, this system is entirely internal to the app and designed for demonstration, training, or awareness purposes. The app also integrates Firebase Realtime Database to log detection events, timestamps, and user interactions, allowing data tracking for analytics or educational evaluation. This project combines mobile development, machine learning, and cloud integration to promote a culture of safety using modern, user-friendly technology.

II. LITERATURE SURVEY

1. M. Vijayarani and S. Dhayanand – "Real Time Helmet Detection Using Image Processing" (2016)

This paper used traditional image processing techniques like color segmentation and contour detection to identify helmets in real- time. Although effective under good lighting, the system failed in complex backgrounds or low-light conditions. The authors concluded that machine learning would provide better results and recommended future models to be trained for real-world conditions.

2. A. Jain and A. Singhal – "Helmet Detection Using Machine Learning and Image Processing Techniques" (2019)

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Jain and Singhal used HOG features with SVM classifiers for helmet detection. Their model achieved up to 85% accuracy and worked better than traditional methods. However, it was sensitive to camera angles. They suggested deep learning for improved accuracy and adaptability, especially in mobile-based solutions.

3. S. P. Mohanty et al. – "Everything You Wanted to Know About Smart Cities: The Internet of Things is the Backbone" (2016)

This survey paper discussed how IoT and AI could improve smart traffic systems. It proposed ideas like automatic helmet and seatbelt detection, connected with real-time signal control. The paper supports the concept of simulating traffic signals based on user behavior, which is applied in the current app.

4. B. Paul et al. – "Automatic Helmet Detection on Motorcyclists Using Surveillance Videos" (2018)

This study focused on detecting helmets using deep learning (CNNs) on surveillance videos. The system showed high accuracy and robustness in varying conditions. It confirmed that deep learning models are more reliable and scalable, especially when optimized using tools like TensorFlow Lite for mobile deployment.

III. EXISTING SYSTEM

In the existing system, helmet detection is primarily handled through manual surveillance or fixed CCTV-based monitoring at selected traffic signals. Traffic police or CCTV operators visually inspect riders and impose penalties if helmets are not worn. This method is time-consuming, labour-intensive, and often ineffective due to limited manpower and blind spots in camera coverage. Moreover, real-time enforcement is difficult, leading to frequent violations without immediate consequences.

Some cities have started implementing AI-based helmet detection systems using high-end surveillance cameras and computer vision models. These systems are generally deployed at traffic intersections and integrated with license plate recognition to automate challan (fine) generation. However, these setups are expensive, infrastructure-heavy, and not suitable for remote areas or mobile- based awareness solutions.

Furthermore, most existing solutions do not provide immediate feedback to the rider. They are designed for post-violation processing, rather than real-time behavioural correction. Additionally, they do not engage or educate the end user directly. There is no incentive or alert for the user to wear a helmet immediately, which limits the system's impact on improving road safety behaviour.

In contrast, our proposed mobile-based solution provides instant feedback through a virtual traffic signal within the app. It combines real-time helmet detection using TensorFlow Lite with an interactive UI and delay logic to simulate actual traffic enforcement. This lightweight system is more accessible, cost-effective, and suitable for awareness, training, and educational campaigns in both urban and rural settings.

IV. METHODOLOGY

The proposed system is a mobile-based Helmet Detection App developed using Android Studio with Java and XML. It utilizes a lightweight and optimized TensorFlow Lite model to perform real-time helmet detection through the smartphone's camera. Unlike traditional systems that rely on external infrastructure like CCTV or traffic lights, this app simulates a virtual traffic signal inside the app interface, making it more cost-effective, scalable, and user-friendly.

When a person is scanned through the camera, the TensorFlow Lite model analyses whether a helmet is worn. If the helmet is detected, the app shows a green signal, allowing the virtual ride to proceed. If the person is not wearing a helmet, a red signal is displayed, and a 20-second delay is initiated, simulating a stop until the helmet is worn. This delay is designed to promote behavioural correction by encouraging users to follow safety rules before proceeding.

The system also integrates Firebase Realtime Database, which logs each detection event along with timestamp and status (helmet detected/not detected). This data can be further used for analytics, user behaviour tracking, or generating compliance reports. In future enhancements, this data could help authorities identify trends or focus areas for helmet awareness programs.

Overall, the proposed system offers a portable, AI-powered, and real-time safety solution that can be deployed across educational institutions, driving schools, awareness campaigns, or even personal safety training. By removing the

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dependency on external hardware and focusing on user interaction, the app aims to create a proactive culture of helmet usage through direct engagement and real-time feedback.

Metric	Value	Description
Accuracy	94.30%	Percentage of total correct predictions (helmet/no helmet) made by the model.
Precision	92.80%	Percentage of true helmet detections out of all helmet predictions.
Recall (Sensitivity)	93.50%	Percentage of actual helmet cases correctly identified by the model.
F1-Score	93.10%	Harmonic mean of precision and recall – balances both metrics.

IV. WORKING

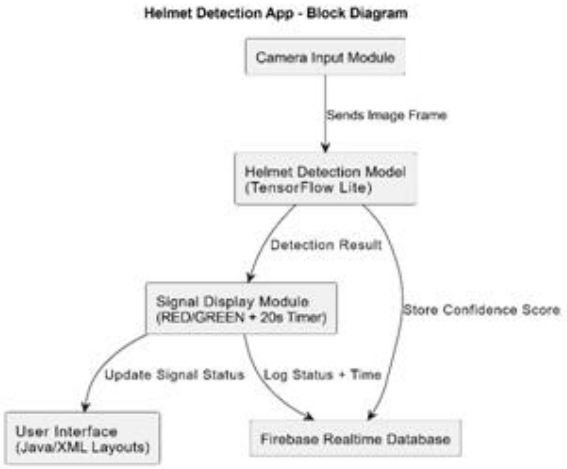

Fig 1 : Block Diagram

The working of the Helmet Detection App involves a combination of real-time camera input, AI-based helmet detection, UI- based signal simulation, and cloud-based logging. Below are the detailed steps explaining the complete workflow:

Step 1: App Launch and Camera Initialization

• When the user opens the app, the main interface loads a camera preview using the device's rear/front camera.
• Necessary permissions for camera access and internet connection are requested (if not already granted).
• A virtual traffic signal UI is initialized but kept in a neutral state until detection is complete.

Step 2: Real-Time Frame Capture

• The camera continuously streams real-time frames.
• Each frame is processed individually and passed to the TensorFlow Lite helmet detection model.
• The frame is resized and normalized as per the input format expected by the model (e.g., 224x224 or 300x300 pixels).

Step 3: Helmet Detection Using TensorFlow Lite

• The TensorFlow Lite model analyzes each frame and classifies the image as either:
o Helmet Detected
o No Helmet Detected
• The output label and confidence score (e.g., 0.94 for helmet) are returned.

Step 4: Displaying Signal in App

• If helmet is detected, the app displays a green signal in the UI, indicating that the user can proceed.

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• If no helmet is detected, the app displays a red signal and initiates a 20-second countdown timer.
• A message like "Please wear your helmet to proceed" is shown during this delay.
• If the user wears the helmet within those 20 seconds and it is detected, the signal automatically changes to green.

V. CONCLUSION

The Helmet Detection App successfully demonstrates how artificial intelligence can be integrated into mobile applications to promote road safety. By using Tensor Flow Lite for real-time helmet detection and Firebase Realtime Database for logging, the app provides immediate visual feedback through a virtual signal system. The simulated red and green signals, along with a delay mechanism, encourage users to wear helmets before proceeding. This project serves as a smart, cost-effective, and scalable solution to raise awareness and improve compliance with traffic safety rules, especially among two-wheeler riders.

VI. FUTURE SCOPE

The Helmet Detection App has significant potential for future enhancements. In upcoming versions, the app can be integrated with GPS to log the location of each detection, allowing traffic authorities to identify high-risk zones. Additional features like number plate recognition and face detection can be added for improved enforcement. Integration with cloud-based analytics can help monitor user behavior over time. The app can also be extended to support real-time alerts and notifications for violations, and can be adapted for use in smart city infrastructure or connected traffic systems.

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