IOT Enabled Smart Safety System For Two-Wheelers

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Abstract

The smart vehicle management system is an advanced safety solution that integrates several sensor technologies with an Arduino-based control system to increase traffic safety and prevent theft of the vehicle. It consists of an MQ -3 sensor, a helmet confirmation system with IR -sensor and an alcohol section system using an MPU -6050 accelerometer/gyroscope. If an accident occurs, the system automatically triggers an emergency alert through GSM and sends predetermined contacts to GPS coordinates. In addition, an anti-theft system prevents unauthorized vehicle movement by enabling distance through SMS, providing real -time updates to the owner. A separate Yolov 7-based helmet detection module works independently, using a vision-based verification system that does not interfere with primary hardware functions. Traditional sensors with modern imaging techniques By combining the safety measures, the system ensures safety, reliability and increasing operational integrity in different circumstances. This multi-layer approach reflects the coexistence of the underlying hardware solutions and the A-interest verification, which provides a comprehensive safety structure.

Keywords: Arduino, MQ-3 alcohol sensor ,MPU-6050 accelerometer ,GPS ,GSM and YOLOv7.

I. INTRODUCTION

Road safety and vehicle safety have proven to be significant traffic safety and vehicle safety have become important concerns due to increasing number of accidents theft and traffic rules worldwide driving under the influence of alcohol failure to use helmets and unwanted accidents has given rise to thousands of incompatibility each year. In addition theft of vehicles has presented an important challenge to officers and vehicle owners. Including smart technologies in vehicles have the ability to reduce these risks by automating the enforcement of security measures and integrating real -time monitoring and vigilant systems.The smart safety system addresses these problems by integrating alcohol section helmet detection prevention of accident and distance vehicles through SMS. The system provides a comprehensive security solution that can be implemented in two -wheelers ensuring that the rider follows basic safety protocols such as using helmets and riding under the influence of alcohol in addition in the inappropriate event of an accident the system immediately informs emergency contacts and authorities and provides the location of an accident to the rapid response time. Stolen prevention facilities improve the safety of the vehicle so that the owner can track the bike and control its ignition from externally using SMS commands. The

inspiration behind this project is to create a smart integrated system that can easily increase safety and vehicle safety using costly available cost -effective sensors and microcontroller techniques. The increasing number of traffic accidents related to two -wheelers was an important motivation for the project due to the consumption of alcohol and the absence of helmets in addition the dangerous frequency of vehicle theft emphasized the need for theft and the need for prevention system. The motorcycle which is a common means of transport suffers from theft and accidents especially. Current methods to prevent driving using helmets and detecting accidents are often dependent on manual enforcement or post -back reporting which may be disabled or too late to prevent life loss with rapid progress of iot and sensor technologies it became possible to develop a system that could automatically avoid accidents detect theft and notify the respective parties in real time. By integrating these functions into a single system the smart safety system provides an active solution for safety and safety problems in the motor vehicles sector.

Problem statement : With the increasing number of road accidents, particularly involving two-wheelers, there is a critical need for systems that can enhance rider safety and vehicle security. Factors such as drunk driving, failure to wear helmets, and theft of motorcycles pose significant risks to riders and their vehicles. Current enforcement mechanisms often rely on manual compliance, which can be ineffective. Therefore, there is a need for a comprehensive Smart Safety System that can automatically:

1. Prevent a vehicle from starting if alcohol is detected in the rider's breath.
2. Ensure compliance with helmet usage by detecting whether the rider is wearing a helmet before allowing ignition.
3. Detect accidents or falls and send immediate emergency alerts with the location of the incident.
4. Monitor for theft attempts by sending alerts if the vehicle is moved without unlocking.
5. Provide a secure method for the rider to unlock the vehicle remotely via SMS.

Objectives : The main objectives of the Smart Safety System are:

1. **Alcohol Detection and Ignition Locking:** Use an alcohol sensor (MQ-3) to detect the rider’s alcohol level and prevent the vehicle from starting if alcohol is detected. This feature promotes safe driving by inhibiting drunk driving.
2. **Helmet Detection:** An IR sensor is used to detect whether the rider is wearing a helmet. The bike will not start until the helmet is worn, ensuring compliance with safety regulations.
3. **Accident and Fall Detection:** The MPU6050 accelerometer and gyroscope sensor detect any abnormal tilting or impact that indicates an accident or fall. When an accident is detected, an emergency SMS with GPS coordinates is sent to predefined contacts, enabling quick rescue operations.
4. **Theft Prevention and Detection:** The system includes a theft detection feature where an alert SMS is sent to the owner if the bike is moved without unlocking. This prevents unauthorized movement of the vehicle.
5. **Remote Unlocking via SMS:** The rider can unlock the vehicle by sending a secret code via SMS. This allows for secure remote access and vehicle control, adding an additional layer of convenience and security.
6. **YOLOv7-based helmet detection:** It’s Running in parallel but without interaction. This module processes camera input to identify helmets using machine learning, serving as an experimental showcase of vision-based safety verification. Importantly, it does not influence ignition control, sensor readings, or any other hardware component, ensuring that the core safety mechanisms remain unaffected.

II. LITERATURE REVIEW

C. Nandhini et.al [1] This paper introduced a recent progress in intelligent transport systems its has improved traffic management and safety through technologies such as helmet detection and several rider detection traditional approaches are often dependent on hand -prepared functions and wooden stage processes including object segmentation motorcycle detection and helmeticity wales such as histograms and vector machines svm of circular huff transform cht oriented gradients hog have been widely used even though they suffer from high calculation costs and reduce the accuracy of real -time scenario deep learning-based approaches especially contrane neural network cnn such as alexnet faster r-cnn and yolov 3 have shown major reforms in accuracy and efficiency detection these models often use field -based identities for helmetity and face challenges in the overloaded environment despite these progress questions such as partial obstacles poor lighting and different weather conditions are challenging for existing solutions highlighting the need for stronger and adaptable models. Praveenkumar et.al [2] This system integrates a rocker sensor to detect unusual inclination to potential accidents. In detection, the GPSR (GPSR) module determines the geographical coordinates properly. The data received is then sent to predetermined emergency contacts through Short Message Service (SMS) and at the same time loads up to Thinger.IO Cloud Server to monitor external monitoring. The engineer, as a cost -eligible solution, facilitates quick readiness by automating the system alert generation, reducing the response time and reduced death rice. Ramu A et.al [3] This system integrates Rider security only includes more than helmet compliance, as the presence of non-essential auxiliary components such as Bluetooth module, in-hall sound system (earplugs) and top-mounted light units can contribute to censorship to help cognitive overload, weakened status and security-activated decisions. In order to reduce these potential distractions and related risks, it is recommended to eliminate non-protection-overnatural elements. An advanced intelligent helmet system, which is equipped with an influence-infuttered accident detection mechanisms and GPS-essential blind spot monitoring, significantly improves the status of awareness and prevention of accidents. This sensor -intensive safety structure makes it possible to detect and analyze danger in real time, and facilitate quick response tasks and active risk reduction to adapt rider safety Md.Motaharul et.al [4] It introduced An MPU6050 (Gyro sensor and accelerometer), SIM808 GPS, GPRS module, GSM module, Raspberry Pi 3 Model B, and a system is proposed to detect bicycle accidents using Arduino Uno. The system is located on the bike, and in the event of an accident, the sensor will detect the effect and send an information message, the contact information to hospital nearby and police stations and to the registered family members. The system includes a Gyro sensor that calculates the bicycle angle, which is then sent to Arduino and treated by raspberries. When an accident is detected, the system properly identifies the situation and sends details to emergency contacts, including the nearest police stations, hospitals and family members. The purpose of this solution is to reduce the number of injuries from bicycle accidents by enabling timely help and quick response to the emergency services.

Dr. V. Kumara Swamy et.al [5] review of paper literature discusses several advances in vehicle monitoring and alcoholic section systems to increase traffic safety this universal status system GPS checks existing techniques such as based vehicle monitoring which provides real -time room monitoring and ensures the safety of the vehicle. In addition the paper examines the mechanisms that detect alcohol which includes breathing analyzers and sensors inducted in vehicles to identify drunken drivers last studies emphasize. The effectiveness of integrating the GPS with an alcohol section to prevent driving accidents various techniques including GLSM global mobile communication modules for notification generation and automatic engine lock systems are reviewed where the driver is reviewed as a practical approach. To ensure safety in addition the assessments accept the role of microcontroller sensors and wireless communication in the development of strong and effective systems .By consolidating insights after previous research the paper identifies holes in traditional methods and suggests an integrated solution to detect vehicle monitoring and alcohol to reduce traffic accidents and increase total transport safety.

Oguntimilehin A,et.al [6]reviews examine various approaches to car accident and reporting systems, which focus on the progressive progress made possible by the Internet of Things (IoT). Existing systems are often dependent on built -in sensors, GPS and GSM modules to explore confrontation and forwarding

information for emergency services. Traditional accident detection systems are limited in their ability to provide real -time data and delay emergency preparedness. Recent studies emphasize the use of accelerometer and gyroscopic sensors to accurately detect sudden detection in speed patterns. In addition, integration with cloud platforms and mobile applications has been exposed to real -time data analysis and remote monitoring. The machine learning algorithm is also used to improve the accuracy of accident detection by distinguishing between false alarms and actual conflicts. Despite this progress, there are challenges in ensuring reliable communication in remote areas and maintaining the system strength. The proposed system in this study creates these concepts by offering a strong IoT competition construction that ensures timely detection and reporting of accidents, thus increasing traffic safety and reduces incompatibility.

Sharan L et.al [7] This presented a research has discovered many tasks including RF communication GSM and cloud-based systems to improve security measures various sensor technologies such as bioelectric sensors gas detectors and face identification have been used to increase helmet functionality while existing solutions show significant progress in the prevention of accidents and detects danger challenges such as crafts system complexity and spontaneous integration persist the review emphasizes the need for continuous innovation to limit the smart helmet system for extensive use and to increase reliability standards in industries.Syed Inthiyaz, V et.al [8] It's highlighted various advances in smart helmet techniques with the aim of integrating the sensor and communication module by integrating rider safety traditional helmets provide passive protection but new innovations have introduced functions such as alcohol section accident reporting and rider approval previous studies have focused on detecting alcohol consumption using mq-3 sensors making sure the vehicle does not begin ignition if the rider is drunk other research efforts have detected accidents using accelerometer and gyroscope with GPS and GSM modules to notify urgent situation contacts in case of accidents in addition smart helmet design has included iot-based real-time tracking system which uses platforms such as thinkspek to provide live data monitoring however there are challenges in securing user comfort the reliability of the system and effective wireless communication while RF modules have been used for helmet-to-bike communication their one-way transmission limit indicates alternative wireless communication technology the reviewed literature emphasizes the importance of integrating security measures into the helmet to reduce the deadly road deadlie with attempts to limit and improve these wide adoption systems.

Gunjan Chhabra,etal, et.al [9] This introduced proposes an intelligent system that increases safety with two-wheeler rider by merge machine learning and iot technologies this focuses on detecting alcohol consumption when using EEG signal analysis and ensures that an intoxicated rider cannot start a vehicle in addition the system monitors helmet use the vehicles speed and location in real time machine learning classifies as multi-layer perception(MLP) support vector machine(SVM) , k-Nearest Neighbors (KNN) and naive bees are evaluated with about 95 of accurate to find the effect of alcohol if it is found that the cyclist is full the system neutralizes the ignition of the vehicle to prevent unsafe riding in addition it sends warning and live location updates to family members in emergency cases by addressing important security problems such as drunk driving negligence and speed the system provides a comprehensive solution that supports traffic safety initiatives and helps to reduce accidents especially in india's growing two -wheeler markets. Joao Perp et.al [10]reviews the literature undergoes discussion of the development of smart cities along with progress in ad hoc networks habit and vehicles of vehicles which led to the development of systems with a view to growing the safety of weak road users vru and 2wheelers these systems use sensors and message interchange between vehicles and infrastructure to create awareness of road users various approaches including its based architecture depend on sin-g5 networks and v2v communication indirect models to detect vru using infrastructure-based sensors and vru detection methods are detected using an ultra-width enforcement in addition the use of smartphone apps is considered to broadcast the vru awareness vams and to transfer vigilant users for potential hazards as a basis for the work developed in this article.

Rajapandian et.al [11] reviews discuss many smart helmets and e-bicycle technologies highlighting the progress of safety and automation it examines previous research on helmets with built -in sensors for prevention communication and keep under observation of accidents. In addition it covers the integration of IoT GPS tracking and voice commands in smart mobility solutions coverable e-bicycles emphasize .The importance of energy efficiency speed control and environmental stability the review also identifies holes in existing systems especially to integrate helmet -based control mechanisms to increase riders safety and convenience.

Robert Plšičík et.al [12]According to market research, motorcycle safety systems can be classified into three groups: the basic alarm without detecting advanced theft, the manufacturer's advanced security systems (although their illegal meeting -evaluation is not publicly available), and the location of the geological status, the system with the wireless interaction with the owner and the location of the geological status. The third category is not widespread, only one product is found in the European market, and GPS cabinets are an option. This prototype of paper falls into the third category, which represents the modified data collection unit for security and emergency applications for individual tracks.Rajapandian.B et.al [13] It introduced "IoT -based smart biometric safety and safety in modern motorcycles" addresses the need for increased safety and user experience in modern motorcycle technology. The existing motorcycle safety systems include the input and alarm system without a key, which provides a degree of convenience and safety. In addition, some motorcycle owners choose aftermarket GPS tracking units to enable real -time room monitoring. Construction of this basis introduces research a smart biometric security system that integrates IoT technology. The purpose of this system is to revolutionize motorcycle security and compete the theft through the implementation of strong hardware solutions

III. METHODOLOGY

The methodology involves a systematic approach to achieve efficient safety system :

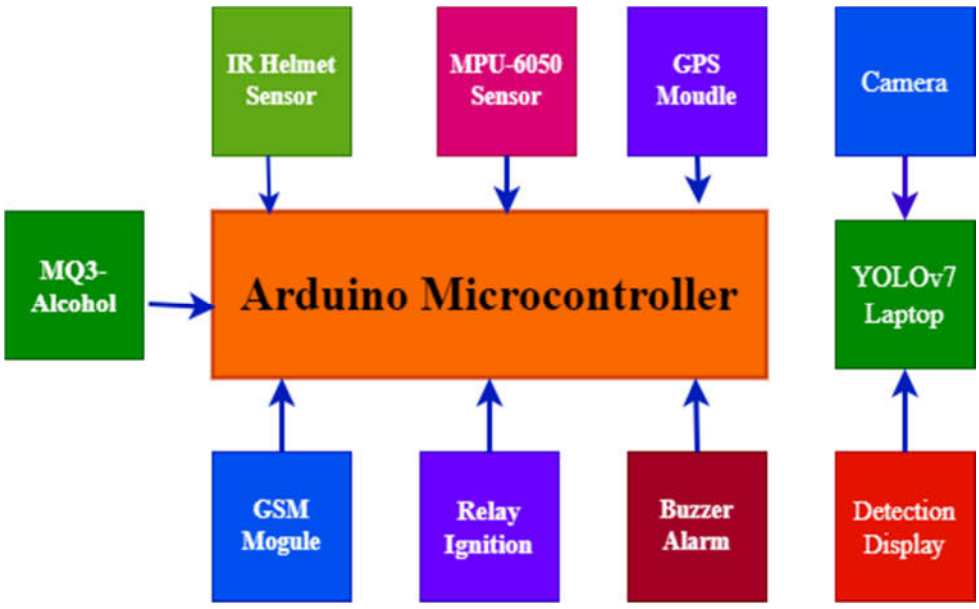

Fig 1: block diagram of Smart Safety System for Two Wheeler’s.

The Smart Vehicle Safety System operates through a multi-layered safety framework combining hardware sensors and an independent computer vision module.
The primary safety are:

- Alcohol Detection: An MQ-3 sensor prevents ignition if alcohol vapor is detected.

- Hardware-Based Helmet Verification: An IR proximity sensor ensures helmet presence before enabling the vehicle.
- Accident Detection: An MPU-6050 motion sensor triggers emergency alerts upon detecting crash-like motion patterns.
- Theft Prevention: Unauthorized movement detection followed by GPS-tracked alerts and SMS-based remote unlocking.

The hardware components form the backbone of the Safety system. They include:

- ESP32 Microcontroller: Acts as the central controller, responsible for managing the main control unit that processes data from sensors and manages the ignition system.
- Sensors : MQ-3 Alcohol Sensor (used for Alcohol detection) ,IR Sensor (Helmet Detection) and MPU-6050 (Accelerometer/Gyroscope)
- Communication Modules: SIM800L GSM Module and NEO-6M GPS Module (GPS drones are equipped with a GPS module that allows them to know their location relative to a network of orbiting satellites).
- Actuation & Power : Relay Module (Ignition Control) and Power Supply Provides the necessary electrical power to all components, ensuring uninterrupted functioning of the system.
- Laptop: Serves as the primary processing unit where the YOLO machine learning model is implemented. It captures and analyzes helmet images to classify them in real time.

The software components integrate seamlessly with the hardware to achieve the desired functionality. Key elements include:

- Arduino IDE: Arduino ide is the software used to write-compile-upload program to arduino. Its a open source software
- Libraries: In Ardunio IDE used some libraries are TinyGPS++, MPU6050_tockn and Software Serial.

YOLOv7 Setup (Independent): Deployed on the laptop, the model performs real-time helmet detection and classification. It identifies objects in images.

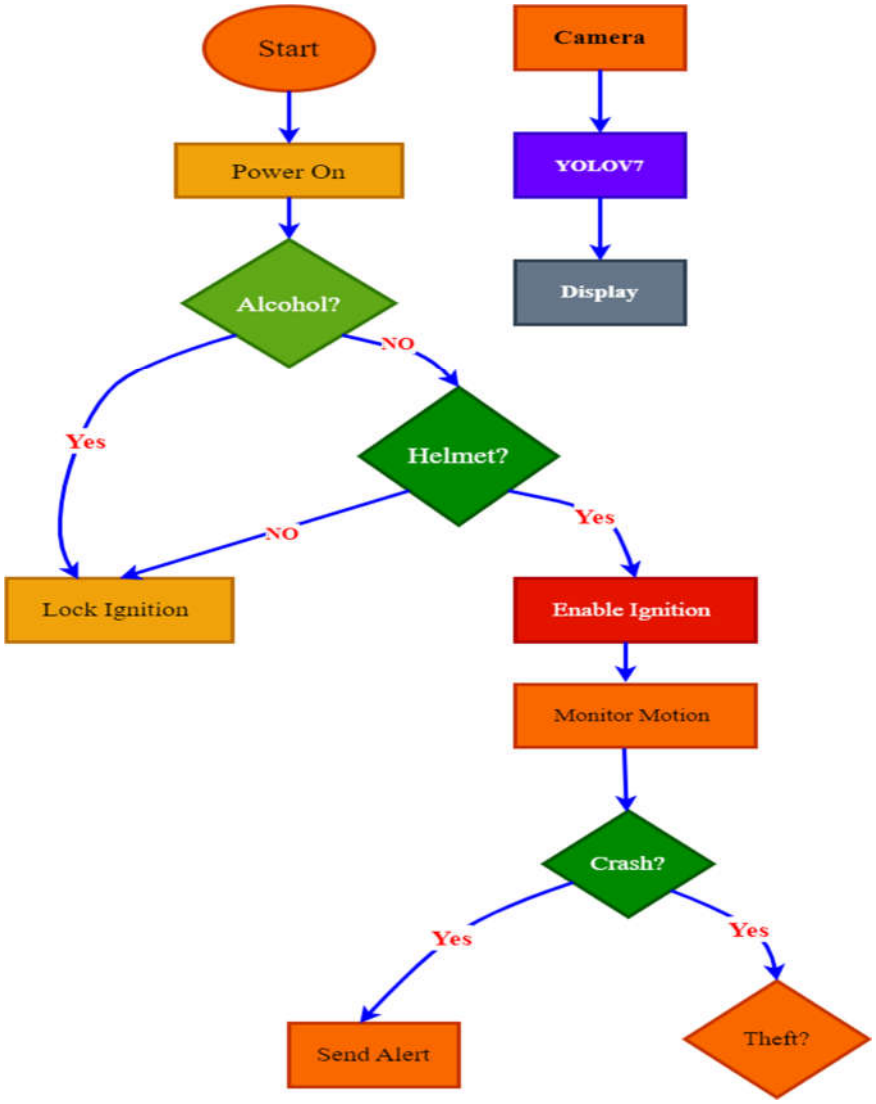

Fig 2: Flow chart of proposed Methodology

This flow chart(fig2) shows a smart vehicle ignition and monitoring system. It starts by turning on the system, followed by alcohol consumption. If alcohol is detected, the ignition closes. If not, check the system if the rider is wearing a helmet. If no helmet is detected, the ignition remains closed; Otherwise, ignition is capable. The system monitors sustained speeds, examines accidents or theft effort. If an accident is detected, a notice is sent. If theft is detected, appropriate measures can be taken. In addition, a camera lives in a Yolov7 object detection model, which shows relevant information.

IV. RESULTS AND DISCUSSIONS.

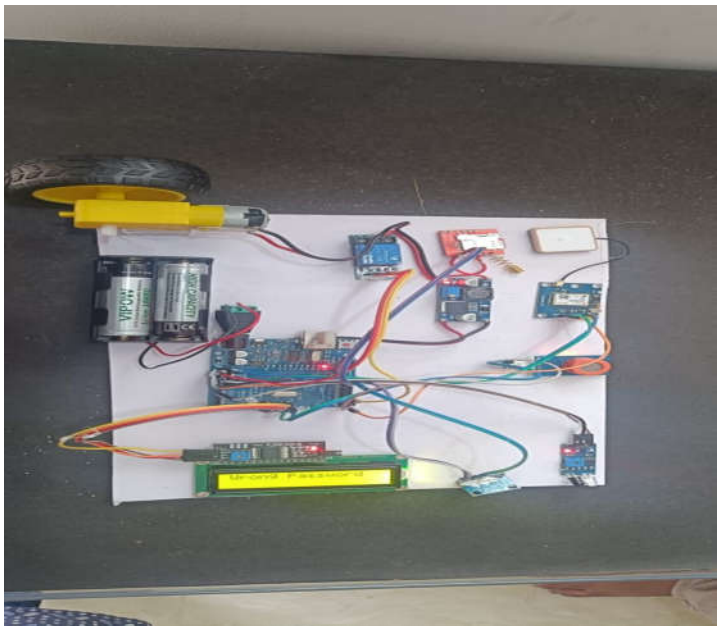

Fig:3 Smart vehicle management system

The implementation of the smart vehicle management system has shown significant reforms in motorcycle safety and safety. One of the main results is an effective prevention of drunk driving and enforcement of helmets, which must significantly reduce the risk of accidents. In addition, the system ensures quick readiness by sending an SMS notice with an exact GPS site for pre-configured contacts in case of an accident, enables time assistance. The anti-chori mechanism improves safety by detecting unauthorized movement and immediately informing the owner while using a secure SMS-based code, ensures a distance-locking system and safety. An integrated data logging function records important events such as alcohol section, helmet use and accidents, analyzes rider behavior, provides valuable insights into analyzing behavior, identifying security trends and improving future security protocols. The system effectively integrates sensor-based monitoring with AI-operated vision module, and ensures that antenna of the vehicle is disabled if alcohol consumption is detected or riders are not worn. An accident detection module operated by an MPU-6050 sensor, which triggers emergency warning with GPS space in incident conditions further further improves safety. In addition, the Yolov 7-based helmet detection modules work independently, showing viability to AI-operated safety enhancement without disrupting core vehicle checks. Despite the efficiency, the system has some limitations, including the sensor blind, network dependency for the GSM/GPS notice and the requirement for an external laptop for Yolov 7 models, affecting the portability. However, the system shows a multi-level, unsuccessful survival of vehicle safety approach, and combines hardware

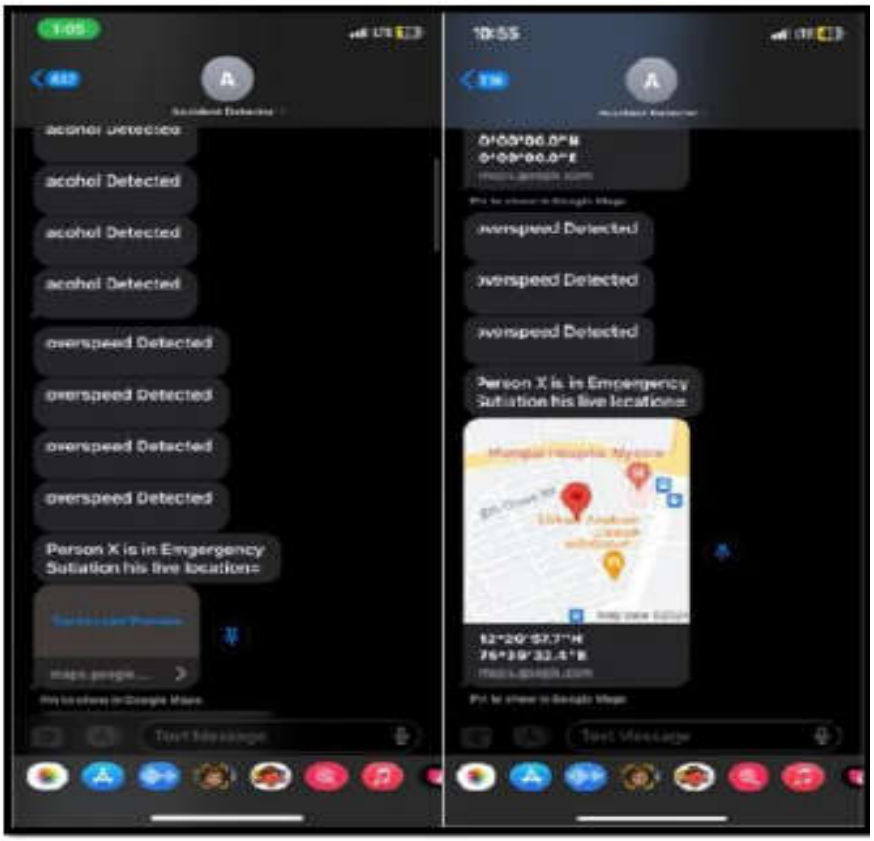

Fig 4:SMS alert

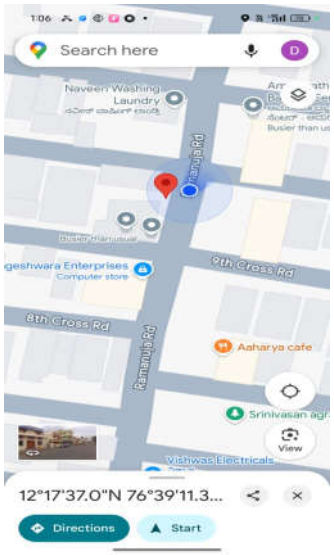

Fig 5 :Location tracking

V. CONCLUSION AND FUTURE SCOPE

This paper integrates Sensor-based safety mechanisms to increase with AI-implemented monitoring system to increase traffic and vehicle safety This prevents ignition in cases of Alcohol holding section or helmet absence , reduces the risk of accidents by detecting accident and incorporating anti-THFT mechanism for better security. YOLOV7-based helmet detection module for security verification without affecting the core control shows the possibility of data vision. Despite the challenges such as the sensor blind spot, network dependency and external laptop the system FAIL-SAFE assures the smart vehicle

management approach. Future progress may include vehicle control, real-time treatment, cloud-based monitoring, better sensor accuracy and better effect efficiency with AI integration. The system can be scaled for RIDE sharing, fleet management and public transport , which ensures security compliance . While the current design maintains isolation for reliability, future improvements can enable secure integration, a fully moving towards autonomous AI-controlled vehicle safety solutions.

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