# Sentinel Sphere: Enhanced Smart Helmet for Navigation and Road Safety

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***Abstract*—Traffic is the main issue that arises on a daily basis in this fast-paced environment. Controlling that traffic to get to the destination on time is really challenging. Even more challenging to monitor are changes due to traffic in real time and vehicle movement. The number of accidents is rising despite the presence of traffic signals, optimal traffic distribution, and emergency police nearby. This could be a one-time problem for rare divers. For regular drivers who operate delivery trucks and do cab responsibilities, this issue is highly significant. The work examines live navigation assistance for users, without distraction to their focus while facilitating accident avoidance and detection. The above aim is being achieved with three APIs, namely Google TTS, Gemini API and Deepgram API, along with sensors like MQ3, accelerometer and gyroscope. This paper helps in handling the safety of the driver and public while driving.**

***Index Terms*—Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning (ML), Road Safety.**

## I. INTRODUCTION

The embedded system along with field of IoT and AI involve in creating wonderful solutions for more complex and traditional problems. A few helpful solutions provide home automation for safe and user-friendly control of home gadgets. This helps in accessing remote gadgets from anywhere and at any time. Likewise this paper concentrates on providing the solution for drivers to facilitate safety and ease of navigation. The drivers nowadays use navigation applications to navigate from source location to destination. The drivers have to type the source and destination and frequently check the phone for the routes, traffic and alternate path allocated. They have to concentrate on the real time traffic which is going behind, before and on sides. This may create distractions on driving. Thus further increases the chances of accident. Idea discussed in this paper helps in reducing accidents and improving the easiness of driving. The users have to give the destination in terms of voice using the sensor and it has been converted to text for navigation. The route has been detected and converted to voice so that the user can listen to it and drive without looking into the phone constantly. The further idea of this paper is to detect the alcohol consumption of the driver and to detect the accidents. Once an accident occurs, the location of the user/driver is sent to the ambulance or to the nearby known person to get help.

## II. RELATED WORK

The idea of creating a system to support drivers is obtained from the following literatures, every second many fatal problems and injuries are happening by accidents which are due drivers as well as public. The drivers have to do their best to avoid accidents, which can be done with the help of collision avoidance system. To address the above problems Patil et al., (2023) have discussed about traditional methods like driver weariness, drowsiness, distractions and intoxication of driver. The accident avoidance can be further reduced with the idea of autonomous vehicles as well as by using traffic and accident detection system. By considering the accident types there are 3 categories, namely rear end collision, T-bone collision and Frontal impact accident. These kinds of accidents are detected and avoided by traffic signal analysis. The cameras are used to detect the accidents and reports are generated by analyzing the data as discussed by Adewopo et al., (2023). A few electric poles are being mounted with devices to detect the accident and generates an alert to prevent them. This idea is implemented by Patil et al., (2022) with help of IoT. By using lighting indicators, vehicles

approaching from the opposite direction are prevented from colliding. If any collision is detected the accident is being reported to nearby police station or hospital. Rajeshwari et al., (2021) have presented various idea of having frameworks to detect accident, namely GPS, GSM and cellphones to detect accidents, mobile applications to detect accidents, programs in cars to detect the accidents, sensors and computer vision along with AI to detect accident. Collision detection, collision avoidance along with traffic detection in autonomous vehicles are discussed by Karnati, & Mehta (2022) and Tewari et.al., (2021). But even though the idea is well enough its implementation is costly. Whatever may be the system enhanced safety is in the driver hands to follow rules and the precaution steps. The driver has to avoid sleeping while driving, avoid consuming alcohol and avoid rash driving. The drowsiness of the driver is detected using AI and ML by giving an alarm to ensure safety as discussed by Radha et al., (2022). As embedded devices are developing, it is very easy to do the above concepts with sensors available in low cost, less weight and high accuracy. For example the accelerometer can be used to detect the activity recognition in learning environment and in medical field for handling patients. Padilla & González, (2016) have presented that the data obtained from the user using accelerometer have been used for better machine and user interaction. Sukor et al., (2018) have presented that the activity of driver obtained from the accelerometer sensor's data are compared with the data available to ensure their performance in driving. Thus, the sensors help in detecting the driver's activity.

## III. OBJECTIVES

- To determine the most accurate and economical route navigation for the user without interfering with other riders.
- To identify a secure technique for warning the public about dishonest drivers.
- To protect riders and assist them in case of an emergency.
- To construct an economical and effective system that may be utilized in conjunction with two-wheelers.

## IV. METHODOLOGY

The flow starts from getting input from the user. The user regularly gives the source and destination in the form of text while searching routes. Here the user gives input in terms of voice, the voice is being captured using microphone and then it is feed to the destination address using Deepgram API. The text from Deepgram is being sent to the Gemini API for destination. The source is being detected using GPS to track live location. Then the route is being detected using Gemini API. The route detected is in the form of the text which can be seen using LCD display. The detected route in text can also be converted into voice or speech suing the Google TTS. The voice can be heard by the user. Then if the user is trying to drive after consuming alcohol it is being detected with the help of MQ3 sensor. If alcohol consumption is detected the user is prohibited from driving, the sirens can also be used to notify others for their safety. The speed of the driver while driving is monitored by using a gyrometer and accidental hits are detected by using an accelerometer. Thus the accidents are being avoided, and the safety of the public along with drivers is being protected.

The routing from the source to destination is also being done with the help of AI and efficient tracking is done. This will help the user to overcome the disadvantages of current system, namely distractions due to driving, difficulty in tracking the location, difficulty in predicting the traffic and difficulty in concentrating with live driving. The proposed system ensures driver and public safety by avoiding accidents due to alcohol consumption or rash driving. There is another type of system that uses RFID to solve above problem as explained in fig 3.1. The navigation system block diagram uses Arduino and an RFID. The RFID reader operates by scanning RFID tags to identify locations and guide users to their desired destination. The RFID reader continuously scans for nearby tags, each containing a unique identifier corresponding to a specific location. When a tag is detected, the reader sends the ID to the Arduino, which processes it to determine the current position. Based on a pre-programmed database of locations and pathways, the Arduino calculates the navigation route and provides step-by-step guidance.

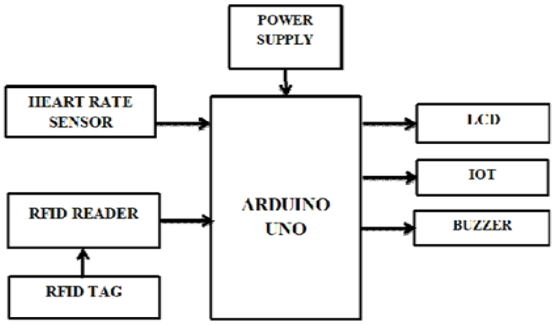


Fig 3.1 Safe driving system with the help of RFID

Directions are displayed on an LCD screen, while LEDs and a buzzer offer visual and auditory cues, such as indicating turns or signalling when the destination is reached. The system can be enhanced with multiple destinations, voice guidance, or integration with mobile apps for greater functionality. This setup is particularly useful in environments like libraries, malls, warehouses, and hospitals, where it simplifies navigation without requiring extensive human assistance. The design is efficient, cost-effective, and adaptable for various applications, ensuring precise and user-friendly guidance while leveraging RFID technology's reliability and ease of use. The disadvantage of the system mentioned in the fig 3.1 have only a particular range of system access because RFID has high interference, static and dynamic allocation. The line of sight is crucial in the old system because the RFID is not in line of sight and the location of the car cannot be determined. The tags can be duplicated, increasing the risk of routing and degrading safety. The accuracy of the proposed idea is higher once AI replaces the aforementioned system. The proposed idea's block diagram is given in the fig 3.2.

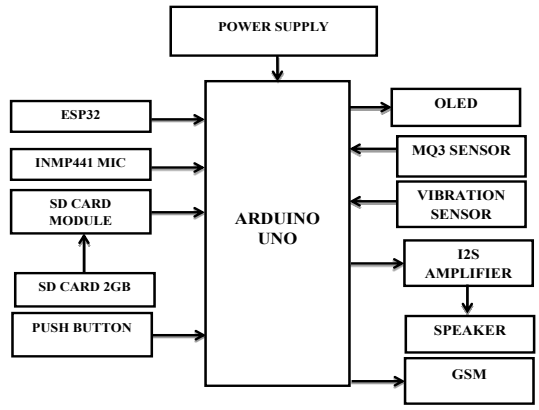


Fig 3.2 Block diagram of proposed system

The proposed work employed two controllers: Arduino Uno and ESP32, to create a comprehensive system. The Arduino Uno is utilized for connecting various sensors, while the ESP32 is responsible for integrating Gemini AI functionalities. Mainly three key APIs are used: the Deepgram API for speech-to-text conversion, Gemini AI for large language model processing, and Google TTS for text-to-speech conversion. The process begins with capturing audio prompts using an INMP441 microphone, for example, "Please provide navigation route from Chennai Tambaram to Chennai Kodambakkam."

The recorded audio is stored on an SD card via an SD card module. The ESP32 retrieves the audio file and sends it to the Deepgram server using the appropriate API, where it undergoes conversion from speech to text. The resulting text serves as a prompt input to the Gemini AI server via its API, which processes the request and responds in JSON format. The ESP32 extracts the relevant text output from the JSON response. This output is then fed into the Google TTS API for conversion back to speech, which is played through an I2S amplifier and speaker. Additionally, the text output is displayed on an OLED screen for visual feedback. The system incorporates an alcohol sensor to monitor the rider's alcohol consumption; if detected above a predetermined limit, alerts are triggered to prevent riding. Moreover, a vibration sensor is used for accident detection in the event of a crash. Thus it provides an efficient system for drivers and public with the help of AI and Embedded system. The API helps to interact with the specific application that is required for specific applications. These APIs has specific keys to fetch the user data to the code and its results back to user or to the other API. In the Google TTS API the text to speech service is enabled and its credential is being extracted, then these credentials are being uploaded to the program so that the text in particular format is converted into speech like MP3 etc. The Google TTS provides options to select the language used, speed of playing the voice, device on which voice can be played etc. The Deepgram API is being used to convert speech to text with the help of generated API key. The voice of user or rider is being obtained from mic and then converted into text format to enter into the Gemini API. With the use of an API key, the route is identified, the route text is saved, shown on

the screen, and converted to speech or voice so that it may be heard through a speaker.

## V. RESULTS

The process of facilitating the riders in driving and in routing using the proposed method helps the most by its embedded solution as shown in fig 5.1.

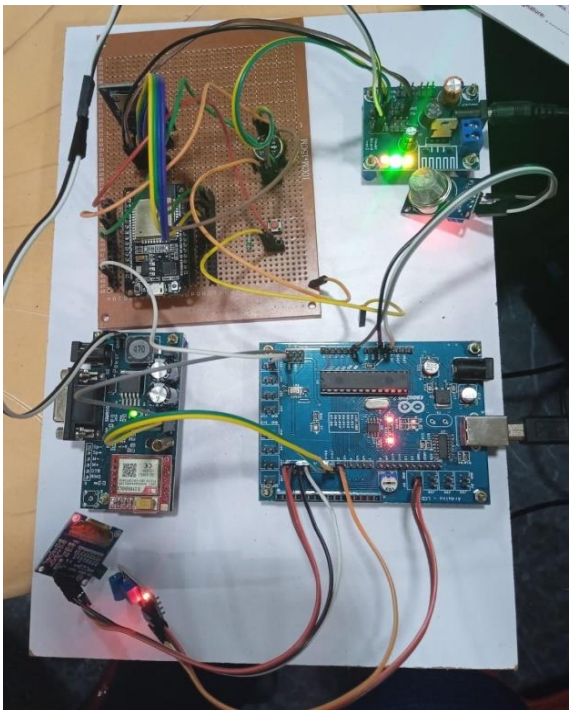

Fig 5.1 Proposed Product

The intelligence of this device helps in tracking dynamic traffic and helps to provide safe navigation as well as driving. This system protects the public by making the riders to follow rules and once any accident is being detected it is being notified to ambulance and to the nearby known person's contact.

## VI. CONCLUSION

A wide use of embedded system in day to day life makes mostly every task as simple as possible. This idea of creating a device for rider and public safety hopefully helps in reducing the accidents and prevents unwanted mesh in the roads. This helps us to reach our needed destination as quick as possible by reducing difficulties in driving. The above idea drastically reduces the distractions of driver like looking into the phone for navigation purposes, which will reduce the accidents. This idea also ensures that the riders are following the rules and protocol of driving while they drive. The system also helps in the critical situation of accidents by sending the accident details with location to the ambulance and to the nearby person known to them. Finally, this embedded implementation is cost efficient so that it can be useful for the two-wheeler drivers widely.

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