VIOLATION DETECTION AND SUSTAINABILITY DESIGN FOR VEHICLES USING IOT AZURE

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report **"VIOLATION DETECTION AND SUSTAINABILITY DESIGN FOR VEHICLES USING IOT and AZURE"** is the bonafide work of **ABDULLAH.R (211420104002), ABISHEK.R (211420104009), ANANDHA DINESH.J (211420104016)** who carried out the project work under my supervision.

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We **ABDULLAH R (21142104002), ABISHEK R (211420104009), ANANDHA DINESH J (211420104016)** hereby declare that this project report titled **"VIOLATION DETECTION AND SUSTAINABILITY DESIGN FOR VEHICLES USING IOT AND AZURE"**, under the guidance of **Dr.L.JABASHEELA,M.E., Ph.D.,** is the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

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ABSTRACT

Our initiative addresses the critical issue of pollution, particularly prevalent in densely populated areas like Delhi, where alarming levels of air pollution persist. With vehicular emissions accounting for over 45% of pollution, our project strategically focuses on curbing the release of key greenhouse gases - CO_2, CO, and NH_3 - emanating from vehicles. We prioritize a comprehensive approach that not only targets emission reduction but also tackles driving violations to foster a more sustainable and environmentally conscious driving culture. Leveraging data from diverse sources, including vehicles and traffic management systems, advanced machine learning algorithms process information to efficiently detect and promptly alert drivers about sustainability standard violations. Additionally, our system offers valuable insights into driving behavior, facilitating continuous improvement. The user interface is designed to be intuitive and user-friendly, providing drivers with easy access to real-time alerts, notifications, and personalized feedback. By prioritizing user experience, we aim to encourage widespread adoption and engagement, ultimately contributing to a collective effort to combat pollution. Through our holistic initiative, we aspire to bring about transformative change in driving habits, thereby contributing significantly to environmental sustainability and the enhancement of air quality in our communities.

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LIST OF ABBREVIATION

AI	-	Artificial Intelligence
API	-	Application Programming Interface
CNN	-	Convolutional Neural Network
CO2	-	Carbon di oxide
CSP	-	Content Security Policy
SMS	-	Short Message Service
CVP	-	Connected Vehicle Platform
GSM	-	Global System for Mobile Communications
GPRS	-	General Packet Radio Service
IoT	-	Internet of Things
IoV	-	Internet of Vehicles
IRDAI	-	Insurance Regulatory and Development Authority of India
LTE	-	Long Term Evolution
PPM	-	Parts per million
TCU	-	Telematics Control Unit
WAVE	-	Wireless Access of Vehicular Environment
WIFI	-	Wireless Fidelity

CHAPTER 1
INTRODUCTION

1.1 Overview

The contemporary landscape of the transportation industry is characterized by its substantial contribution to global greenhouse gas emissions,making the pursuit of sustainability improvements imperative. Moreover, the paramount concern for ensuring the safety of both drivers and passengers necessitates innovative approaches. This report undertakes a comprehensive exploration of how the strategic integration of IoT (Internet of Things) and AI (Artificial Intelligence) technologies in vehicles can serve as a multifaceted solution for addressing these challenges, with a particular focus on violation detection and sustainability design within the transportation ecosystem.

At the forefront of this innovative approach is the utilization of IoTtechnology to enable continuous monitoring of a vehicle's behavior. This entailsthe installation of advanced sensors capable of detecting and capturing various aspects of driving dynamics, such as speeding, sudden acceleration, and abrupt braking. The ensuing dataset is then subjected to sophisticated AI algorithms, which meticulously analyze the information to discern any violations of traffic rules. Furthermore, the incorporation of cameras augments the system's capacityto identify a broader spectrum of infractions, encompassing activities like failure to wear a seatbelt, using a mobile phone while driving, or disobedienceof traffic signals.

Upon the identification of a violation, the system seamlessly generates warnings or alerts the driver, thereby fostering a culture of heightened awareness and compliance with traffic regulations. This proactive approach not only contributes to a reduction in accidents resulting from rule violations but also cultivates an environment conducive to safer roads for all stakeholders.

1.2 Problem Definition

The efficacy of this integrated system extends beyond mere violation detection. The IoT infrastructure, comprised of a network of sensors and devices, enables real-time monitoring of various facets of vehicle operations. This encompasses parameters such as fuel consumption, emissions, and driver behavior. Leveraging the power of machine learning algorithms, the system not only identifies violations related to sustainability standards but also provides drivers with immediate feedback. This feedback mechanism is not limited to highlighting violations; it also offers constructive suggestions for enhancing fuelefficiency and minimizing emissions, thereby fostering responsible and eco- conscious driving practices.

In the broader context, the proposed system represents a holistic approachto promoting sustainable practices within the automotive industry. By addressing both safety and environmental concerns, it stands as a testament to the potential of IoT and AI technologies to drive transformative change. Beyondcompliance with regulations and standards, the system seeks to instill a culture of continual improvement and responsibility among drivers and vehicle operators.

In summation, this paper advocates for a paradigm shift in the transportation industry, underlining the indispensable role of IoT and AI technologies in shaping a safer and more sustainable future. The proposed solution, characterized by its sophistication and multifunctionality, positions itself as a beacon of innovation and progress, heralding a new era in responsible and efficient vehicle operations.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Survey

2.1.1 Detection of Vehicle Violation

Chen et al., (2023) aim to establish a platform for cross-sectoral exchange on sustainable transportation and logistics solutions, specifically highlighting the role of Intelligent Vehicles (IV) technologies in creating sustainable intelligent systems. Their methodology relies on a descriptive and analytical approach, summarizing outcomes from the First DHW-STL within a larger series of Distributed/Decentralized Hybrid Symposia and Conferences on Sustainability for Transportation and Logistics. However, due to the constraints of the letter format, the study may be limited in providing in-depth analysis and empirical data. Additionally, alternative viewpoints on the role of Intelligent Vehicles in achieving sustainability might not be adequately explored.

Kshirsagar et al., (2022) aim to develop an advanced pollution control method for vehicles by integrating sensors and employing an Improved Smoke Detection Algorithm (ISDA). The scope of their work involves real-time monitoring of vehicle emissions across different areas and temperatures using an Online Monitoring System (OMS). The methodology includes deploying sensor nodes in vehicles, which are connected to a central control center for monitoring using ISDA. ISDA categorizes regions into circles to enhance monitoring efficiency under varying temperatures. Data from the OMS is aggregated and visualized using MATLAB. However, the description provided lacks detailed information about the actual drawbacks or limitations of the proposed method. Further insights from the full article are necessary to assess potential challenges.

Kundu et al., (2023) aim to develop a dual-level framework for vehicular smoke monitoring to tackle the challenge of limited training data. Their scope involves proposing a synthetic dataset enhancement method and integrating a transformer network to enhance smoke identification in regions primarily populated by fossil fuel-driven vehicles. The methodology employs a realistic vehicle smoke generation algorithm incorporating mask patterns and filtering to generate synthetic data for training deep neural models. Furthermore, a transformer network integrated with YOLOv5 is introduced for simultaneous smoke region identification and smoky vehicle detection. Challenges in their approach include ensuring the realism of synthetic data, potential limitations in capturing diverse real-world scenarios, and the necessity for continual updates to adapt to evolving vehicular emission patterns.

Maulik and Kundu, (2023) aim to devise a cost-effective and automated solution for the rapid identification of polluting vehicles by leveraging a novel deep learning-based approach with on-road surveillance camera images. The scope of their research involves creating a refined image dataset and training seven prominent deep learning Convolutional Neural Network (CNN) models with limited labeled data. They employ a multi-model feedback process to augment the training dataset and utilize transfer learning techniques for on-road pollutant detection. However, potential drawbacks of their methodology include challenges associated with accurately labeling diverse pollutants, the substantial computational resources required for training deep learning models, and potential limitations in the real-world applicability and generalization of the proposed approach.

Nguyen et al., (2022) aim to tackle the challenge of vehicular sensor deployment (VSD) for air pollution monitoring by focusing on utilizing public buses to reduce deployment costs. Their scope involves formulating an optimal solution using Integer Linear Programming (ILP) and proposing approximation algorithms. The methodology converts the VSD problem into a flow network and models it as an ILP considering air sampling requirements and capacity constraints. Furthermore, the study introduces an approximation algorithm (LPR-RRA) and a greedy-based algorithm (GBA) to efficiently address the VSD problem. However, potential drawbacks of their approach include limitations in the scalability and generalizability of the proposed algorithms. The effectiveness of these algorithms may rely on specific environmental and operational factors, which could affect their applicability across diverse scenarios.

2.1.2 Integration of IOT

Zavvos et al., (2022) aim to offer a comprehensive examination of privacy and trust issues within the realm of the Internet of Vehicles (IoV) particularly focusing on service-level concerns. Their scope encompasses addressing worries pertaining to personal information privacy, multi-party privacy, trust, and consent in IoV contexts. The methodology employed involves categorizing various privacy concerns into four distinct categories, organizing end-user services based on the voluntary and involuntary nature of information exchange, and pinpointing open research problems. The study highlights general approaches to tackle these identified issues. However, drawbacks of their analysis include potential challenges in quantifying the trade-off between privacy and service functionality, establishing mechanisms for automated consent negotiation, instilling trust in the IoV and its services, and resolving conflicts stemming from multi-party privacy concerns.

Ma et al., (2023) ambitious task of addressing persistent urban traffic problems by conducting a thorough examination of existing research on vehicle speed control strategies. Their approach involves categorizing the vast body of research based on vehicle types, problem scenarios, and the methodologies employed. By categorizing existing studies in this manner, the authors provide a structured overview that aids in identifying patterns and trends in the field. The methodology employed encompasses not only the classification of research but also a comprehensive analysis of literature pertaining to vehicle speed and the evaluation of various methods used for speed guidance. Despite the systematic approach adopted, the review highlights deficiencies in existing research, indicating limitations in its ability to comprehensively address urban traffic issues. This acknowledgment underscores the need for future research to overcome these shortcomings and proposes directions to enhance the effectiveness of vehicle speed guidance techniques, thus contributing to more efficient and sustainable urban transportation systems.

Islam et al., (2022) aim to develop a wireless health monitoring system utilizing My Signals for Arduino Uno and integrating sensors for vital signs. The scope involves identifying and integrating various health sensors such as temperature, ECG, oxygen saturation, and pulse rate with the My Signals development shield for Arduino Uno. The methodology centers around the integration of these health sensors with the My Signals platform to enable remote health monitoring. However, the description provided lacks detail regarding the specific methodologies employed beyond sensor integration, potentially limiting the understanding of the project's implementation and its broader applicability. Further elaboration on the project's methodology could enhance clarity and facilitate replication or adaptation of the system in similar contexts.

Rauniyar et al., (2023) aim to contribute to sustainable transportation by designing a real-time monitoring system for noise and exhaust emissions. Their scope involves employing the cloud-enabled Nautilus platform to collect data from vehicles in European cities. The methodology revolves around utilizing artificial intelligence (AI) algorithms to evaluate this collected data for categorization and analysis. However, potential drawbacks of their approach may include challenges in achieving widespread implementation of the monitoring system and possible technical issues related to data collection, such as connectivity problems or sensor reliability issues. Further exploration and validation of the system's effectiveness in real-world settings could provide valuable insights into addressing these potential drawbacks and enhancing the system's utility for sustainable transportation initiatives.

Nicole Berdy, Senior Program Manager at Azure IoT, the primary aim is to elucidate the throttling mechanisms integrated into IoT Hub. These mechanisms are designed to mitigate potential Denial of Service (DoS) attacks and uphold optimal service performance. The scope of the paper encompasses a comprehensive exploration of how throttling strategies are implemented based on various categories, including device connections and telemetry rates. This includes a detailed discussion on the factors considered when implementing throttling, such as the intended usage of the IoT Hub and monitoring resource utilization. However, potential drawbacks of these throttling mechanisms include costs incurred on registered devices due to potential limitations in the number of connections or messages allowed. Additionally, the need for customer support to address issues related to device caps and throttling parameters may pose challenges for users. These considerations underscore the importance of carefully aligning these throttling mechanisms with the overall service design, ensuring a balance between security measures and the seamless operation of IoT devices and applications

2.2 Comparison with existing system:

S.no.	Author name	Title	Aim/Scope	Methodology	Drawback
1.	Y. Chen, H. Zhang and F. -Y. Wang	Society-Centered and DAO-Powered Sustainability in Transportation 5.0: An Intelligent Vehicles Perspective (2023)	Establish a platform for cross-sectoral exchange on sustainable transportation and logistics solutions, with a focus on Intelligent Vehicles (IV) technologies and their potential for creating sustainable intelligent systems.	Utilize a descriptive and analytical approach to summarize outcomes from the First DHW-STL, part of a larger series of Distributed/Decentralized Hybrid Symposia and Conferences on Sustainability for Transportation and Logistics.	Limited in-depth analysis due to the letter format. May lack specific empirical data and alternative viewpoints on the role of Intelligent Vehicles in achieving sustainability.
2.	P.R. Kshirsagar, H.Manoharan, F.Al-Turjman and K.K.Maheshwari	Design and Testing of Automated Smoke Monitoring Sensors in Vehicles (2022)	To develop an advanced pollution control method for vehicles through sensor integration, utilizing an Improved Smoke Detection Algorithm. The scope includes real-time monitoring of vehicles across different areasand temperatures via an Online Monitoring System (OMS).	Sensor nodes are deployed, connected to a central control center, and monitored using ISDA. ISDA categorizes regions into circles to enhance monitoring under varying temperatures. Data from OMS is aggregated and visualized using MATLAB. Efficiency is tested through three cases:	Limited information provided, and actual drawbacks not specified in the description. Further details from the full article are required to assess potential limitations or challenges in the proposed method.

3.	S. Kundu, U. Maulik, R. Sheshanarayana and S. Ghosh	Vehicle Smoke Synthesis and Attention-Based Deep Approach for Vehicle Smoke Detection (2023)	Developing a dual-level framework for vehicular smoke monitoring, addressing the scarcity of training data by proposing a synthetic dataset enhancement method and integrating a transformer network for efficient smoke identification in regions dominated by fossil fuel-driven vehicles.	Utilizing a realistic vehicle smoke generation algorithm with mask patterns and filtering to create synthetic data for deep neural model training. Introducing a transformer network integratedwith YOLOv5 for simultaneous smoke region identification and smoky vehicle detection.	Challenges include ensuring the realism of synthetic data, potential limitations in capturing diverse real-world scenarios, and the need for constant updates to adapt to evolving vehicular emission patterns.
4.	U. Maulik and S. Kundu	Automatic Vehicle Pollution Detection Using Feedback Based Iterative Deep Learning (2023)	The aim of this research is to develop a low-cost, automated solution for swift detection of polluting vehicles through a novel deep learning-based strategy using on-road surveillance camera images.	The methodology involves creating an enhanced image dataset, training seven popular deep learning CNN models with low labeled data, employing a multi-model feedback process to expand training samples, and utilizing transfer learning for on-road pollutant detection.	Drawbacks include potential challenges in accurately labeling diverse pollutants, the need for extensive computational resources for training deep learning models, and potential limitations in real-world applicability and generalization.

5.	D.H.P. Nguyen, V.V.Le, T. N. Nguyen, B.H. Liu, S.I. Chu and S. -M. Hu	Minimizing Deployment Cost for Vehicular Sensor Networks in Air Monitoring Applications (2022)	The aim of this research is to address the vehicular sensor deployment (VSD) problem for air pollution monitoring, focusing on leveraging public buses to minimize deployment costs. The scope includes formulating an optimal solution using ILP and proposing approximation algorithms.	The methodology involves converting VSD into a flow network, formulating it as an ILP model considering air sampling requirements and capacity constraints. Additionally, the study proposes an approximation algorithm (LPR-RRA) and a greedy-based algorithm (GBA) for efficient VSD problem-solving.	Drawbacks include potential limitations in the proposed algorithms' scalability and generalizability. The effectiveness of the algorithms may depend on specific environmental and operational factors, impacting their applicability in diverse scenarios.
6.	E. Zavvos, E. H. Gerding, V. Yazdanpanah, C. Maple, S. Stein and m. c. schraefel	Privacy and Trust in the Internet of Vehicles (2022)	The article aims to provide a comprehensive overview of privacy and trust issues in the Internet of Vehicles (IoV) at the service level, addressing concerns related to personal information privacy, multi-party privacy, trust, and consent.	The methodology involves formalizing various privacy concerns into four categories, taxonomizing end-user services based on voluntary and involuntary information, and identifying open research problems. General approaches to address these issues are highlighted.	Drawbacks include potential challenges in measuring the trade-off between privacy and service functionality, achieving automated consent negotiation, establishing trust in the IoV and its services, and resolving conflicts arising from multi-party privacy concerns.
7.	C. Ma, Y. Li and W. Meng	A Review of Vehicle Speed Control Strategies	This paper aims to address persistent urban	The methodology involves categorizing	Existing research is founddeficient, indicating

		(2023)	traffic problems by reviewing existing research on vehicle speed control strategies. It categorizes research based on vehicle type, problem scenarios, and methodologies.	existing research based on vehicle type and problem scenarios, summarizing literature on vehicle speed, and analyzing methods employed for speed guidance.	limitations in addressing urban traffic issues comprehensively. Future research suggestions are proposed to overcome these limitations and enhance the effectiveness of vehicle speed guidance
8.	Mohammad Shahidul Islam, Gan Kok Beng, Nowshad Amin, Mohammad Tariqul Islam	IoT Based Health Monitoring System with LoRa Communication Technology (2022)	This project utilizes MySignals for Arduino Uno to create a wireless health monitoring system, integrating sensors for vital signs	Identify and integrate various health sensors (temperature, ECG, oxygen saturation, and pulse rate) with the MySignals development shield for Arduino Uno	Identify and integrate various health sensors (temperature, ECG, oxygen saturation, and pulse rate) with the MySignals development shield for Arduino Uno
9.	A. Rauniyar *et al*	NEMO: Real-Time Noise and Exhaust Emissions Monitoring for Sustainable and Intelligent Transportation Systems (2023)	The aim is to contribute to sustainable transportation by designing a real-time monitoring system for noise and exhaust emissions..	The research employs the cloud-enabled Nautilus platform to collect data from vehicles in European cities. AI algorithms evaluate this data for categorization,	Possible drawbacks may include challenges in achieving widespread implementation, potential technical issues in data collection.
10.	Nicole Berdy Senior Program Manager, Azure IoT	IoT Hub throttling and you	The aim of this paper is to clarify the throttling mechanisms implemented in IoT Hub to safeguard against potential Denial of Service attacks and maintain optimal service performance.	Implement throttling based on categories like device connections and telemetry rates, considering intended use and monitoring resource usage.	Coston registered devices and needforcustomer support to increase device caps are potential drawbacks, emphasizing alignment with service design

CHAPTER 3
THEORETICAL BACKGROUND

3.1 Implementation Environment

In the ever-evolving landscape of environmental consciousness and regulatory adherence within the automotive sector, Vehicure emerges as a groundbreaking solution designed to address the complexities associated with pollution control standards and road safety. At the forefront of this transformative initiative is the integration of cutting-edge technologies, including IoT (Internet of Things) and AI (Artificial Intelligence), within the innovative framework of green Telematics.

The impetus behind Vehicure lies in its response to the stringent pollutioncontrol standards set by the government, mandating a cap of 1500 parts per million (PPM) of CO_2 emissions per vehicle. This imperative underscores the pressing need for proactive measures to ensure compliance and rectify deviations from these standards. Vehicure steps into this void by presenting a holistic solution that transcends mere monitoring, evolving into a dynamicsystem that not only tracks emissions but also dynamically influences user behavior and regulatory adherence.

The intricacy of Vehicure's approach becomes evident in its continuous surveillance of emission levels. Leveraging IoT, the system meticulously monitors and analyzes emissions in real-time, addressing concerns stemming from the inactive use or prolonged usage of vehicles without routine servicing. This not only ensures adherence to regulatory limits but also positions Vehicure as a proactive enforcer of environmental responsibility. The utilization of AI algorithms further refines this process, enabling nuanced analysis and identification of patterns that might lead to emissions exceeding prescribed thresholds

One of the distinctive features of Vehicure lies in its symbiotic relationship with the Insurance Regulatory and Development Authority of India (IRDAI). In instances where emissions surpass the stipulated limits, the system automatically triggers notifications to IRDAI, paving the way for potential fines that are subsequently reflected in the yearly insurance premiums of vehicle owners. This intricate interplay between environmental responsibility, regulatory compliance, and financial consequences sets a precedent for an innovative model that intertwines ecological sustainability with economic repercussions.

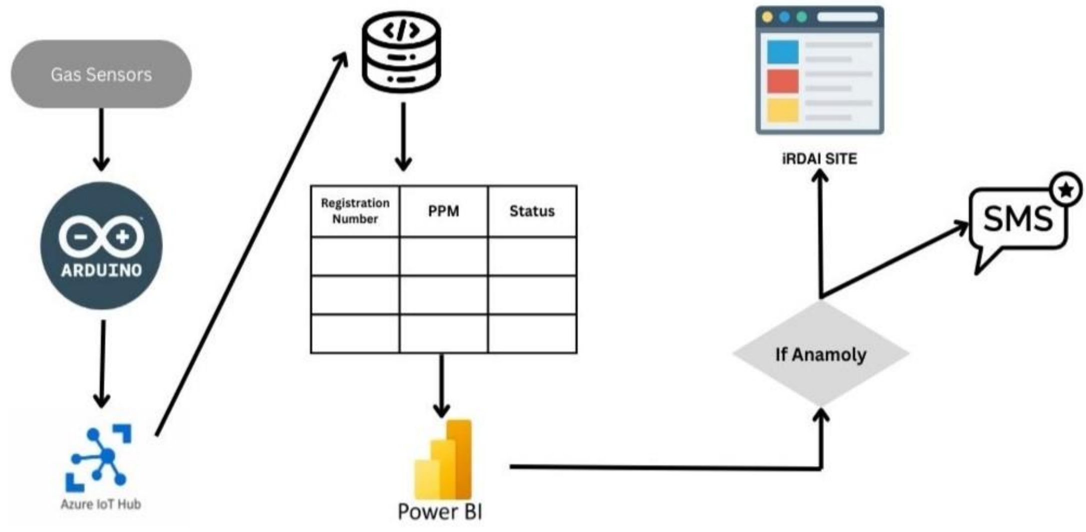
Beyond its role as an emissions watchdog, Vehicure extends its capabilities to actively address various traffic violations, adding an additional layer of safety and regulatory adherence. The system instantaneously notifies nearby hospitals in the event of an accident, streamlining emergency response measures and potentially minimizing casualties. Furthermore, Vehicure delves into the realm of driver behavior, deploying advanced technologies like OpenCV to detect signs of drowsiness or the use of mobile devices while driving. In instances of detected drowsiness, an intelligently installed buzzer serves as an effective wake-up mechanism, further heightening the system's efficacy in promoting road safety.

The technological backbone of Vehicure is the Telematics Control Unit (TCU), a sophisticated hardware module meticulously designed to orchestrate seamless communication with both the in-vehicle network (CAN Bus) and the backend cloud server (GPRS). This central hub serves as the nerve center of the system, collecting and consolidating critical vehicle data, including diagnostics, real-time location, and speed. This wealth of information is then transmitted securely to the cloud server over diverse wireless networks such as GPRS, cellular, or LTE, ensuring not only data integrity but also the efficient processing and analysis of the voluminous datasets.

A ground breaking addition to Vehicure is the incorporation of an accelerometer, enhancing its capabilities to detect instances where drivers violate traffic signals. This feature not only serves as a preventative measure against accidents but also contributes significantly to the reduction of collateral damages, underscoring the system's efficacy in fostering a safer and more responsible driving environment. Moreover, the system acts as a proactive safeguard against accidents resulting from drowsiness during high-speed driving, elevating Vehicure to a pioneering position in road safety and accident prevention.

In the broader context of societal impact, the implementation of Vehicure heralds a transformative shift towards sustainable and responsible practices within the automotive sector. By seamlessly integrating IoT and AI technologiesinto the intricate fabric of the automotive landscape, our solution not only ensures stringent regulatory compliance but also nurtures a culture of responsible driving practices. Vehicure stands as an exemplar of innovation, showcasing the profound potential of technology-driven solutions to not only address complex challenges in the automotive industry but also actively contribute to sustainability and safety on our roads. In the grand tapestry of technological evolution, Vehicure emerges not just as a solution but as a harbinger of a new era where technology becomes an indispensable ally in the pursuit of a cleaner, safer, and more responsible automotive ecosystem.

3.2 System Architecture



3.1 Architecture Diagram

Within the intricacies of the outlined system architecture, the device is equipped with gas sensors seamlessly embedded in the ARDUINO model. These gas sensors play a pivotal role in scrutinizing vehicular emissions, and upon detecting that a particular vehicle has exceeded the predetermined emission threshold, an instantaneous SMS alert is dispatched to the designated recipient. This real-time communication mechanism ensures swift notification, allowing for prompt corrective actions and contributing to the overall efficacyof the system.

The foundation of the system rests upon the IoT Sensors Layer, an extensive network of sensors strategically placed throughout the vehicle. These sensors are tasked with the real-time collection of multifaceted data, ranging from fuel consumption and emissions to nuanced aspects of driver behavior. Positioned in critical areas such as the engine, exhaust system, and driver's seat, these sensors offer comprehensive insights into various facets of vehicle operations.

As the data flows in from the IoT Sensors Layer, the journey continues into the Data Processing Layer, where sophisticated machine learning algorithms come into play. These algorithms meticulously process the amassed data, unraveling intricate patterns in driver behavior and vehicle operations. Thediscerning capabilities of these algorithms extend to identifying violations against sustainability standards, including but not limited to excessive idling, harsh braking, and speeding. The invaluable outcome is a nuanced feedbackloop that not only detects infractions but also guides the driver on how to enhance their driving practices for improved fuel efficiency, reduced emissions, and sustainable driving habits.

The Alert System Layer acts as the harbinger of corrective action. When violations are detected, this layer dynamically generates alerts and notifications to the driver. These alerts manifest in various forms, such as visual cues or auditory signals, with warning lights or beeps prompting the driver to take immediate corrective measures. This real-time responsiveness is essential in fostering an environment of heightened driver awareness and compliance.

Building on this real-time interaction, the Feedback System Layer complements the driver's experience by providing continuous insights into their driving behavior and vehicle operations. This feedback, delivered in real-time through a dashboard display or a dedicated mobile app, goes beyond merealerts. It offers constructive suggestions on optimizing fuel efficiency, minimizing emissions, and cultivating sustainable driving practices. This layer serves as an integral component in the holistic approach towards fosteringresponsible and eco-conscious driving habits.

The Cloud Computing Layer elevates the system's capabilities by incorporating cloud-based platforms. These platforms serve as repositories for the wealth of data collected from multiple vehicles. Beyond storage, cloud- based solutions enable advanced data aggregation, facilitating more intricate data analysis and the deployment of sophisticated machine learning algorithms. This layer represents a pivotal element in harnessing the collective intelligence derived from the entire vehicular fleet.

Culminating in the User Interface Layer, the system extends a user-friendly interface for drivers to seamlessly interact with the wealth of information and functionalities embedded within. Whether through a dashboard display or a dedicated mobile app, this interface provides a comprehensive overview of vehicle performance, driver behavior, and real-time feedback and alerts. It serves as the nexus where technology and user engagement converge, creating an intuitive platform for drivers to stay informed and take proactive measures.

In essence, the outlined system architecture encapsulates a comprehensive and interconnected ecosystem. From the initial gas sensors detecting emissions violations to the layers processing data, generating alerts, providing feedback, and leveraging cloud-based capabilities, each component plays a crucial role in fostering responsible driving practices, reducing emissions, and contributing to a sustainable and eco-conscious automotive landscape.

3.3 Existing System

Currently Vehicle Health checkup approach is implemented for guidance,gyroscopic, object detection and speed monitoring of vehicles. Insurance companies has brought such an amazing idea that is “PAY FOR YOUR USE”. Premiums are calculated based on the distance you travel and how you travel. It requires the installation of a tracking device. The faster you ride the higher will be your insurance amount.

Connected Vehicle Platform (CVP) developed by Ford uses IoT sensors and machine learning algorithms to monitor vehicle performance and provide feedback to drivers on how to improve fuel efficiency and reduce emissions.The system can also detect and alert drivers of any violations in terms of sustainability standards, such as excessive idling or aggressive driving.

Another existing system is the Eco Drive system developed by Bosch. The system uses a combination of IoT sensors and AI algorithms to monitor driver behavior and provide real-time feedback to drivers on how to improve their driving behavior to increase fuel efficiency and reduce emissions. The system can also detect and alert drivers of any violations, such as speeding or harsh braking, that contribute to excessive fuel consumption and emissions.

The BMW ConnectedDrive system uses IoT sensors and machine learning algorithms to optimize the energy consumption of its electric andhybrid vehicles. The system monitors various aspects of vehicle performance, such as battery charge and traffic conditions, to predict the optimal route and speed for the vehicle to minimize energy consumption and reduce emissions.

These existing systems demonstrate the potential of IoT and AI technologies to improve sustainability and reduce violations in the automotive industry. However, there is still room for further research and development in this field to promote sustainable practices and reduce the environmental impact of vehicles.

3.4 Proposed Methodology

The stringent pollution control standards mandated by the government, calling for a limit of 1500 parts per million (PPM) of CO_2 emissions per vehicle, our groundbreaking solution, Vehicure, emerges as a comprehensive approach to mitigate environmental impact and ensure regulatory compliance. The intricacies of this innovative system lie in the seamless integration of IoT (Internet of Things) and AI (Artificial Intelligence) through the innovative realmof green Telematics.

Vehicure not only monitors emissions but addresses the pervasive issue of prolonged vehicle usage without proper servicing, which often results in emissions exceeding prescribed norms. By implementing IoT and AI technologies, we establish a dynamic and proactive system that tracks the emission rates of vehicles in real-time. In the event of emissions surpassing the defined threshold, the system intimates the Insurance Regulatory and Development Authority of India (IRDAI). Subsequently, fines are imposed on the vehicle owner, impacting their yearly insurance premium. This transformative solution not only enforces adherence to pollution control standards but also establishes a tangible link between environmental responsibility and financial consequences.

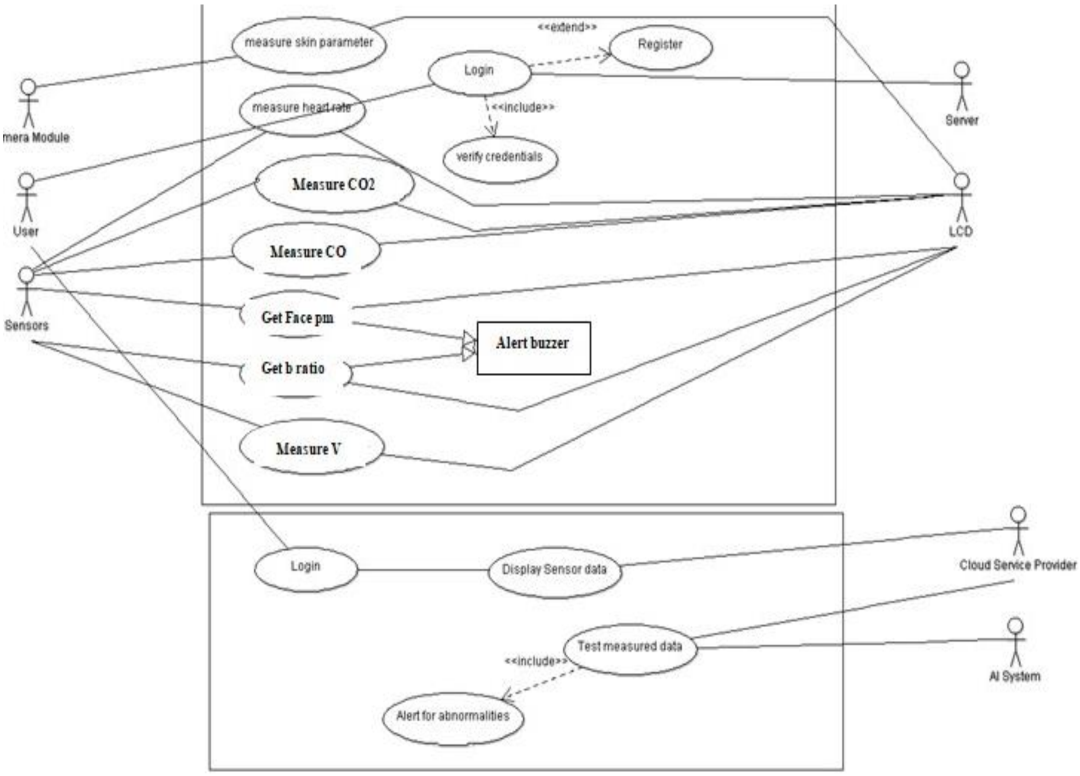
At the core of Vehicure's scientific underpinnings lies the Wireless Accessof Vehicular Environment (WAVE), a confluence of telecommunications and informatics applied in wireless technologies and computational systems. To capture exhaust quality, Vehicure incorporates state-of-the-art sensors, including the MQ-7 sensor for CO, TGS2602 sensor for ammonia and H_2S, and MG811 sensor for CO_2. The data generated by these sensors are securely stored in a Telematics Cloud Server, such as Azure, facilitating seamless access throughour web application.

The comprehensive sensor suite is further augmented by accelerometer, vibration, and gyroscopic sensors, instrumental in monitoring the vehicle's speed and stability. Leveraging Azure's Dynamic Threshold in-metrics alert, a meticulously trained Machine Learning Algorithm analyzes the sensor output data to detect anomalies. This dynamic setup allows for real-time adjustment of alert thresholds based on the pollutants' PPM exceeding their safe limits. In suchinstances, an alert message is promptly triggered to the user's phone through the Twilio SMS API Service, creating an immediate awareness of environmental violations and the need for corrective actions.

Beyond emissions control, Vehicure also addresses violations of traffic rules, incorporating mechanisms to charge users directly for offenses such as over-speeding. The user's data is intricately updated on the IRDAI website, subsequently shared with insurance agencies. This multifaceted approach ensures that fines reflecting the severity of violations are factored into theindividual's annual insurance premium, serving as both a deterrent and a means of reinforcing responsible driving practices.

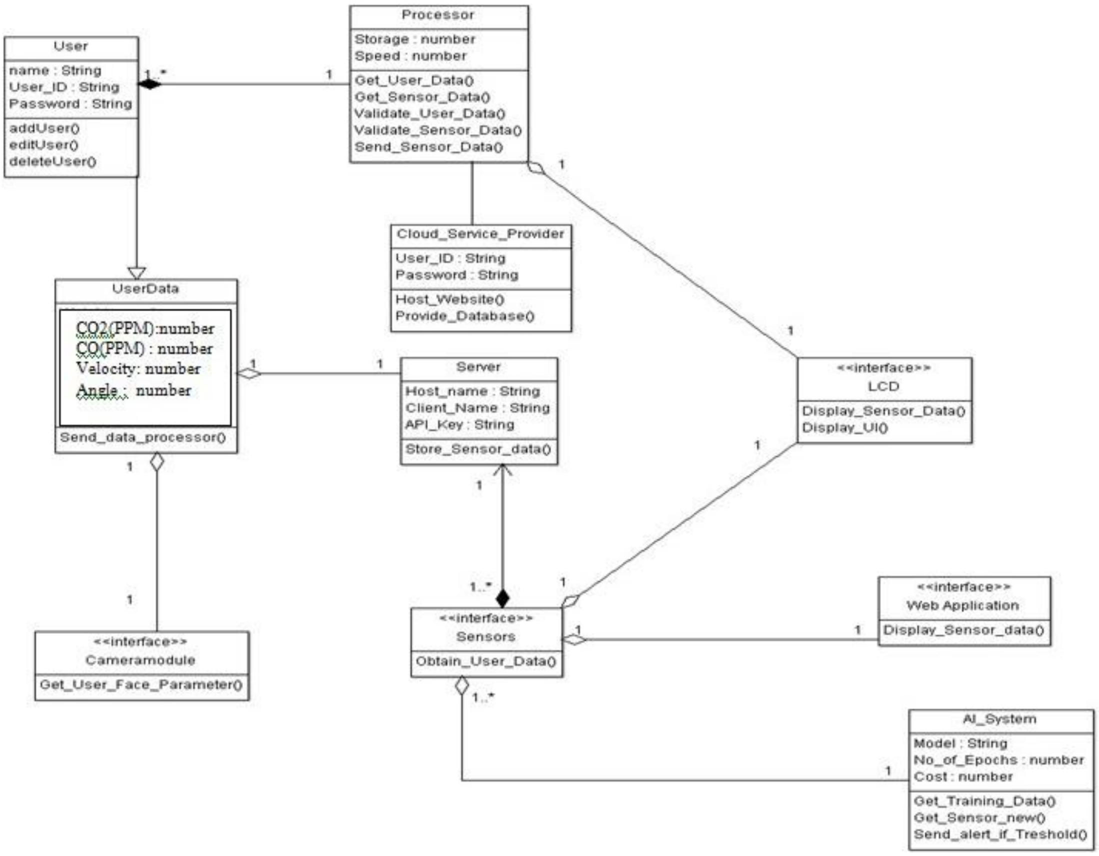
Vehicure stands as a pioneering solution that transcends conventional emissions monitoring, addressing both environmental sustainability and regulatory adherence. By seamlessly integrating IoT and AI technologies, leveraging advanced sensor suites, and utilizing Azure's dynamic alert capabilities, Vehicure creates a robust ecosystem that not only detects anomaliesbut also enforces consequences, thereby fostering a more conscientious and sustainable automotive future.

3.5 System Design



3.2 Use case diagram for VIOLATION Detection

In this use case diagram, The Server represents projection of all fetched data and contains attributes such as the CO2 level, sender information, threshold value and Face parametrics. Sensors are responsible for fetching all the necessary data andrelaying it to the CSP via its IOT Hub service, provide facilities to store those sensordata and classify the stable and threshold crossed states and decides whether to update the DB of Web Application or process with SMS Alert.



3.3 Class diagram for VIOLATION Detection.

In this class diagram, the main classes are Server, Sensors and Web Application. The Server represents projection of all fetched data and contains attributes such as the CO2 level, sender information, threshold value and Face parametrics. Sensors is the main class responsible for fetching all the necessary data and relaying it to the CSP via its IOT Hub service, provide facilities to store those sensor data and classify the stable and threshold crossed states and decides whether to update the DB of Web Application or process with SMS Alert.

CHAPTER 4

SYSTEM IMPLEMENTATION

4.1 Module Description

VIOLATION DETECTION consists of 2 main modules. They are

- Software module.
- Hardware module.

4.1.1 Software module

Software module designed to provide real-time information about vehicles that cross a predefined threshold. This system aims to enhance vehicle performance monitoring and driver behavior analysis through an intuitive user interface. The module utilizes Next.js for front-end development, Node.js for back-end services, Firebase for real-time database management, Twilio SMS API for communication, and is hosted on Render and Vercel for seamless deployment.

The system detects vehicles crossing predefined thresholds, such as speed limits, and captures relevant information. Utilizing a dashboard display or web application, the system presents real-time data on vehicle performance, driver behavior, and any detected threshold crossings. Drivers can interact with the system through the interface, enabling them to access information about their vehicle's performance and receive notifications or alerts. The module incorporates data analytics to provide insights into vehicle usage patterns, driver behavior trends, and potential areas for improvement. Using the Twilio SMS API, the system can send alerts and notifications to drivers or fleet managers regarding critical events, such as threshold crossings or maintenance reminders.

Technologies Used

Next.js: For building the front-end user interface, providing a seamless and responsive user experience.

Node.js: For developing the back-end services, handling data processing, and managing server-side operations.

Firebase: For real-time database management, enabling instant data updates and synchronization across devices.

Twilio SMS API: For integrating SMS-based communication, enabling the system to send alerts and notifications to users.

Render and Vercel: For hosting the application, ensuring scalability, reliability, and high performance.

The Violation Detection System offers a robust solution for vehicle performance monitoring and driver interaction. By leveraging the latest technologies and a user-friendly interface, the system aims to improve vehicle safety, efficiency, and overall driving experience.

4.1.2 Hardware module

Checks whether the vehicle has crossed the threshold using gassensors

This layer includes a network of IoT sensors installed throughout the vehicle to collect real-time data on various aspects of vehicle performance, such as fuel consumption, emissions, and driver behavior. The sensors can be installed in various parts of the vehicle, such as the engine, exhaust system,and driver's seat, to monitor different aspects of vehicle operations.

Controller used: Node MCU(ESP8266) and Raspberry Pi ver-4 Processor.

Sensors used: SGP30(CO2 and TVOC) sensor, GSM Module, GPS module, Camera module, Vibration sensor.

Now these sensors are connected to the central controlling unit and is fabricated as a singular module which can be fixed with existing telematic unit in all 4 wheeler and heavy duty vehicles.

Use of cloud

For large scale integration of vehicular network : Azure (IoT Central).

For a singular prototype: Thingspeak Cloud.

The data picked up by these sensors which are now transmitted and stored in backup in the controller is sent bit by bit to the thingspeak cloud platform where the live analytics is provided for the vehicular emission. Now this data is packed to a json format and is sent over to the web application on request.

With increasing number of integrations of this device we may switch over to Azure cloud which provides overall IoT system management through their IoT Central service and the Power BI is used to visualize the implementations and the emission data from the vehicles.

Drowsiness and Distraction detection

Here, we will place the camera module alongside the display for reverse camera in vehicles separately covering the driver's seat for monitoring his face. Any signs of Distraction or sleepiness will be readily identified by our Computer Vision Algorithm processed in raspberry pi and signals the triggering of alarm system in the vehicle. Once triggered the driver has to utilize the 1 minute delay per execution in the monitoring system to correct his actions else the alarm will keep going off indefinitely till the vehicle is on. We have used Haar Cascade method to capitalize a Model providing sufficient Negative Images and manually to train the algorithm in order to improve the efficiency and accuracy of the model. We have also used CNN to trace the facial markers and mask the object separately to provide distinction between live images and Phone when compared to other background objects which has loss percentage of 12% currently thereby increased the overall performance of the model. Phone detection using Convolutional Neural Networks (CNN) involves the application of deep learning to identify and localize phones within images or videos. CNNs are particularly well-suited for this task due to their ability to automatically learn hierarchical patterns and features from visual data. The process typically involves training a CNN on a dataset of annotated images, where the network learns to recognize the unique characteristics of phones, such as their shape, color, and texture. During inference, the trained model can then be used to detect phones in new images or video frames with high accuracy. This technology has numerous applications, including in security systems, autonomous vehicles, and augmented reality.

CHAPTER 5

RESULT & DISCUSSION

The synergistic integration of Internet of Things (IoT) and ArtificialIntelligence (AI) technologies for the purpose of detecting violations and augmenting the sustainability of vehicles holds immense promise in reshaping the landscape of the transportation sector. This harmonious fusion of advanced technologies not only has the potential to significantly enhance road safety but also stands as a formidable force in mitigating the environmental impact associated with vehicular operations. As technology continues to evolve at an unprecedented pace, it is anticipated that novel and inventive solutions will continue to emerge, further propelling the transformative potential of IoT and AIin the automotive domain.

At its core, the application of IoT and AI technologies in the detection of violations and the promotion of sustainability within vehicle design is poised to make substantial strides in reducing the ecological footprint of vehicles. This groundbreaking integration envisions instilling environmentally conscious practices within the automotive industry, fostering a paradigm shift towards responsible and sustainable driving practices. The continuous evolution of technology, coupled with an increasing focus on environmental sustainability, positions IoT and AI as key enablers in ushering in a new era of eco-friendly transportation. To delve into specifics, the proposed system capitalizes on real- time data gathered from IoT sensors and harnesses the analytical capabilities of machine learning algorithms. This amalgamation empowers the envisioned system to comprehensively monitor and evaluate various facets of vehicle performance and driver behavior. The real-time analysis facilitates the timely identification of violations, enabling the system to provide instantaneous feedback and alerts to drivers. This feedback mechanism serves as a powerful tool in cultivating more efficient driving practices, curbing emissions, and ensuring heightened compliance with regulations and sustainability standards.

The architecture of the proposed system is thoughtfully designed to benot only robust but also scalable and adaptable. This ensures seamless integration with existing vehicle systems and diverse IoT platforms, catering to the diverse needs of fleet managers, individual drivers, and regulatory bodies. The inclusive nature of the system acknowledges the multifaceted stakeholders within the automotive industry, creating a unified platform that can be leveraged by various entities to promote sustainable practices and curtail violations.

Targeted user groups, such as fleet managers, individual drivers, and regulatory bodies, can derive significant benefits from the envisioned system. Fleet managers, for instance, can utilize the system to optimize their operations, ensuring that their fleets adhere to sustainability standards and regulations.Individual drivers stand to benefit from real-time feedback, guiding them towards more eco-friendly driving habits. Regulatory bodies, on the other hand, can leverage the system to enforce and monitor compliance with established standards, thereby contributing to a safer and more sustainable transportation ecosystem.

Overall, the convergence of IoT and AI technologies for the dual purposesof violation detection and sustainability enhancement in vehicles represents not just a technological advancement but a profound paradigm shift in the automotive industry. This amalgamation stands as a testament to the industry's commitment to environmental responsibility and safety, steering it towards a more sustainable and conscientious future. The ongoing research and development in this domain are poised to unlock even greater potential, shaping an automotive landscape that is both technologically advanced and environmentally sustainable.

5.1 System Testing

TESTCASE ID	TESTCASE/ ACTION TO BE PERFORMED	EXPECTED RESULT	ACTUAL RESULT	RESULT
1.	Selecting “LOGIN” butt on	Display homepage	Displays home page	Pass
2	The server parses the required data	Server parses the file by database	Server parses the file by database	Pass
3.	The website should display information specific to the user	All the required datais displayed to the user once logged in successfully	The required data is displayed to the user correctly	Pass
4.	The sensors collecting the data from the vehicle	The collection of data is periodical	The server receives the data periodically from the Iot device	Pass
5.	Sms should be send if vehicle crosses the threshold	Sms sent to individuals’ mobilenumber	Sms sent to individuals’ mobile number	Pass
6.	Data displayed if vehicle crosses the threshold second time	Individuals details displayed on table	Individuals details displayed on table	Pass
7	The image processing algorithm detects the drowsiness of the driver	If the algorithm detects the drowsiness the alert is to be sent to the user.	The alert has been sent to the user if the driver is drowsy	Pass

CHAPTER 6

CONCLUSION & FUTURE WORK

6.1 Conclusion

In conclusion, the envisioned project heralds a transformative era in the automotive industry by harnessing the immense potential of Internet of Things (IoT) and Artificial Intelligence (AI) technologies. The integration of these cutting-edge advancements promises to revolutionize how violations are detected and sustainability is enhanced within vehicle design, paving the way for a more eco-conscious and technologically advanced future.

The project's core objectives of enhancing road safety, reducing the ecological footprint of vehicles, and fostering sustainable practices underscore its commitment to addressing critical challenges in the transportation sector. By leveraging real-time data from IoT sensors and deploying sophisticated machinelearning algorithms, the system is poised to comprehensively monitor various aspects of vehicle performance and driver behavior. This proactive approach not only identifies violations promptly but also provides timely feedback and alerts to drivers, promoting more efficient driving practices, lower emissions, and improved compliance with regulations and sustainability standards.

In essence, this project is not merely a technological advancement but a catalyst for positive change in the automotive industry. It embodies a commitment to environmental sustainability, road safety, and regulatory adherence, positioning itself as a trailblazer in shaping a future where vehicles seamlessly integrate with intelligent systems, fostering a safer, greener, andmore responsible transportation ecosystem. The ongoing research and development in this domain will undoubtedly propel the automotive industry towards new horizons, setting the stage for a future where technology and sustainability coalesce for the greater good.

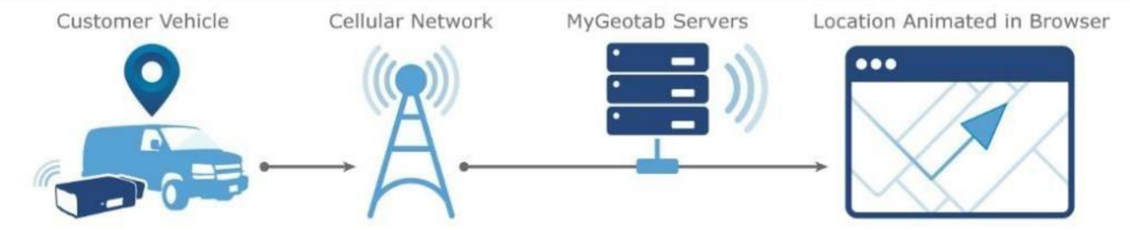
6.2 Future Scope

GPS technology and on-board diagnostics (OBD) is used to plot the asset's movements on a computerized map.

A Telematics engineer will be working in Linux environments, either to administer the device or to use it to automate processes. Thus, Bash is alanguage that comes with all Unix based systems. It is an excellent scripting language for automating tasks

At the heart of the telematics device lies the Telematics Control Unit (TCU), a pivotal hardware module serving as the central nerve center. This sophisticated unit establishes crucial communication interfaces with both the in-vehicle network, known as the CAN Bus, and the backend cloud server via GPRS. The TCU's primary function revolves around the meticulous collection of vital vehicle data, encompassing diagnostics information, real-time location, and the vehicle's speed, obtained through various interfaces.

The TCU seamlessly collates this diverse array of information and undertakes the responsibility of transmitting it to the designated cloud server. This transmission occurs over wireless networks, offering versatility through options such as GPRS, cellular connectivity, or LTE. The transmission is executed in a meticulously packaged format, ensuring the integrity and efficiency of data transfer. In essence, the TCU serves as a sophisticated bridge, facilitating the seamless flow of critical vehicle data from the in-vehicle network to the cloud server, thereby forming a robust and interconnected telematics system.



6.1 Future implementation

APPENDICES

A1: SDG Goals

SDG Goal 11: Sustainable Cities

1. **Road Safety:** By utilizing IoT and AI to monitor and detect traffic violations, the system enhances road safety. Identifying and alerting drivers about violations such as speeding, sudden acceleration, or not wearing a seatbelt can prevent accidents, contributing to safer road**s.**
2. **Resilient Infrastructure:** Implementing IoT sensors and AI for real-timemonitoring of various vehicle aspects contributes to creating resilient infrastructure. The system helps in early detection of potential issues, ensuring the continuous and reliable functioning of vehicles, thus contributing to resilient transportation systems.
3. **Environmental Impact:** By addressing fuel consumption, emissions,and promoting sustainable driving practices, the system has the potential to reduce the environmental impact of vehicles. This aligns with the targetof minimizing the adverse environmental impact of cities, including air quality improvement.
4. **Regulatory Compliance:** Ensuring that vehicles comply with traffic regulations and sustainability standards contributes to buildingsustainable and well-regulated cities. The proposed system helps in monitoring and enforcing compliance, supporting the creation of orderly and safe urban environments.
5. **Smart Cities**: The integration of IoT and AI in vehicles is a step towardsdeveloping smart cities. The proposed system leverages technology to enhance safety and sustainability, contributing to the overall intelligence and efficiency of urban transportation systems.

SDG Goal 13: Climate Action

1. **Reduction of Greenhouse Gas Emissions:** The implementation of IoT and AI technologies in vehicles allows for real-time monitoring of fuel consumption and emissions. Machine learning algorithms identify and address driving behaviors that contribute to excessive emissions, actively working towards reducing the carbon footprint of vehicles.

2. **Integration of Climate Considerations in Vehicle Design:** Sustainability design features, facilitated by IoT and AI, aim to reduce theoverall environmental impact of vehicles.
   By incorporating climate-conscious considerations in vehicle operations, the project actively contributes to SDG Goal 13's objective of integrating climate change measures into national policies, strategies, and planning.

3. **Overall Contribution to Climate Action:** The comprehensive approach of violation detection and sustainability design in transportation, enabled by IoT and AI, aligns with the broader goals of SDG 13 - Climate Action.Through the reduction of emissions, promotion of sustainable practices, and enhancement of regulatory compliance, the project serves as a tangible contribution towards addressing the global challenge of climate change.

4. **Support for Global Initiatives:** By aligning with climate action initiatives and regulations, the project supports global efforts to combat climate change, emphasizing the interconnectedness of local actions with the broader sustainability agenda.

A2: Source Code

Front end implementation

index.html:

```
<div>
<Head>
<title>IRDAC</title>
<meta name="description" content="Generated by create next app" />
<meta name="viewport" content="width=device-width, initial-scale=1" />
<link rel="icon" href="/favicon.ico" />
<link
rel="stylesheet"

href="https://fonts.googleapis.com/css2?family=Material+Symbols+Outlined:o
psz,wght,FILL,GRAD@48,400,0,0"
        />
</Head>
<nav className="bg-orange-400 flex justify-between flex-wrap">
<a className="inline-flex items-center">
<Image
src="/logo.jpg"
            alt="app logo"
            width={100}
            height={12}
className={"pt-1 px-3 mb-2 rounded-1xl cursor-pointer"}
            priority
          />
<span className="text-xl text-white font-bold tracking-wide">
            IRDAC
</span>
</a>
<div>
          {/* <button className=' inline-flex p-3 lg:hidden hover:bg-gray-400
rounded ml-auto '>
<span className="material-symbols-outlined">
menu
</span>
</button> */}
<button
```

```
            data-collapse-toggle="navbar-default"
            type="button"
            class="inline-flex p-3 ml-auto text-sm text-gray-500 rounded-lg md:hidden
hover:bg-gray-100 focus:outline-none focus:ring-2 focus:ring-gray-200 dark:text-
white dark:hover:bg-orange-200 dark:focus:ring-orange-600"
            aria-controls="navbar-default"
            aria-expanded="false"
            data-target="navbar-default"
>
<span class="sr-only">Open main menu</span>
<svg
              class="w-6 h-6"
              aria-hidden="true"
              fill="currentColor"
viewBox="0 0 20 20" xmlns="http://www.w3.org/2000/svg"
>
<path
                fill-rule="evenodd"
                d="M3 5a1 1 0 011-1h12a1 1 0 110 2H4a1 1 0 01-1-1zM3 10a1 1 0
011-1h12a1 1 0 110 2H4a1 1 0 01-1-1zM3 15a1 1 0 011-1h12a1 1 0 110 2H4a1
1 0 01-1-1z"
                clip-rule="evenodd"
></path>
</svg>
</button>
</div>
<div className="hidden w-full md:blockmd:w-auto" id="navbar-default" >
<ulclassName=" px-28 py-6 justify-end flex space-x-10 lg:float-row " >
<li className="cursor-pointer text-smhover:text-white">Home</li>
<li className="cursor-pointer text-smhover:text-white">
              About us
</li>
<li className="cursor-pointer text-smhover:text-white">
              Contact us
</li>
<li className="cursor-pointer text-smhover:text-white">
              Support
</li>
</ul>
</div>
</nav>
<Table /></div>
```

Back-end implementation:

server.js

```
const express = require("express")
const cors = require("cors")
const dotenv = require("dotenv")
const morgan = require("morgan")
var models = require("./models");
const app = express()
dotenv.config({path:"config/config.env"})var
corOptions = { origin:"http://localhost:5000",
    credentials: true,
}
models.sequelize.sync()
.then(function () { console.log('Connected
to Database!!')
    }).catch(function (err) {
console.log(err, "Something went wrong with the Database Update!")
});

app.use(morgan('tiny')) app.use(cors(corOptions))

app.use(express.json())

app.use(express.urlencoded({ extended:true }))

const router = require('./routes/Router.js')
app.use('/api',router)

app.get("/",(req,res)=>{
res.json({Message:"Server is running on port 6000"})
})
const PORT = process.env.PORT

app.listen(PORT,()=>{
console.log(`Server is running on port ${PORT}`);
})
```

Controller.js

```
var bCrypt = require("bcryptjs"); const
model = require("../models"); const
userppm = require('./ppmstatus')const
Users = model.users;
const irdac = model.irdac;
```

```
const accountSid = process.env.TWILIO_ACCOUNT_SID;
const authToken = process.env.TWILIO_AUTH_TOKEN; const
client = require('twilio')(accountSid, authToken);
var generateHash = function (password) {
  return bCrypt.hashSync(password, bCrypt.genSaltSync(8), null);
};

 async function signin(req, res) {
  // const { body, headers, method } = req;

  let info = {
    username: req.body.username,
    password: req.body.password,
  };
console.log(Users);
  var isValidPassword = function (userpass, password) {
    return bCrypt.compareSync(password, userpass);
  };

  await Users.findOne({
    where: {
      username: info.username,
    },
  })
.then(function (user) {if
      (!user) {
res.status(401).json({ Message: "That email does not exist" });
console.log("Email does not exist");
```

```
      } else if (!isValidPassword(user.password, info.password)) {
console.log("incorrect password");
res.status(400).json({ Message: "incorrect password" });
      } else {
res.status(200).json({ Message: "success", status: true });
      }
    })
.catch(function (err) {
console.log("Error:", err);
    });
}

 async function fetchppm (req, res) { const
  { body, headers, method } = req;let
  output = []

  for (let i = 0; i<userppm.ppm.length; i++) {if
               (userppm.ppm[i].status) {
                   const user = await irdac.findOne({
                       where: {  registration_number: userppm.ppm[i].registration_no,
},
                     });

if( userppm.ppm[i].ppm==2000){
client.messages
.create({from: '+1 540 384 9819', body: 'Reminder:your vehicle has crossed the
threshold', to: '+919025650110'})
.then(message => console.log(message.sid));
}else{
                       console.log(false);
                     }
let responsesss = {user:user,ppm:userppm.ppm[i].ppm}output.push(responsesss)
               } else {
                   console.log("false");
               }

  }
res.status(200).json( output );
  };


   async function addusers(req, res) {
```

```
    const { body, headers, method } = req;
    const { username, password } = body;

    if (!username || !password) {
      return res.status(400).json({ message: "Missing username/password" });
    }


        let params = {
          username: username,
          password: password,
        };
        if (params.username.length&&params.password.length) {
Users.findOne({
            where: {
              username: params.username,
            },
          }).then(function (user) {if
            (user) {
res.status(400).json({ Message: "That email is already taken" });
            } else {
params.password = generateHash(params.password);
              const user = Users.create(params);
res.status(200).json({ Message: "Successfully added user" });
            }
          });
        } else {
res.status(300).json({ Message: "empty field" });
        }


  }
  const irdacaddusers = async (req, res) => {
    const { body, headers, method } = req;

      let info = {
registration_number: req.body.registration_number,name:
        req.body.name,
        bank: req.body.bank, phone_number:
req.body.phone_number,
aadhar_number: req.body.aadhar_number,
      };
```

```
        const user = irdac.create(info);
res.status(200).json({ Message: "Successfully added user" });

  };

module.exports = {
signin,
fetchppm, addusers,
irdacaddusers  };
```

Routes.js

```
const Controller = require("../controller/controller")

const router = require("express").Router()

router.post('/signin',Controller.signin) router.get('/fetchppm',Controller.fetchppm)
router.post('/addusers',Controller.addusers)
router.post('/irdacaddusers',Controller.irdacaddusers)

module.exports = router
```

ARDUINO CODE:

```
#include <ESP8266WiFi.h>
#include "ThingSpeak.h" // always include thingspeak header file after other
header files and custom macros
#include "SparkFun_SGP30_Arduino_Library.h" // Click here to get the library:
http://librarymanager/All#SparkFun_SGP30
#include <Wire.h>

SGP30 mySensor; //create an object of the SGP30 class

char ssid[] = "Airtel_abishek";     // your network SSID (name)
char pass[] = "abishek2003";     // your network password
int keyIndex = 0;           // your network key Index number (needed only for
WEP)
WiFiClient  client;
unsigned long myChannelNumber = 2237374;
const char * myWriteAPIKey = "PBE3QW3O1X8OSVYU";

unsigned long previousMillis = 0; // will store last time LED was updatedconst
long interval = 20000;  // interval at which to blink (milliseconds)

int    co2,tvoc;
void setup() {
  // put your setup code here, to run once:
```

```
  Serial.begin(115200);   //   Initialize   serial
  Wire.begin();

  WiFi.mode(WIFI_STA); ThingSpeak.begin(client);  //
  Initialize ThingSpeak

  if (mySensor.begin() == false) {
    Serial.println("No SGP30 Detected. Check connections.");
    while (1);
  }
  mySensor.initAirQuality();

}

void loop() {


  // put your main code here, to run repeatedly:
  if(WiFi.status() != WL_CONNECTED){
  Serial.print("Attempting to connect to SSID: ");
  Serial.println("EMCOG_LAB"); while(WiFi.status()
  != WL_CONNECTED){
      WiFi.begin(ssid, pass); // Connect to WPA/WPA2 network. Change thisline if
using open or WEP network
      Serial.print(".");
      delay(10000);
    }
    Serial.println("\nConnected.");
  }
  unsigned long currentMillis = millis();

  if (currentMillis - previousMillis >= interval) {
      // save the last time you blinked the LED
    previousMillis = currentMillis;

    co2 = mySensor.CO2; tvoc
    = mySensor.TVOC;
    mySensor.measureAirQuality();
    Serial.print("CO2: ");
    Serial.print(co2);
    Serial.print(" ppm\tTVOC: ");
    Serial.print(tvoc);
    Serial.println(" ppb");

    ThingSpeak.setField(1, co2);
    ThingSpeak.setField(2, tvoc);
```

```
    int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);if(x
    == 200){
      Serial.println("Channel update successful.");
    }
    else{
      Serial.println("Problem updating channel. HTTP error code " + String(x));
    }
  }

}
```

COMPUTER VISION IMPLEMENTAION:
(for drowsiness and distraction detection)

ClassifierMain.py

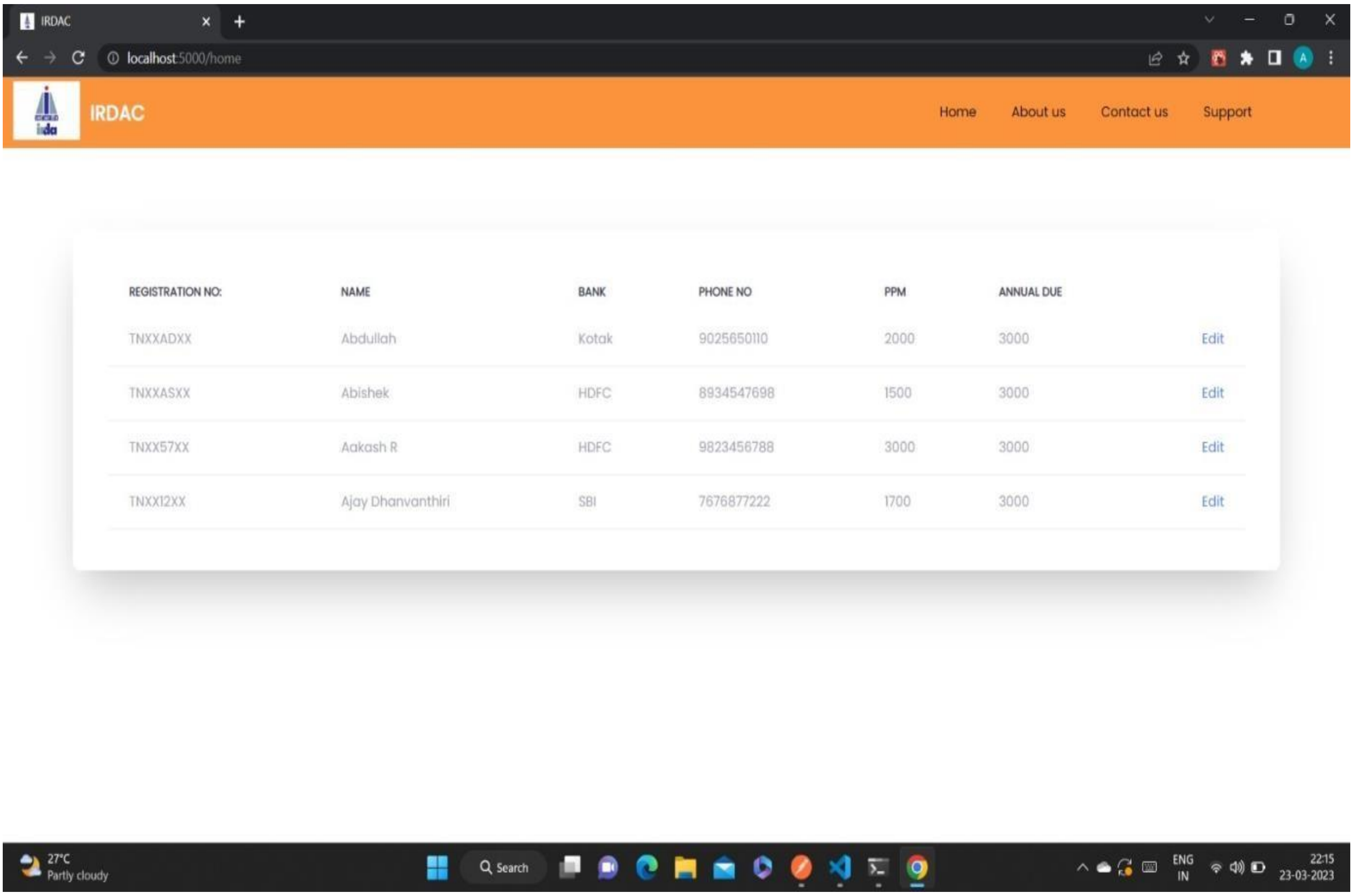
```
import cv2
import numpy as np
from scipy.spatial import distance as dist from imutils import face_utils
import numpy as np import imutils import dlib
import cv2 import playsound import requests

def eye_aspect_ratio(eye):
# compute the euclidean distances between the vertical A = dist.euclidean(eye[1], eye[5])
B = dist.euclidean(eye[2], eye[4])

# compute the euclidean distance between the horizontal C = dist.euclidean(eye[0], eye[3])
# compute the eye aspect ratio ear = (A + B) / (2.0 * C)
return ear



# calculating mouth aspect ratio def mouth_aspect_ratio(mou):
# compute the euclidean distances between the horizontal X = dist.euclidean(mou[0], mou[6])
# compute the euclidean distances between the vertical Y1 = dist.euclidean(mou[2], mou[10])
Y2 = dist.euclidean(mou[4], mou[8]) # taking average
Y = (Y1 + Y2) / 2.0
# compute mouth aspect ratio mar = Y / X
return mar



#Setup classifier

face_cascade=cv2.CascadeClassifier('haarcascade_frontalface_default.xml')
```

```
eye_cascade=cv2.CascadeClassifier('haarcascade_eye.xml')

phone_cascade=cv2.CascadeClassifier('Phone_Cascade.xml') phone_usage = 0

cap=cv2.VideoCapture(0)

#Drowsiness

EYE_AR_THRESH = 0.25
EYE_AR_CONSEC_FRAMES = 50
MOU_AR_THRESH = 0.75

COUNTER = 0
yawnStatus = False yawns = 0

# the facial landmark predictor
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor("D:\\shape_predictor_68_face_landmarks.dat")

(lStart, lEnd) = face_utils.FACIAL_LANDMARKS_IDXS["left_eye"] (rStart, rEnd) =
face_utils.FACIAL_LANDMARKS_IDXS["right_eye"] (mStart, mEnd) =
face_utils.FACIAL_LANDMARKS_IDXS["mouth"]

while True:
ret, img=cap.read() ret, frame = cap.read()
gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY) prev_yawn_status = yawnStatus
rects = detector(gray, 0)

# loop over the face detections for rect in rects:

shape = predictor(gray, rect)
shape = face_utils.shape_to_np(shape)

leftEye = shape[lStart:lEnd] rightEye = shape[rStart:rEnd] mouth = shape[mStart:mEnd] leftEAR
= eye_aspect_ratio(leftEye)
rightEAR = eye_aspect_ratio(rightEye) mouEAR = mouth_aspect_ratio(mouth)
# average the eye aspect ratio together for both eyes ear = (leftEAR + rightEAR) / 2.0

leftEyeHull = cv2.convexHull(leftEye) rightEyeHull = cv2.convexHull(rightEye) mouthHull =
cv2.convexHull(mouth)
```

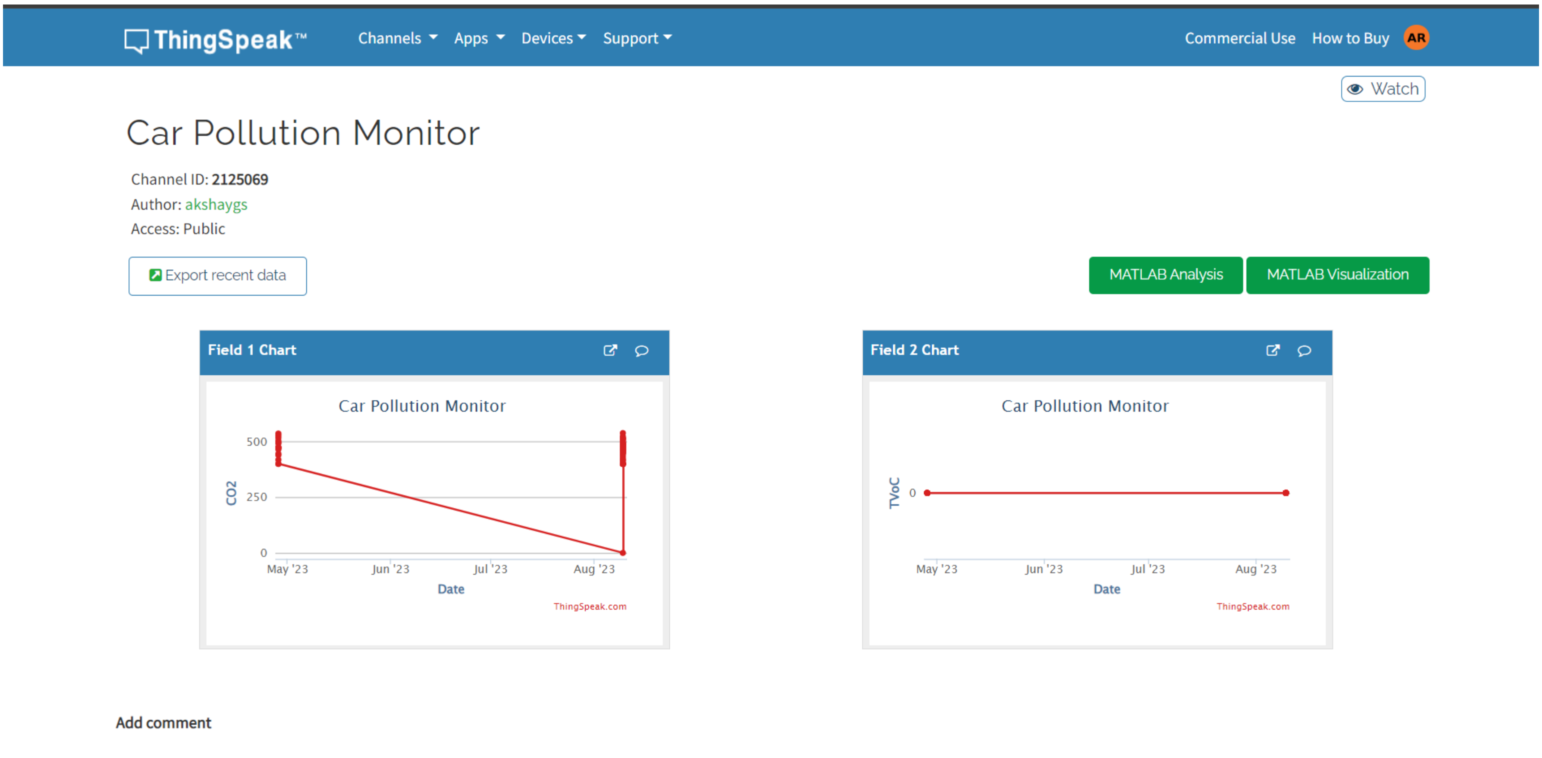
```
if ear < EYE_AR_THRESH:
COUNTER += 1
cv2.putText(img, "Eyes Closed ", (10, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

# if the eyes were closed for a sufficient number of if COUNTER >=
EYE_AR_CONSEC_FRAMES:
cv2.putText(img, "DROWSINESS ALERT!", (10, 50),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
#playsound.playsound('./' + 'alarm1.mp3')



else:
COUNTER = 0
cv2.putText(img, "Eyes Open ", (10, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 0), 2)

# yawning detections

if mouEAR > MOU_AR_THRESH: cv2.putText(img, "Yawning ", (10, 70),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
yawnStatus = True
# output_text = "Yawn Count: " + str(yawns + 1) # cv2.putText(frame, output_text,
(10,100),cv2.FONT_HERSHEY_SIMPLEX, 0.7,(255,0,0),2)
else:
yawnStatus = False

if prev_yawn_status == True and yawnStatus == False: yawns += 1
#cv2.imshow("Frame", frame) #key = cv2.waitKey(1) & 0xFF

#if key == ord("q"): #  break

gray=cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

#Use classifier to detect faces faces=face_cascade.detectMultiScale(gray, 1.3, 5)

phones=phone_cascade.detectMultiScale(gray, 3, 9) key = cv2.waitKey(1) & 0xFF
if key == ord("q"): break

for (x,y,w,h) in phones:
cv2.rectangle(img, (x,y), (x+w, y+h), (255,0,255), 2) font = cv2.FONT_HERSHEY_SIMPLEX
```

```
cv2.putText(img,'Phone',(x-w,y-h), font, 0.5, (11,255,255), 2, cv2.LINE_AA)
#base_url = "https://api.thingspeak.com/update"

# ThingSpeak API key
#api_key = "MMAHXEBLUT3RPPTZ"

# Data value you want to send #data_value = 42.0 phone_usage+=1
#playsound.playsound('./' + 'beep-09.mp3')
#response = requests.get(base_url, params={'api_key': api_key, 'field1': phone_usage})

# Check if the request was successful #if response.status_code == 200:
#print("Data sent successfully to ThingSpeak!") #print(phone_usage)
#else:
#print("Failed to send data to ThingSpeak.")

for (x, y, w, h) in faces:
cv2.rectangle(img, (x,y), (x+w, y+h), (255,0,0), 3) roi=img[y:y+h, x:x+w]
roi_gray=gray[y:y+h, x:x+w] eyes=eye_cascade.detectMultiScale(roi_gray) #for (ex, ey, ew, eh)
in eyes:
#cv2.rectangle(roi, (ex,ey), (ex+ew, ey+eh), (0,255,0), 2)

#url = 'https://irdai-server.onrender.com/api/distraction'

#r = requests.post(url, json={"count":phone_usage})

#print(r.json()) cv2.imshow('img', img)
if (cv2.waitKey(30) & 0xff)==27: break

cap.release()
cv2.destroyAllWindow
```

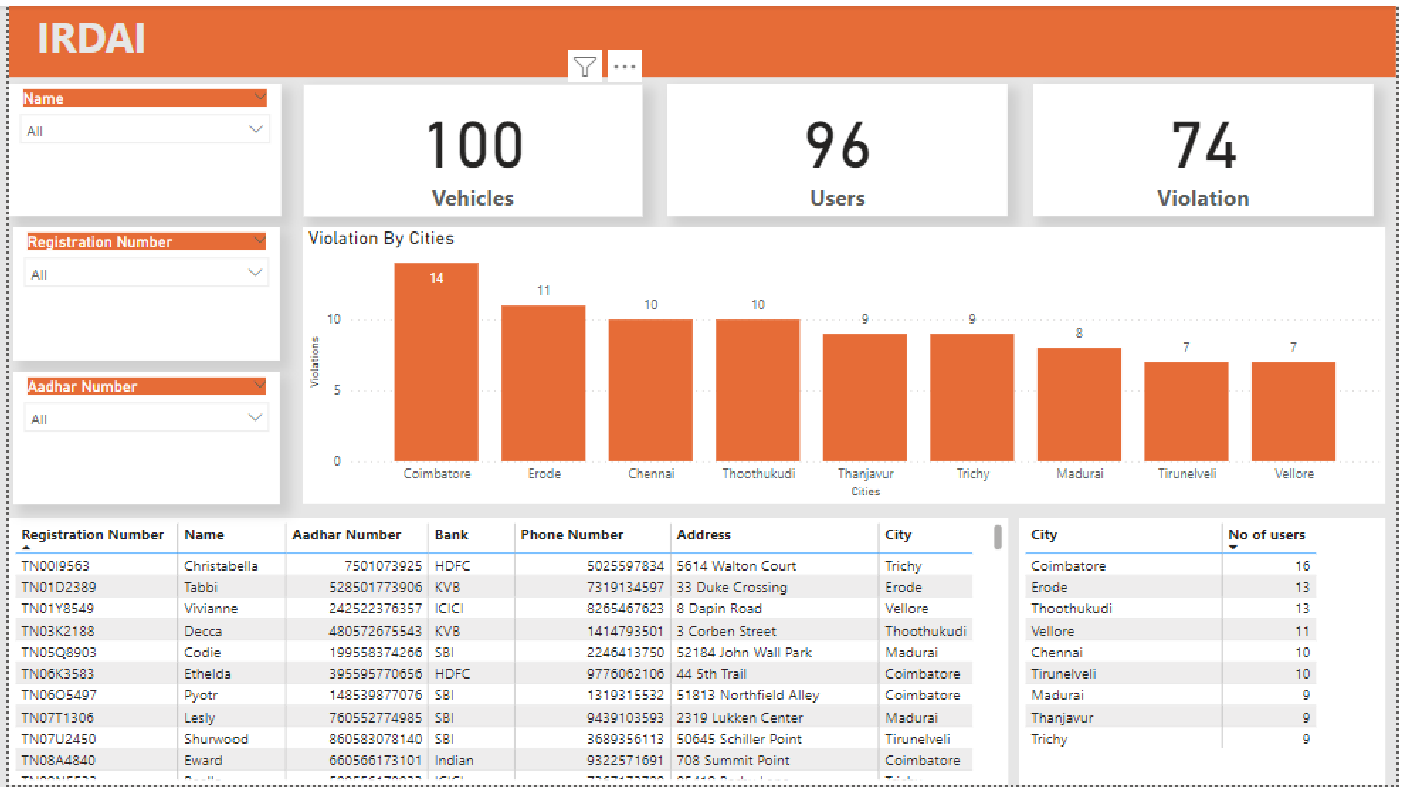
A3: Output Screenshots



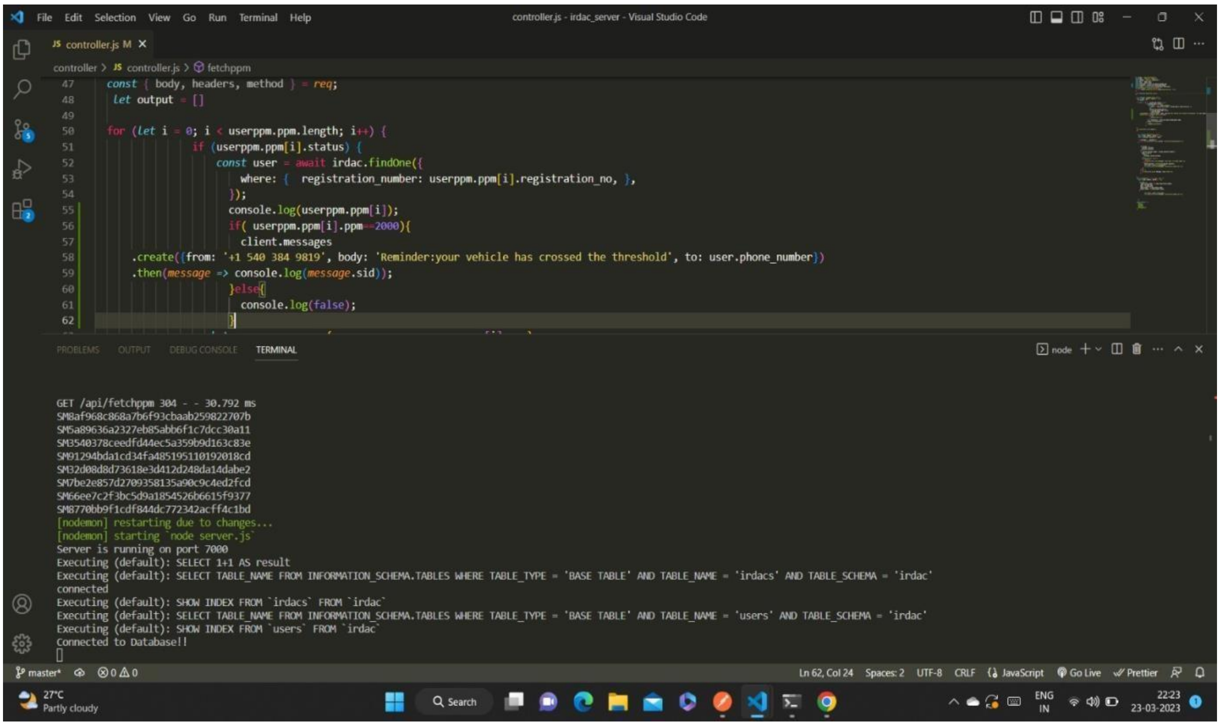
A.3.1 IRDAI Sample Site



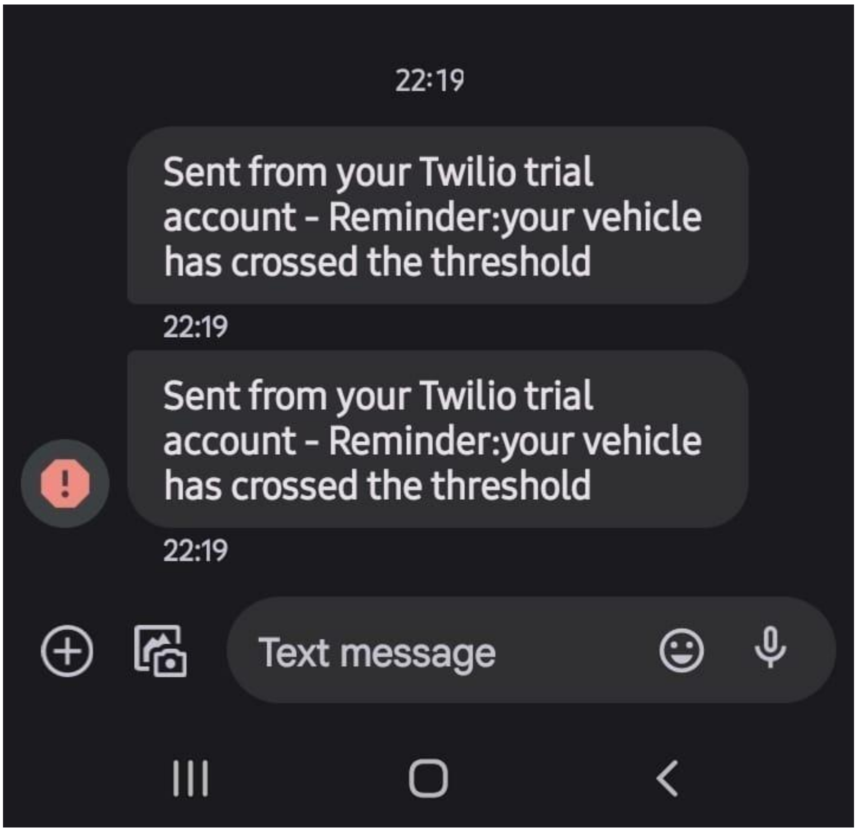
A3.2 Thing Speak Portal



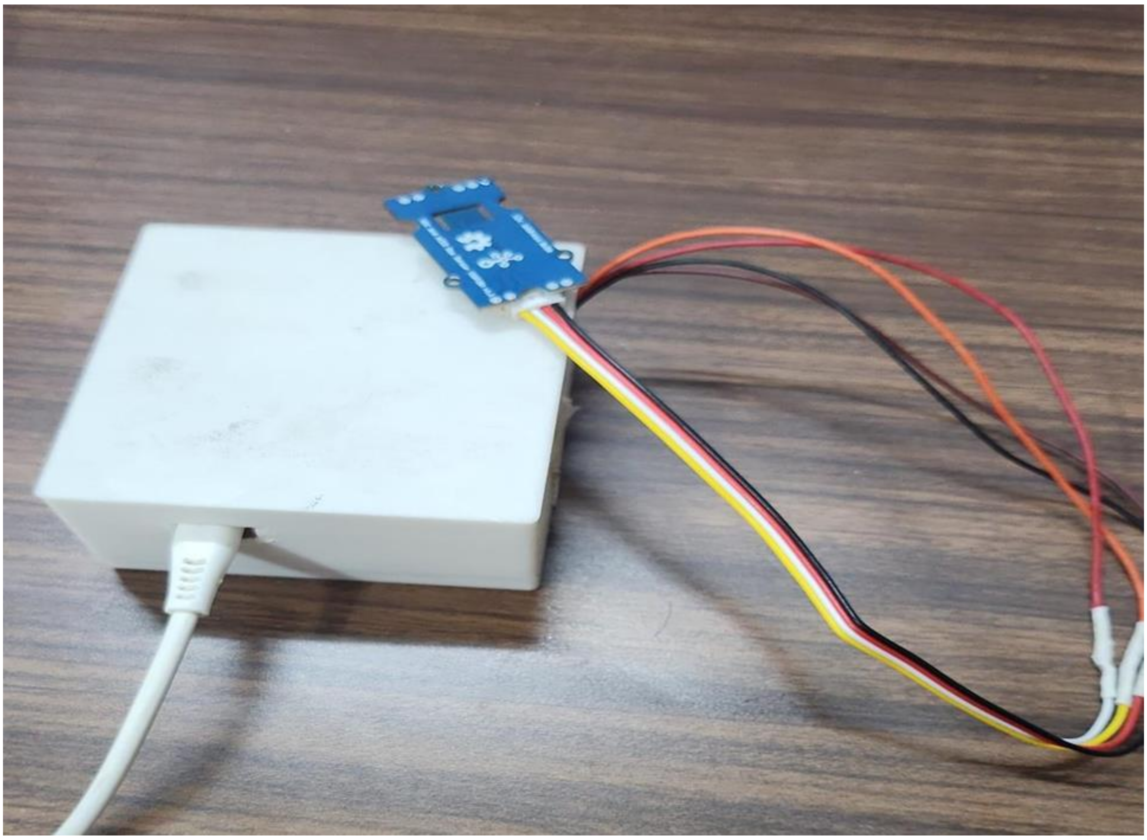
A.3.3 Power BI Dashboard



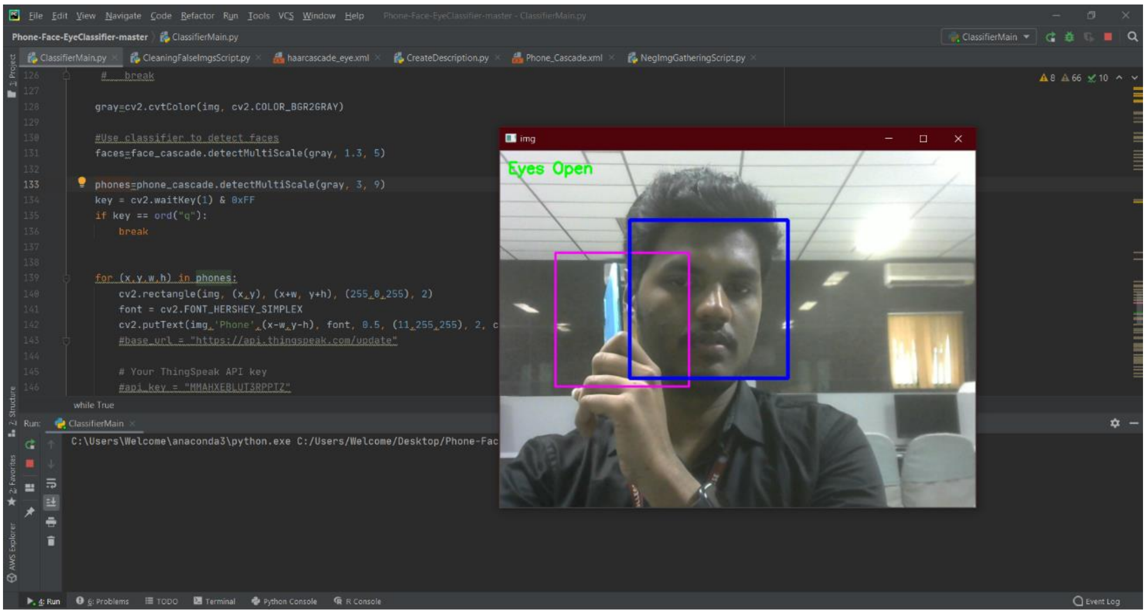
A.3.3 Data Base Setup



A.3.4 Twilio SMS Setup



A.3.5 Vehicure Product



A.3.6 Distraction Detection of the driver

A4: Patent Proof

FORM 1 THE PATENTS ACT, 1970 (39 of 1970) & THE PATENTS RULES, 2003 APPLICATION FOR GRANT OF PATENT [See sections 7,54 & 135 and rule 20(1)]	(FOR OFFICE USE ONLY) Application No.: .... Filing Date: .... Amount of Fee Paid: .... CBR No.: .... Signature: ....

1. APPLICANT(S):

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			College, Bangalore Trunk Road Varadharajapuram Nasarathpettai Poonamallee				

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3. TITLE OF THE INVENTION: VEHICURE

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5. PRIORITY PARTICULARS OF THE APPLICATION(S) FILED IN CONVENTION COUNTRY:

Sr.No.	Country	Application Number	Filing Date	Name of the Applicant	Tilte of the Invention

6. PARTICULARS FOR FILING PATENT COOPERATION TREATY (PCT) NATIONAL PHASE APPLICATION:

International Application Number	International Filing Date as Allotted by the Receiving Office
PCT//	

7. PARTICULARS FOR FILING DIVISIONAL APPLICATION

Original (first) Application Number	Date of Filing of Original (first) Application

8. PARTICULARS FOR FILING PATENT OF ADDITION:

Main Application / Patent Number:	Date of Filing of Main Application

9. DECLARATIONS:

(i) Declaration by the inventor(s)

I/We ,S RAJESHKANNAN,R ABISHEK,R ABDULLAH,R LAXMAN MAHADEVAN,ANANDHA DINESH J,Dr L JABASHEELA, is/are the true & first inventor(s) for this invention and declare that the applicant(s) herein is/are my/our assignee or legal representative.

(a) Date: -----

(b) Signature(s) of the inventor(s): ....

(c) Name(s): S RAJESHKANNAN,R ABISHEK,R ABDULLAH,R LAXMAN MAHADEVAN,ANANDHA DINESH J,Dr L JABASHEELA

(ii) Declaration by the applicant(s) in the convention country

I/We, the applicant(s) in the convention country declare that the applicant(s) herein is/are my/our assignee or legal representative.

(a) Date: -----

(b) Signature(s) : ....

(c) Name(s) of the singnatory: S RAJESHKANNAN,R ABISHEK,R ABDULLAH,R LAXMAN MAHADEVAN,ANANDHA DINESH J,Dr L JABASHEELA

(iii) Declaration by the applicant(s)

- **The Complete specification relating to the invention is filed with this application.**
- **I am/We are, in the possession of the above mentioned invention.**
- **There is no lawful ground of objection to the grant of the Patent to me/us.**
- **I am/We are, the assignee or legal representative to true first inventors.**

10. FOLLOWING ARE THE ATTACHMENTS WITH THE APPLICATION:

Sr.	Document Description	FileName
1	COMPLETE SPECIFICATION	Patent Details.pdf
2	DRAWINGS	VEHICURE- Architectire Diagram and Images.pdf

I/We hereby declare that to the best of my/our knowledge, information and belief the fact and matters stated hering are correct and I/We request that a patent may be granted to me/us for the said invention.

Dated this(Final Payment Date): ------------

Signature: ....

Name: S RAJESHKANNAN

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The Patent office at CHENNAI

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FORM 9

THE PATENT ACT, 1970
(39 of 1970)
&
THE PATENTS RULES, 2003

REQUEST FOR PUBLICATION

[See section 11A (2) rule 24A]

I/We **S RAJESHKANNAN,R ABISHEK,R ABDULLAH,R LAXMAN MAHADEVAN,ANANDHA DINESH J,Dr L JABASHEELA** hereby request for early publication of my/our [Patent Application No.] TEMP/E-1/27171/2024-CHE

Dated **22/03/2024 00:00:00** under section 11A(2) of the Act.

Dated this(Final Payment Date):------------
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Name of the signatory

To,
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G.A.R.6
[See Rule 22(1)]
RECEIPT

Docket No 45039 **Date/Time 2024/03/22 21:50:41**

To
S RAJESHKANNAN

UserId: rajmag.abi

Department of ECE, St. Joseph's College of Engineering, OMR, Semmencherry, Chennai

CBR Detail:

Sr. No.	App. Number	Ref. No./Application No.	Amount Paid	C.B.R. No.	Form Name	Remarks
1	E-12/3467/2024/CHE	202441022581	2500	20099	FORM 9	
2	202441022581	TEMP/E-1/27171/2024-CHE	1600	20099	FORM 1	VEHICURE

TransactionID	Payment Mode	Challan Identification Number	Amount Paid	Head of A/C No
N-0001372304	Online Bank Transfer	2203240057862	4100.00	1475001020000001

Total Amount : ₹ 4100.00
Amount in Words: Rupees Four Thousand One Hundred Only

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