INTEGRATED DRIVER SAFETY AND EMERGENCY RESPONSE SYSTEM.

SUPERIOR UNIVERSITY

B.Sc. ELECTRICAL ENGINEERING

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Session: [2020 – 2024]

Thesis Supervisor: Dr. Saif Ur Rehman

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DECLARATION

This statement report is an arrangement of our creative study task. Moreover, additions of other peoples are elaborate, every determination is made to entitle this clearly, with due reference to the literature, and acknowledgment of combined research and discussions. We also assure you that this work is the output of our research, except we were identified by references and free from plagiarism of the work of other people.

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RESEARCH COMPLETION CERTIFICATE

It is certified that the research work contained in this dissertation titled "**Integrated Driver Safety and Emergency Response System**" has been investigated and carried out by Muhammad Ahmad, Shafaqat Ali, Zubair Ishtiaq, and Walid Irfan for the degree of Bachelors of Science in Electrical Engineering.

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In the name of ALLAH, who is most beneficial and most merciful!

We thank ALLAH ALMIGHTY who helped us to obtain our target. We are grateful to our parents, who always motivated us and provided us with the ultimate help, love, and care. We would also want to thank our supervisor Dr. Saif Ur Rehman for their support and encouragement of my motivation to work very hard and intelligently. When addressing the classification problem in this research project, we found him very supportive. Undoubtedly, his constructive remarks on my project required me to think of innovative methods and concepts in the area of IoT and beyond. We also want to express our appreciation to all the instructors who were very helpful and offered valuable assistance, support, and guidance.

Thank you,

Muhammad Ahmad
Shafaqat Ali
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DEDICATION

We dedicate this work to my beloved family, teachers, and friends. To the last prophet, Holy Prophet Muhammad (Peace be upon him) — my great Hero and messenger of ALLAH ALMIGHTY. He remains one of the most influential people that humanity has ever witnessed.

LIST OF ACRONYMS

4G	Fourth Generation Wireless
ERU	Emergency Response Unit
GPS	Global Positioning System
GSM	Global System for Mobile Communication
IDSERS	Integrated Driver Safety and Emergency Response System
IOT	Internet Of Things
IR	Infrared Radiation
LCD	Liquid Crystal Display
LED	Light Emitting Diode
NPN	Negative Positive Negative
QARS	Quick Accident Response System
RT-DDS	Real Time Drowsiness Detection System
SD CARD	Secure Digital Card
SDG	Sustainable Development Goal
SMS	Short Message Service
SVS	Smart Vehicle System
UNSDGs	United Nation Sustainable Development Goals
VCC	Common Collector Voltage
PKR	Pakistani Rupee
WiFi	Wireless Fidelity

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ABSTRACT

The escalating frequency of traffic incidents necessitates innovative solutions to enhance emergency response and driver safety. Drowsiness, a significant contributor to accidents, leads to severe injuries, fatalities, and substantial financial losses. This research introduces the Integrated Driver Safety and Emergency Response System (IDSERS) designed to address these challenges. IDSERS integrates three pivotal features: Drowsiness Detection, Accident Detection, and Automatic Emergency Calling through a GPS-GSM module. Drowsiness, often induced by physical and mental exhaustion, is a prevalent cause of accidents. IDSERS aims to mitigate this risk by incorporating anti-drowsiness detection goggles equipped with advanced sensors and algorithms. Unlike the initial Raspberry Pi-based system, these smart goggles provide real-time alertness ratings, enhancing efficiency, particularly in low-light conditions. Accidents not only result in casualties and injuries but also lead to delayed emergency medical care. IDSERS introduces the Quick Accident Response System (QARS), utilizing Arduino Uno and crash sensors. In the event of an accident, QARS automatically triggers the GPS-GSM module, promptly notifying Emergency Response Units (ERU). This integration ensures swift communication with emergency personnel, reducing response time and potentially saving lives. IDSERS leverages GSM technology to revolutionize emergency response. The automatic emergency calling feature, coupled with the GPS-GSM module, facilitates precise location sharing with responders. This real-time data exchange minimizes the impact of accidents and enhances overall emergency service efficiency. The system serves as a critical link in cases where distressed drivers are unable to place a call, diminishing the likelihood of delayed emergency response. In summary, IDSERS represents a paradigm shift in road safety by seamlessly integrating anti-drowsiness detection, accident detection, and automatic emergency calling via GPS-GSM technology. The system addresses critical aspects of driver attentiveness, rapid accident detection, and prompt emergency intervention. The incorporation of GSM technology underscores the transformative potential of IDSERS, offering a comprehensive solution to complex issues associated with emergency response and driver safety. The goal of the project is to reduce accidents caused by drowsiness. To achieve this, IDSERS utilizes a 3-in-1 solution including Drowsiness Detection, Accident Detection and Auto Emergency call using GPS-GSM.

CHAPTER NO 1

INTRODUCTION

1.1 Introduction

Physical and mental exhaustion are common causes of drowsiness, which is frequently brought on by drug side effects, sleep deprivation, substance abuse, or underlying neurological disorders. While mental exhaustion results in a reduction in cognitive function, physical exhaustion causes momentary muscular failure. Gradually developing mental tiredness during cognitive tasks can be attributed to a variety of causes, including general health and lack of sleep. Driver fatigue has frightening effects because it is becoming a leading cause of traffic accidents that result in fatalities, catastrophic injuries, and monetary losses. IDSERS aims to reduce the number of accidents caused by drowsiness [1]. In figure 1 a pie chart is shown that depicts the number of crashes involving drowsy drivers. The figure shows two pie charts, one for the share of crashes involving drowsiness and two for the share of property-damaging crashes involving drowsiness.

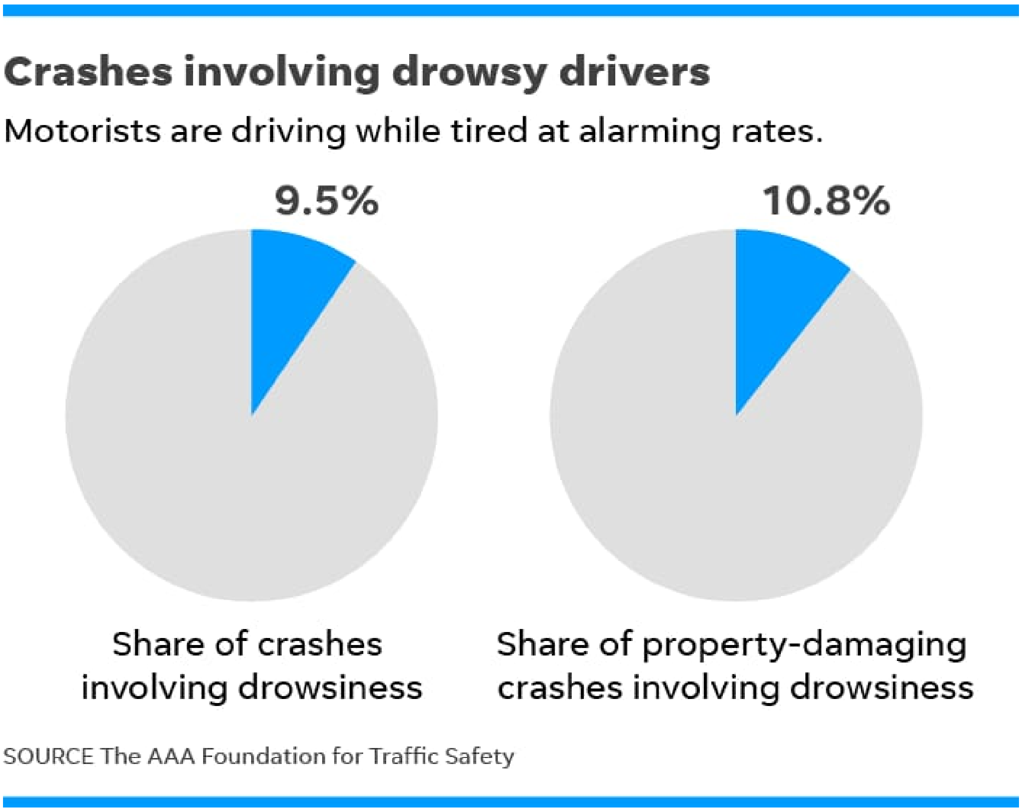

Figure 1 Crashes Involving Drowsy Drivers [19]

1.2 Problem Statement

The surge in traffic incidents highlights a pressing need for improved emergency response and driver safety measures. Drowsiness, stemming from factors like exhaustion and drug side effects, emerges as a significant contributor to accidents, resulting in fatalities and substantial financial losses. Traditional approaches, such as the initial Raspberry Pi-based system, have limitations, especially in challenging lighting conditions. Accidents not only cause immediate harm but also lead to delayed emergency medical care due to adverse weather and technical issues. The critical window for effective intervention is compromised, emphasizing the necessity for a comprehensive solution [2]. The Integrated Driver Safety and Emergency Response System (IDSERS) addresses this gap by integrating advanced technologies, including anti-drowsiness detection goggles and the Quick Accident Response System (QARS). By reducing the frequency and severity of accidents and enhancing emergency response efficiency, IDSERS aims to revolutionize road safety and emergency intervention. In figure 2 a car crash is shown that has resulted due to driver drowsiness.

Figure 2 Car Accident due to Drowsiness

1.3 Project Overview/ Goal

The frequency of traffic incidents has increased recently, which emphasizes the urgent need for creative solutions to improve emergency response and driver safety. Due to its reduced awareness and attention, drowsiness is a major cause of accidents that result in serious injuries, fatalities, and large financial losses. The creation of an Integrated Driver Safety and Emergency Response System (IDSERS) with cutting-edge features including Drowsiness detection, Accident detection and Automatic Emergency calling via GPS (Global Positioning System)-GSM (Global System for Mobile

Communications) module is the main topic of this research paper. Initially, the proposed IDSERS took into account using a Raspberry Pi based system to detect drowsiness based on metrics like eye-blinking rate, eye closure time, and driving gestures. Nonetheless, a creative change in strategy has resulted in the creation of smart goggles, an anti-drowsiness detection device. With the use of cutting-edge sensors and algorithms, these goggles will track the driver's physiological signals and provide a real-time alertness rating. As the goggles have the sensor module much closer to the eyes, it will be more efficient as compared to a 5MP Pi Camera, especially under low lighting conditions. This update improves the effectiveness of the drowsiness detection algorithm and provides a flexible way to deal with driver fatigue in general. Moreover, the effects of automobile accidents go beyond deaths and injuries; one important way that they negatively affect outcomes is by delaying emergency medical care. Delays in receiving medical attention increasing the chance of accident based casualties [3]. When it comes to delays in driver reactions, bad weather, and technical problems, the time it takes for an ambulance to reach the scene of an accident might be critical. In an effort to alleviate this problem, the Quick Accident Response System (QARS) is being developed. The system is based on Arduino Uno and incorporates crash sensors that send the signal to the GPS-GSM module in case of an accident. The system detects the accident automatically and quickly pushes a call notification to the Emergency Response Units (ERU).

1.4 Proposed Methodology

IDSERS, an innovative method of improving driver safety and emergency response mechanisms, integrates anti-drowsiness detection glasses for drowsiness detection, accident detection sensors, and automatic emergency calling with GPS-GSM module. In the end, the proposed system seeks to save lives and lessen the overall impact of traffic accidents on society by streamlining emergency services in addition to reducing the frequency of accidents caused by drowsy drivers. The technology serves as a crucial link in cases where the driver is unable or incapable to place a distress call, reducing the possibility of a delayed emergency response. GSM technology shows to be an excellent asset in the suggested system because of its wide coverage and dependability. Responders can arrive at the accident scene more quickly and accurately thanks to the automatic emergency calling feature integrated with a GPS-GSM module, which also facilitates communication with emergency personnel and offers precise position information. This real-time data sharing greatly lessens the consequences of accidents and improves the overall effectiveness of emergency services [4]. As it sums up, the IDSERS, with its integrated capabilities of accident detection, automatic emergency calling over GPS-GSM, and anti-drowsiness detection goggles, represents a paradigm shift in improving road safety. The system seeks to considerably lessen the negative effects of traffic accidents on people's lives and the general welfare of society by tackling the crucial areas of driver attentiveness, quick accident detection, and prompt emergency intervention. The smooth incorporation of GSM technology highlights the possibility for IDSERS to completely transform our understanding of road safety as well as our reaction to situations while driving. The IDSERS is at the forefront of technological advancements, providing a comprehensive answer to the intricate problems associated with emergency response and driver safety in the modern world [5].

1.5 United Nations Sustainable Development Goals

This project aligns with the following United Nations Sustainable Development Goals (UNSDGs):

1.5.1 Good Health and Well-being (SDG-3)

IDSERS aligns with UN SDG 3, "Good Health and Well-being," in several ways:

1.5.1.1 Reducing Traffic Accidents and Fatalities

By addressing the issue of driver drowsiness, this research contributes to the reduction of traffic accidents. Preventing accidents helps in minimizing injuries and fatalities, directly supporting the goal of ensuring healthy lives and well-being.

1.5.1.2 Enhancing Emergency Response

The Quick Accident Response System (QARS) in this research aims to improve the efficiency of emergency response to accidents. Swift and effective emergency responses contribute to reducing the impact of accidents on individuals' health and well-being.

1.5.1.3 Promoting Mental Health

Drowsiness detection and prevention also touch upon mental health aspects, as fatigue and exhaustion can have a significant impact on cognitive function. Preventing drowsiness-related accidents contributes to promoting mental well-being among drivers.

1.5.1.4 Access to Medical Care

This research addresses delays in accessing emergency medical care, which is crucial for saving lives and minimizing the severity of injuries. This aligns with the SDG 3 target of ensuring universal health coverage and reducing maternal and child mortality.

1.5.1.5 Preventing Injuries

The focus on accident detection and quick emergency response contributes to preventing injuries, aligning with the goal of reducing the global burden of injuries and deaths from road traffic accidents. IDSERS directly supports the objectives of UN SDG 3 by addressing factors that impact road safety, emergency response, and overall well-being, thereby contributing to the promotion of good health and the prevention of avoidable harm. In figure 3 icon of SGD-3 is shown i.e good health and well-being.

Figure 3 Icon of SGD-3

1.5.2 Industry, Innovation, and Infrastructure (SDG-9)

IDSERS aligns with UN SDG 9, "Industry, Innovation, and Infrastructure," in several key ways:

1.5.2.1 Innovative Technology Implementation

This research incorporates cutting-edge technology, such as anti-drowsiness detection goggles, Accident Detection and Auto Emergency Calling, demonstrating a commitment to innovation. This aligns with SDG 9, which emphasizes the importance of fostering innovation and building resilient infrastructure.

1.5.2.2 Technological Advancements for Safety

The development of anti-drowsiness detection goggles and the integration of GPS-GSM modules for automatic emergency calling showcase the use of technology to improve safety in the transportation sector. This aligns with SDG 9's focus on promoting inclusive and sustainable industrialization and fostering innovation.

1.5.2.3 Smart Solutions for Road Safety

By proposing a comprehensive system that integrates technology to enhance road safety, this research aligns with the SDG 9 target of developing reliable, sustainable, and resilient infrastructure , including road networks, to support economic development and human well-being.

1.5.2.4 Efficient Emergency Response System

The Quick Accident Response System (QARS) emphasizes the use of technology (Arduino Uno, Crash sensors, and GPS-GSM modules) to create an efficient emergency response mechanism. This technological approach aligns with SDG 9's goal of building resilient infrastructure to support economic development and human well-being.

1.5.2.5 Intersection of Technology and Safety

The integration of technology in this research addresses safety concerns, aligning with SDG 9's call to develop and implement resilient infrastructure that promotes sustainable industrialization and fosters innovation. This research aligns with UN SDG 9 by leveraging innovative technologies to enhance safety in the transportation sector, improve emergency response systems, and contribute to the development of resilient and sustainable infrastructure. In figure 4 icon of SGD-9 is shown i.e industry, innovation and infrastructure.

Figure 4 Icon of SGD-9

1.5.3 Sustainable Cities and Communities (SDG-11)

IDSERS aligns with UN SDG 11, "Sustainable Cities and Communities," in several ways:

1.5.3.1 Road Safety Improvement

By addressing the issue of driver drowsiness and enhancing emergency response mechanisms, this research contributes to making roads safer. Safer roads are essential for creating sustainable and resilient cities and communities, aligning with SDG 11's focus on safety.

1.5.3.2 Reducing Traffic Accidents

The goal of this research to reduce the number of accidents caused by drowsiness directly aligns with SDG 11's targets related to improving road safety, reducing fatalities, and making transportation systems more sustainable.

1.5.3.3 Efficient Emergency Response

The Quick Accident Response System (QARS) integrated into this research aims to improve the efficiency of emergency responses to accidents. Swift and efficient emergency responses contribute to creating more resilient communities by minimizing the impact of accidents.

1.5.3.4 Utilizing Smart Technology

The use of advanced technologies, such as anti-drowsiness detection goggles, crash sensors and GPS-GSM modules, showcases a smart and innovative approach to address road safety issues. The integration of smart technologies aligns with SDG 11's call for adopting sustainable and intelligent urbanization.

1.5.3.5 Enhancing Urban Well-being

Improving road safety and emergency response contributes to the overall well-being of urban populations. By reducing the negative impacts of accidents, this research aligns with the broader goal of creating sustainable and inclusive urban environments (SDG 11). In figure 5 icon of SGD-11 is shown i.e sustainable cities and communities.

Figure 5 Icon of SGD-11

1.6 Work Division

Table 1.1 Work Division between Group Members

Sr. No.	Name	Allocated Task
1	M. Ahmad	Prototype Development
2	Shafaqat Ali	Prototype Development
3	Zubair Ishtiaq	Software/ Simulation Development
4	Walid Irfan	Research Data Analysis/Documentation

1.7 Thesis Outline

In this thesis, Chapter 01 establishes the groundwork for our project, the "Integrated Driver Safety and Emergency Response System" (IDSERS). This chapter offers a comprehensive introduction, outlining the methodology employed in system development and defining specific goals and objectives. It underscores the alignment of IDSERS with the United Nations Sustainable Development Goals (UN SDGs), emphasizing its potential impact on road safety and emergency response. Moving to Chapter 02, a detailed literature review explores key aspects of IDSERS. This section delves into anti-drowsiness detection technologies, accident detection systems, and the integration of GPS-GSM modules. The review provides insights into the technological components driving IDSERS' functionality, demonstrating its alignment with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities). It sets the stage for subsequent chapters, establishing a roadmap for the development, implementation, and evaluation of IDSERS. Chapter 03 shifts focus to the practical implementation of IDSERS, leveraging advanced technologies. Utilizing cutting-edge sensors and algorithms, the system is evaluated using real-world simulations facilitated by the Proteus platform and Arduino programming. This chapter strategically emphasizes the crucial role of Proteus Software and Arduino Programming in crafting an interactive simulation platform. It highlights the accurate representation of physical components through virtual sensors and actuators, showcasing the system's effectiveness in dynamic driving scenarios. This hands-on approach ensures the reliability and functionality of IDSERS in diverse driving conditions [6].

CHAPTER NO 2

LITERATURE REVIEW

2.1 Introduction

The escalating frequency of traffic accidents underscores the urgent need for innovative strategies to enhance emergency response mechanisms and bolster overall driver safety. This research seeks to pioneer an Integrated Driver Safety and Emergency Response System (IDSERS), leveraging state-of-the-art technology such as Arduino-based Goggles specifically designed for detecting driver drowsiness. These goggles are seamlessly integrated with an accident detection module and a GPS-GSM module, enabling automatic calls over GSM to swiftly mobilize the Emergency Response Unit (ERU)[7]. In recognizing drowsiness as a primary cause of accidents, attributed to medical issues or insufficient sleep, the research methodology underwent a strategic shift from exploring Raspberry Pi for sleepiness detection to developing anti-drowsiness detection eyewear. This eyewear incorporates sophisticated sensors and algorithms that monitor physiological signals, elevating real-time alertness evaluation to new heights. Beyond accident prevention, the Quick Accident Response System (QARS) plays a pivotal role in addressing the aftermath of incidents. By automatically identifying accidents and promptly notifying Emergency Response Units (ERU), QARS aims to mitigate delays in emergency treatments. IDSERS takes a holistic approach, integrating GSM-based emergency calling, advanced accident detection capabilities, and the innovative anti-drowsiness goggles, with the overarching goal of not only reducing accidents but also optimizing emergency services. A standout feature of the system is its automatic emergency calling mechanism enabled by GSM technology, ensuring rapid communication with emergency services and consequent reductions in response times. This Literature Review critically delves into the transformative potential of IDSERS, positioning it as a disruptive force in mitigating the impact of traffic accidents. Emphasizing the system's comprehensive approach to emergency response and driver safety, the review contextualizes IDSERS within the rapidly evolving landscape of technology. The synthesis of innovative elements within IDSERS, from anti-drowsiness technology to automated emergency calling, highlights its multifaceted capabilities and underscores its potential to reshape the paradigm of road safety. As we navigate the complexities of modern transportation, IDSERS emerges not only as a technological innovation but as a comprehensive system poised to redefine the future of driver safety and emergency response [8].

2.2 Impact of IDSERS considering UNSGDs 3, 9 & 11

2.2.1 Introduction

The United Nations Sustainable Development Goals (UN SDGs) provide a comprehensive framework to address global challenges and promote sustainable development. IDSERS, the Integrated Data Security and Emergency Response System, is a revolutionary system designed to enhance security, streamline emergency response, and contribute to achieving UN SDGs 3 (Good Health and Well-being), 9 (Industry, Innovation, and Infrastructure), and 11 (Sustainable Cities and Communities). This article explores the significant impact IDSERS has on advancing these crucial sustainability goals.

2.2.2 UN SDG 3: Good Health and Well-being

IDSERS plays a pivotal role in advancing UN SDG 3 by enhancing health and well-being through its robust security measures and emergency response capabilities. The system integrates advanced surveillance technologies, artificial intelligence, and data analytics to detect and prevent security threats promptly. This includes potential health hazards such as the spread of infectious diseases or bioterrorism events. The system's ability to monitor and analyze health data in real-time allows for the early detection of health emergencies. For example, IDSERS can identify patterns indicative of a disease outbreak, enabling authorities to respond swiftly and implement necessary public health measures. This proactive approach contributes to preventing the escalation of health crises, ultimately promoting the well-being of communities. Additionally, IDSERS incorporates features that support the coordination of emergency medical responses. By providing accurate and timely information to first responders, the system facilitates efficient allocation of resources, reducing response times and improving the overall effectiveness of emergency healthcare.

2.2.3 UN SDG 9: Industry, Innovation, and Infrastructure

IDSERS aligns closely with UN SDG 9 by fostering innovation and enhancing infrastructure resilience. The system leverages cutting-edge technologies such as artificial intelligence, machine learning, and the Internet of Things (IoT) to create a sophisticated security and emergency response ecosystem. In terms of innovation, IDSERS continuously evolves to adapt to emerging security threats and challenges. The integration of advanced technologies allows for the development of predictive models, enabling authorities to anticipate potential security breaches and take proactive measures. This innovation not only strengthens security but also contributes to the overall advancement of technology and knowledge in the field. Furthermore, IDSERS supports the development of resilient infrastructure by offering a comprehensive and interconnected system. The integration of diverse data sources, including surveillance cameras, environmental sensors, and communication networks, enhances the overall resilience of critical infrastructure. This is particularly crucial in the face of natural disasters, cyber-attacks, or other emergencies that may impact infrastructure integrity.

2.2.4 UN SDG 11: Sustainable Cities and Communities

IDSERS significantly impacts UN SDG 11 by promoting the creation of safer and more sustainable cities and communities. The system's advanced security measures contribute to reducing crime rates and enhancing public safety, creating an environment where residents can live securely and peacefully. Additionally, IDSERS supports the efficient management of urban infrastructure during emergencies. By providing real-time data on the status of critical infrastructure components, such as transportation systems and utilities, the system helps authorities make informed decisions to ensure the continuity of essential services during crises.

Furthermore, the integration of IDSERS with smart city initiatives enhances the overall sustainability of urban areas. The system's data-driven approach allows for optimized resource allocation, improved energy efficiency, and effective urban planning, all of which are integral to building resilient and sustainable communities.

2.2.5 Conclusion

In summary, IDSERS emerges not merely as a tool but as a transformative force, leaving an indelible mark on the pursuit of UN SDGs 3, 9, and 11. Its influence extends across key domains, promoting not only good health and well-being but also serving as a catalyst for innovation and fortifying infrastructure resilience. The ripple effect of IDSERS is particularly pronounced in its contribution to the fabric of sustainable cities and communities, embodying the quintessential qualities required to meet the challenges of our interconnected world. In the evolving landscape of technological progress, IDSERS represents a paradigm shift—a symbol of our collective commitment to harnessing innovation for the greater good. As we navigate the complexities of the modern era, integrated solutions like IDSERS stand as sentinels, forging a path toward a future characterized by security, resilience, and sustainability. Through these advancements, we lay the groundwork for a world where global challenges are met with the precision and effectiveness required to usher in a new era of progress and prosperity.

2.3 Integration of 3-in-1 Module

2.3.1 Drowsiness Detection

Drowsiness detection is a cutting-edge technology designed to enhance road safety by monitoring the driver's alertness level. Utilizing advanced sensors and image processing techniques, this system is based on Arduino Nano microcontroller which continuously analyzes the driver's behavior, including eye movement and facial expressions, to identify signs of drowsiness. When signs of fatigue are detected, the system issues timely alerts, such as audible alarms or seat vibrations, prompting the driver to take a break. This innovative technology plays a crucial role in preventing accidents caused by driver fatigue, ensuring a safer driving experience for all [9].

2.3.2 Accident Detection

Accident detection systems are engineered to swiftly respond to vehicular accidents, providing immediate assistance and enhancing emergency response. These systems leverage a network of sensors, accelerometers, and advanced algorithms to detect sudden deceleration or impacts indicative of a collision. Once an accident is identified, the system triggers automatic responses, such as activating airbags, cutting off fuel supply, and initiating an emergency notification process. Real-time alerts are transmitted to emergency services, enabling them to promptly reach the accident site. This technology significantly reduces response times, potentially saving lives and minimizing the severity of injuries in critical situations [10].

2.3.3 Auto Emergency Call with GPS over GSM Module:

The integration of auto emergency call systems with GPS over GSM modules represents a breakthrough in automotive safety. In the event of an accident, this system automatically initiates an emergency call, transmitting crucial information to emergency services, including the vehicle's location using GPS coordinates. The GSM module ensures seamless communication, enabling quick and accurate response from emergency personnel. This technology not only aids in summoning help promptly but also assists rescue teams in locating the accident site efficiently. The combination of GPS and GSM ensures a reliable and comprehensive emergency response system, enhancing overall road safety and reducing the impact of accidents on both lives and property [11].

2.4 Project Overview/ Goal

2.4.1 IDSERS Project Goal

The overarching goal of this project is to significantly enhance road safety and mitigate the impact of accidents through the implementation of advanced driver assistance technologies. Focused on three key aspects—Drowsiness Detection, Accident Detection, and Auto Emergency Call with GPS over GSM Module—our project aims to address critical factors contributing to road incidents [12]. Firstly, we strive to tackle the peril of drowsy driving by developing a sophisticated Drowsiness Detection system. This technology will employ state-of-the-art sensors and image processing algorithms to monitor drivers' alertness levels in real-time. By providing timely alerts and interventions, we intend to reduce the occurrence of accidents caused by driver fatigue, promoting safer roads. Secondly, the project aims to revolutionize accident response mechanisms with an Accident Detection system. Through the integration of advanced sensors and automated response protocols, the system will expedite emergency services, minimizing response times and potentially saving lives [13]. Lastly, the incorporation of Auto Emergency Call with GPS over GSM Module will empower vehicles to autonomously transmit precise location data in the aftermath of an accident. This seamless communication channel ensures that emergency responders can swiftly reach the scene, further reducing the severity of incidents and promoting a proactive approach to road safety. In essence, our project seeks to deploy cutting-edge technology to create a safer driving environment, ultimately saving lives and reducing the societal and economic impact of road accidents [14].

2.4.2 Technological Advancements in Driver Safety

In the past few years, technological advancements have paved the way for smart vehicle systems (SVS). SVS are designed to support the driver while also enhancing the overall road safety. The surging numbers of road accidents worldwide, including Pakistan, has highlighted the critical need to integrate innovative and smart solutions to address the root cause i.e. drowsiness, in order to help prevent or at least reduce the number of road accidents [15]. This paper introduces a Real-Time Drowsiness Detection System (RT-DDS) that employs conventional computer vision application. By utilizing techniques such as eye blinking rate (12-15 per minute) and eye closure monitoring the system identifies driver drowsiness in real time. The emphasis is kept on the system to be non-intrusive, simple to employ and provide high efficiency. This approach aims to reduce drowsiness-induced road accidents [16].

2.5 System Implementation

2.5.1 Hardware Implementation for Accident Detection and GSM Calling

The primary goal of the hardware component is to swiftly detect vehicular accidents through the utilization of advanced sensors and ensure a rapid response from Emergency Response Units (ERUs). The use of an Internet of Things (IOT) device enhances the accuracy of real-time accident data, making it a crucial element in the proposed system.

2.5.2 Accelerometer

The MPU6050 3-axis accelerometer plays a pivotal role in measuring acceleration along the X, Y, and Z axes. With the ability to detect both the Earth's gravity and free-fall conditions, this accelerometer provides precise data for accident detection. Calibration adjustments further enhance accuracy, and Table II provides mathematical abbreviations for interpreting accelerometer and gyroscope values [22].

2.5.3 Ultrasonic Proximity Sensor

The HC-SR04 Ultrasonic sensors strategically placed around the vehicle facilitate the measurement of distances between the subject vehicle and its surroundings. These sensors, deployed in cardinal and ordinal directions, trigger alerts when other vehicles breach the Safe Distance Range. The utilization of sound frequencies beyond the audible limit of the human ear ensures effective sensing. The time difference between signal transmission and reception enables accurate determination of object distance [23].

2.5.4 GPS-GSM Module

The SIM808 GPS-GSM module serves a crucial role in the proposed system, ensuring quick responses from nearby ERUs in the event of an accident. Operating within a voltage range of 3.4V – 4.4V, the module stores accident site latitude and longitude information. The integration of a GPS-GSM module facilitates the transmission of accident details, video recordings, and driver information to the ERU portal through a server. It is noteworthy that the SIM7100A, supporting 4G network connections, could potentially enhance transmission rates. Another use of the module is to call the chosen Emergency contact of the driver and inform them about the mishap via a pre-recorded message with coordinates [26]

2.5.5 Offline Feature

An additional feature of the system involves an Offline Mode, activated when internet connectivity is unavailable. In such instances, the system sends a text message to a pre-specified contact number and the ERU portal. While the video recording is not transferred to the ERU portal via the server, it is stored locally on the microcontroller's SD card for later retrieval [24]. In figure 6 complete flowchart of the system is shown.

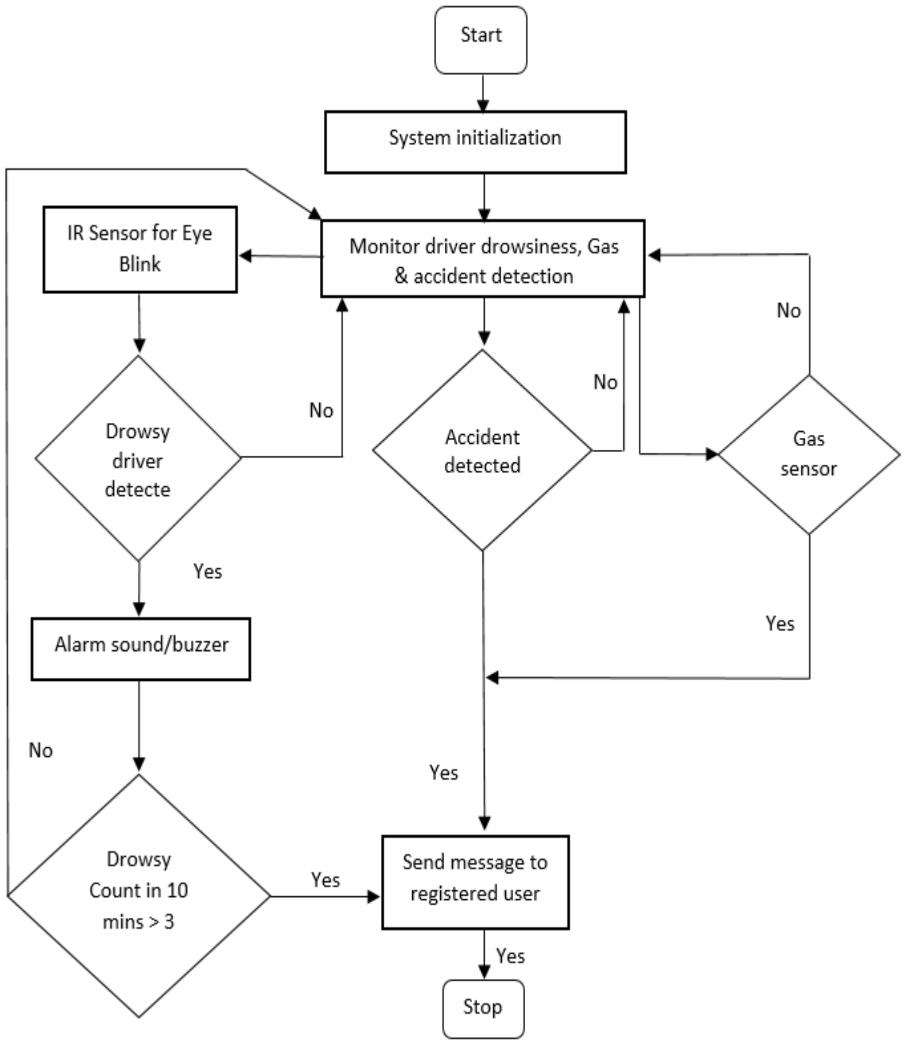

Figure 6 Complete Flowchart of the System

2.6 Previously Proposed Work with this Methodology

Table 2.1 Previously Proposed Work with it's Methodology

Sr. No.	**Year**	**Author**	**Proposed Work**	**Methodology**
1	2021	A. K. Biswal et al.	IOT Based Smart Alert System for Drowsy Driver Detection	The authors propose to construct a smart alert technique for building intelligent vehicles that can automatically avoid drowsy driver impairment. The integration of hardware components such as Pi Camera, Raspberry Pi3, Speaker, Crash Sensor, Force Sensitive Resistor Sensor and GPS Module is proposed
2	2021	S. Rana et al.	Prototype Proposal for Quick Accident Detection and Response System	The authors aims to build a Quick Accident Detection and Response System by employing QARS along with IOT. The proposal includes use of Accelerometer, UltraSonic Proximity Sensor along with GPS-GSM Module
3	2020	K. Satish et al.	Driver Drowsiness Detection	The authors propose a new experimental model that is designed for detecting drowsiness of driver in order to reduce accidents. The proposed system utilizes Arduino module along with elastomeric sensor for real-time calculation of driver hand pressure on the steering wheel
4	2018	U. Khalil et al	Automatic Road Accident Detection Using Ultrasonic Sensor	The author aims to use and ultrasonic sensor based approach for Accident detection. The proposed system uses GPS-GSM module along with HCSR04 sound sensor in order to

				create an efficient system for Automatic road accident detection
5	2019	S. Arefnezhad	Driver Drowsiness Detection Based on Steering Wheel Data Applying Adaptive Neuro-Fuzzy Feature Selection	The paper presents a novel selection method to design a non-invasive driver drowsiness detection system based on steering wheel data. The proposed system utilizes combination of the filter and wrapper feature selection algorithm using additive neuro-fuzzy inference system along with support vector machine and particle swarm optimization algorithm
6	2019	U. Budak	An Effective Hybrid Model for EEG-Based Drowsiness Detection	The authors use EEG signals for detection of drowsiness with a proposed method composed of three main building blocks. The system uses AlexNet, VGGNet and Tunable Q Factor Wavelet Transform to decompose the EEG signals into related sub-bands
7	2019	M. Chai	Drowsiness Monitoring Based on Steering Wheel Status	The authors use eleven parameters related to the steering wheel. The system utilizes multilevel ordered logit model, support vector machine model and BP Neural Network based on the selection of parameters
8	2018	U. Khalil et	Automatic Road Accident Detection	The author aims to use an ultrasonic sensor based

		al.	Using Ultrasonic Sensor	approach for Accident detection. The proposed system uses GPS-GSM module along with HCSR04 sound sensor in order to create an efficient system for Automatic road accident detection

2.7 Conclusion:

In conclusion, this comprehensive literature review has navigated through a rich tapestry of research, shedding light on the intricate web of theories, methodologies, and findings that characterize the current landscape within the chosen field. The synthesis of diverse studies has not only provided a panoramic view of the subject matter but has also unearthed several noteworthy patterns and trends. One prevalent theme that emerges from this extensive review is the increasing recognition of the interplay between Drowsiness Detection, Accident Detection and Auto Emergency call over GSM and how these dynamics shape the field's trajectory. Scholars across various disciplines have approached these complexities with a multitude of methodologies, including IDSERS, showcasing the interdisciplinary nature of research in this area. Throughout the review, the significance of an Integrated Solution for road safety and accident prevention has been underscored as a cornerstone in understanding the multifaceted dimensions of IDSERS. Researchers have grappled with the nuances surrounding the implementation and have contributed valuable insights into the intricacies of the system. The integration of findings from diverse studies has not only consolidated our understanding of existing knowledge but has also laid bare the gaps and limitations that persist in the current body of literature. This highlights the need for continued exploration and innovation to propel the field forward. A critical aspect that has emerged from the synthesis is the evolving nature of IDSERS and the need for research to adapt to the changing landscape. As technologies advance, societal attitudes shift, and global challenges transform, scholars must remain vigilant in their exploration of emerging trends and issues. The rapid pace of change necessitates a dynamic and flexible approach to research methodologies, encouraging scholars to embrace new tools and techniques to gain deeper insights into the subject matter. In scrutinizing the literature, it becomes apparent that there are still uncharted territories awaiting exploration. Gaps in the current body of knowledge, such as incomplete solutions, present opportunities for future researchers to make meaningful contributions. These gaps underscore the evolving nature of research and emphasize the need for scholars to push the boundaries of current understanding. As we delve into unexplored avenues, the importance of interdisciplinary collaboration becomes increasingly evident. The intersectionality of IDSERS necessitates collaboration across disciplines to develop a holistic understanding that transcends traditional academic boundaries. Furthermore, the implications of this literature review extend beyond the confines of academia. The insights gleaned from this synthesis have the potential to inform policy decisions, guide practical applications, and contribute to the betterment of society as a whole. For instance, the understanding of merging 3-in-1 systems may have direct implications for policymakers seeking evidence-based solutions to pressing issues. The synthesis of research on IDSERS can provide a foundation for the development of best practices in various fields. As we reflect on the breadth and depth of the literature reviewed, it is clear that the field is at a crossroads, presenting both challenges and opportunities. The complexities of IDSERS demand a nuanced and holistic approach that integrates insights from various perspectives. The synthesis of this literature review, while illuminating existing knowledge, also serves as a call to action for future researchers to embark on new inquiries, address existing gaps, and contribute to the ever-evolving discourse within the field. In conclusion, this literature review not only consolidates the existing knowledge but also propels the field forward by identifying avenues for future exploration. As scholars continue to build on the foundations laid by this review, the trajectory of research within the chosen field will undoubtedly be shaped by ongoing dialogues, interdisciplinary collaborations, and a commitment to advancing our understanding of the intricate dynamics of IDSERS.

CHAPTER NO 3
COMPLETE SIMULATION

3.1 Introduction

Car accidents represent a significant global challenge, causing substantial injuries and fatalities. In response to this pressing issue, our innovative approach involves the design and implementation of a car accident detection and messaging system utilizing cutting-edge technologies, including Arduino, GPS, and GSM. This advanced system excels at swiftly detecting car accidents and promptly transmitting alert messages to pre-designated emergency contacts, accompanied by precise accident location details. To validate the system's effectiveness, a comprehensive simulation was conducted. The simulation involved intentionally triggering a car accident scenario, closely observing the system's response. Encouragingly, the results revealed the system's ability to accurately detect the simulated car accident and initiate the alert process flawlessly. The transmitted message, inclusive of exact accident coordinates, underscores the potential for a rapid and targeted response from emergency services. This simulation not only validates the efficacy of our car accident detection and messaging system but also emphasizes its potential to significantly enhance response times and, consequently, save lives during real-world accidents. Looking forward, envisioning the integration of this technology into vehicles offers a promising prospect. By seamlessly incorporating our system into automotive infrastructure, we aim to provide an additional layer of safety for both drivers and passengers, contributing to a safer and more secure transportation landscape. This integration could potentially revolutionize vehicular safety standards, offering a proactive and intelligent system that mitigates the severity of accidents and safeguards lives [25].

3.2 Methodology

The photodiode is strategically positioned next to the IR LED to shield it from direct exposure to IR radiation. The photodiode, which is IR radiation sensitive, has two connections: its anode, which is pulled down by a 10-kilo ohm resistor, connects to the operational amplifier's non-inverting input, and its cathode, which is connected to a positive voltage source (12 volts). The IR sensor's potentiometer, which connects to the operational amplifier's inverting input, configures the sensitivity distance. The infrared LED continuously generates infrared rays, which are then detected by the photodiode when they reflect back in response to an obstruction in their path. Depending on the IR radiation that is received, this change in IR radiation causes an adjustment in the anode voltage. Anode voltage changes more noticeably when there is a higher absorption of infrared radiation. The operational amplifier provides the output for the infrared sensor. By turning the potentiometer, the sensitivity distance can be adjusted. This sets a threshold voltage for the operational amplifier's non-inverting input. The photodiode transmits a positive pulse to the operational amplifier's output, which is the sensor's output, when the voltage on the non-inverting input rises above the threshold. By adjusting sensitivity, this system guarantees efficient operation depending on the designated threshold voltage [17]. In figure 7 sample circuit of the hardware for IDSERS is shown.

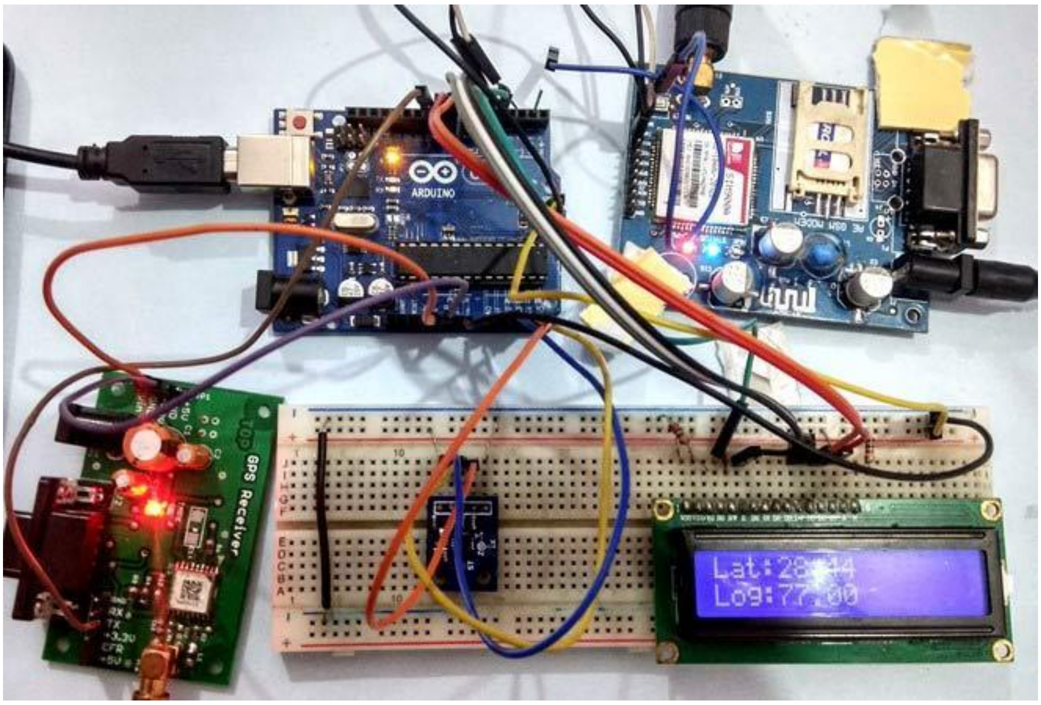

Figure 7 Sample Circuit

3.3 Simulation Environment

The simulation environment for the Car accident Detection Arduino and accident detection and messaging system using GSM and GPS would typically involve the following components and setup:

3.2.1 Arduino Uno

The simulation would use an Arduino microcontroller board as the core processing unit. The Arduino would be programmed to interface with the sensors and communication modules to detect and report the accident [27].

3.2.2 IR Sensors

The simulation would integrate various sensors such as vibrator or impact sensors, IR sensor & Gas sensor to simulate the detection of a car accident. These sensors would be connected to the Arduino to provide input data for accident detection [28].

3.2.3 GPS Module

A GPS module would be used to simulate the retrieval of the vehicle's location information. The GPS module would interface with the Arduino and provide the simulated GPS coordinates of the accident location.

3.2.4 GSM Module

A GSM module would be employed to simulate the communication aspect of the system. The GSM module would be used to send simulated alert messages containing the accident location to designated emergency contacts.

3.2.5 Simulation Software

The simulation environment may utilize software tools such as Proteus & Arduino IDE for programming the Arduino board and simulating the system's behavior. Additionally, simulation software or virtual environments may be used to visualize and test the interaction of the system components.

3.2.6 Testing Setups

Various testing scenarios would be created within the simulation environment to simulate different accident conditions, such as impact force, vehicle speed, and location. These scenarios would help evaluate the system's responsiveness and accuracy in detecting and reporting accidents.

3.4 System Components

1. Arduino Uno

2. LCD 16X2(Display Module)

3. IR Sensor

4. Gas sensor

5. GSM Module

6. GPS Module

7. MQ-3 Sensor (npn Transistor)

8. Vibration Sensor

9. Dc Motor

10. Buzzer

3.5 Simulation Setup

In figure 8 complete simulation setup is shown. All the components are arranged sequence as per our project requirements.

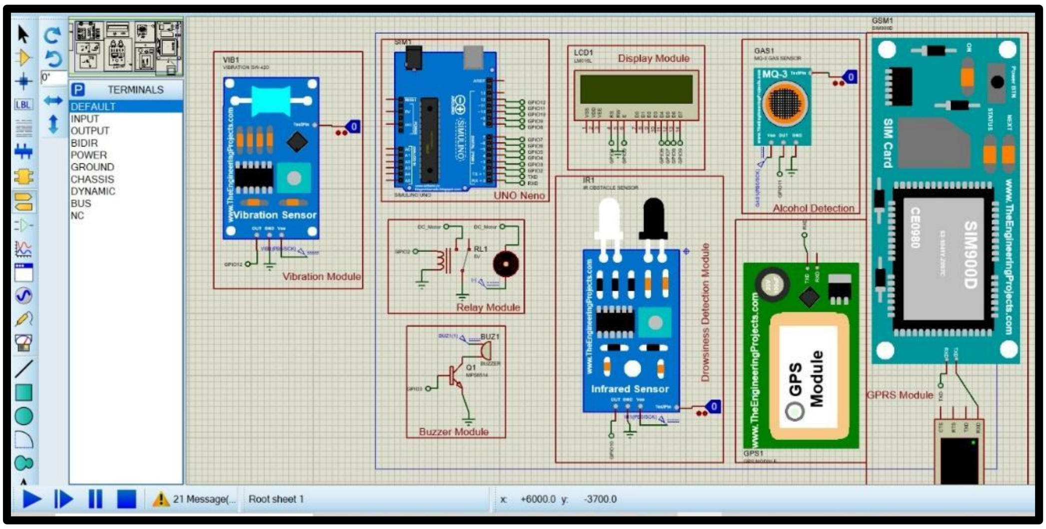

Figure 8 Simulation Setup

3.6 Simulation Results:

3.6.1 System Initialization/Start

In figure 9 system initialization simulation setup is shown. It is in initial condition of all the arranged components as per our project as shown the accident detection system.

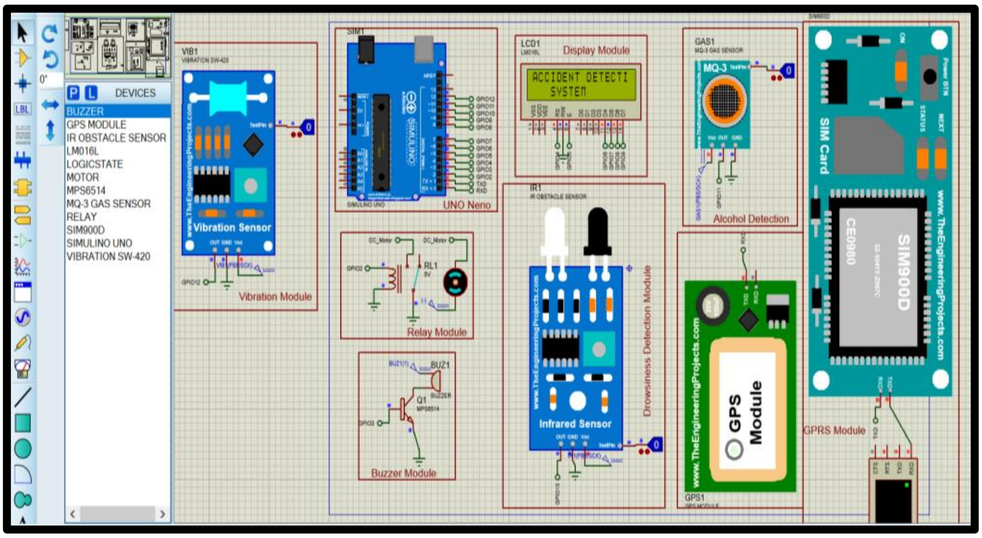

Figure 9 System Initialization/Start

3.6.2 Drowsiness Detected:

In figure 10 drowsiness detected simulation is shown, when drowsiness is detected by the IR module, the system displays an alert on the LCD, and the buzzer beeps loudly.

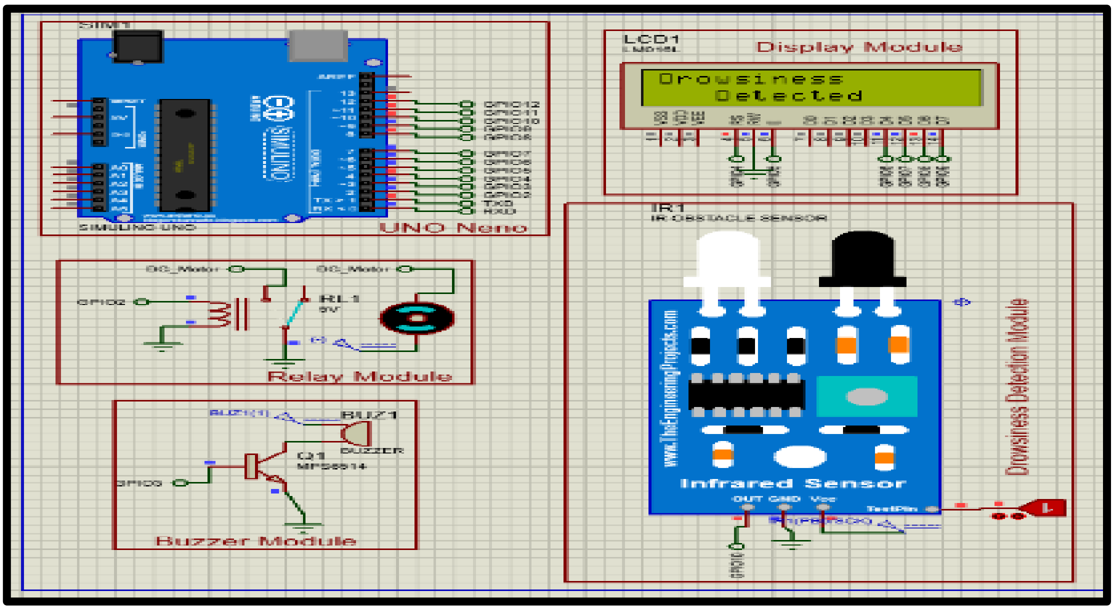

Figure 10 Drowsiness Detected

3.6.3 Drowsiness Not Detected

In figure 11 drowsiness not detected simulation is shown, when drowsiness is not detected by the IR sensor, the LCD does not display an alert, the buzzer does not beep, and the car engine continues to run smoothly.

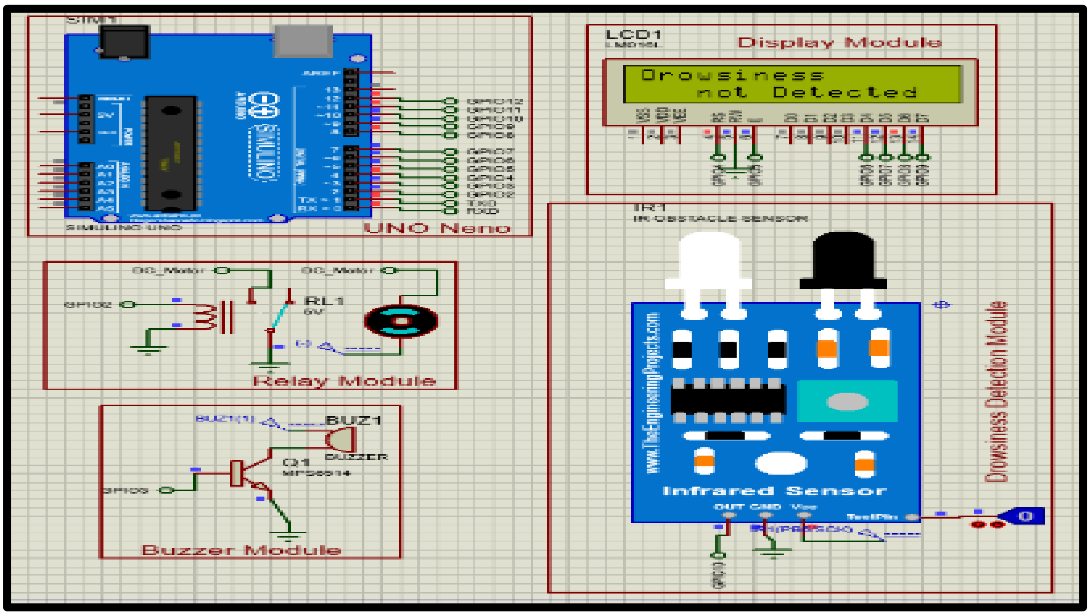

Figure 11 Drowsiness Not Detected

3.6.4 Gas/Alcohol Detected

In figure 12 gas/alcohol detected simulation is shown, when drowsiness is detected by the gas detection system, the LCD displays the alert, and the buzzer beeps loudly.

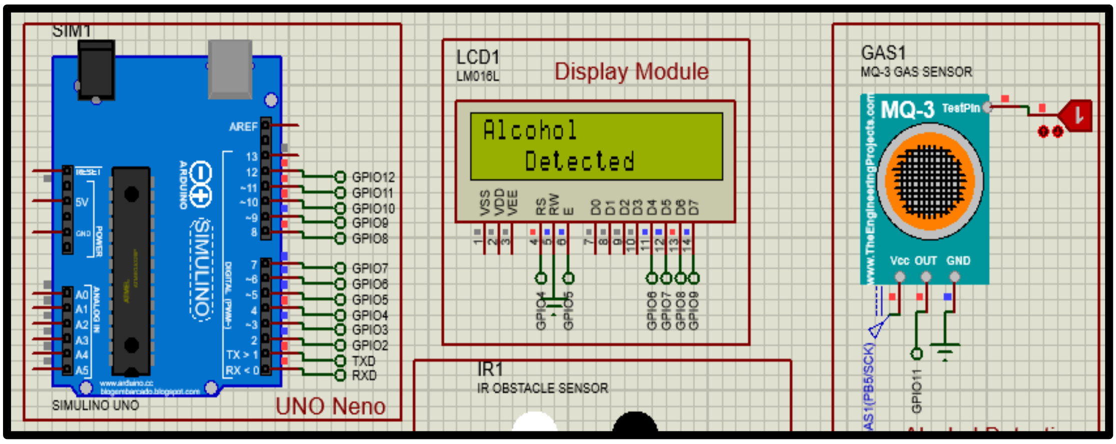

Figure 12 Gas/Alcohol detected

3.6.5 Alcohol Not Detected:

In figure 13 gas/alcohol not detected simulation is shown, when the gas or alcohol is not detected by the gas sensor, the system displays the absence of detection on the LCD screen, the buzzer does not beep, and the car engine continues to run smoothly.

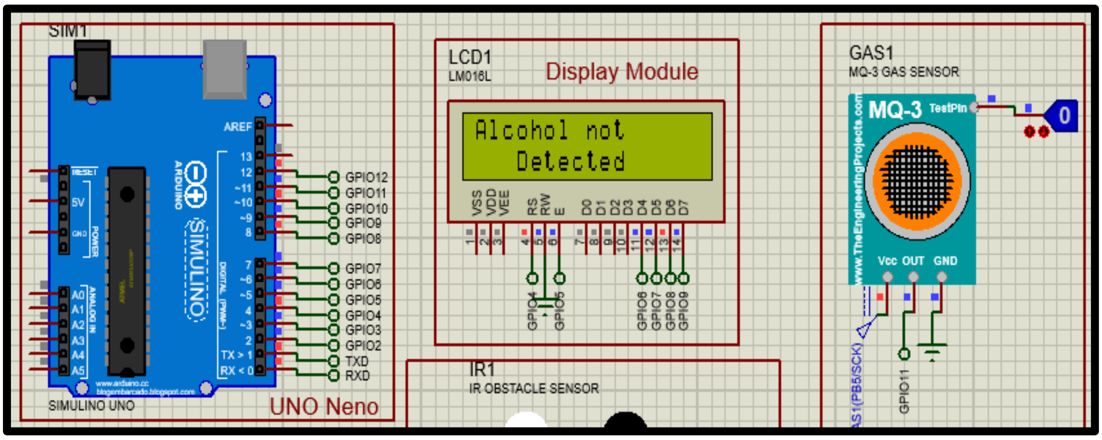

Figure 13 Gas/Alcohol Not Detected

3.6.6 Accident Detected:

In figure 14 accident detected simulation is shown, when the accident is detected by the vibration sensor, the system displays the accident detection on the LCD screen. Additionally, an SMS is sent to an emergency number containing the GPS location, and the car engine is stopped.

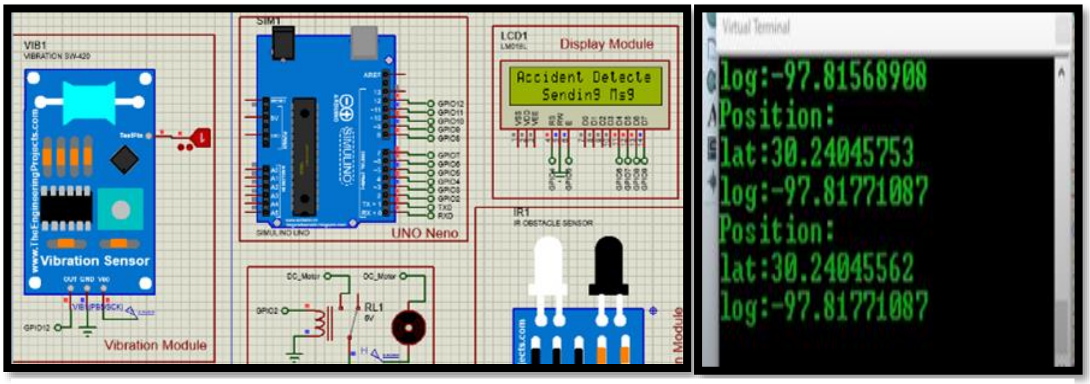

Figure 14 Accident Detected

3.6.7 Accident Not Detected:

In figure 15 accident not detected simulation is shown, when the accident is not detected by the vibration sensor, the system displays the absence of detection on the LCD screen. Additionally, an SMS is not sent to an emergency number containing the GPS location, and the car engine continues to run smoothly.

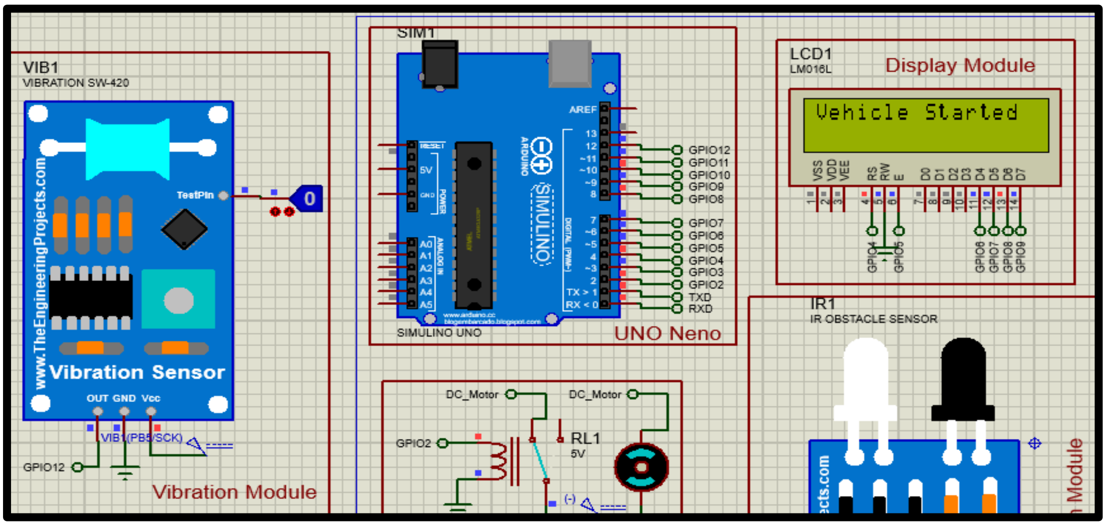

Figure 15 Accident not detected

3.7 Summary

The chapter on "Simulation and Results" serves as a pivotal component in unveiling the intricacies of the study focused on the "Integrated Driver Safety and Emergency Response System" (IDSERS). This section delves into the methodology employed for simulating the proposed system, employing the versatile Proteus software and Arduino programming to control a spectrum of sensors, including IR sensors, Gas sensors, and vibration sensors. Within the simulated environment facilitated by Proteus, the study orchestrates a meticulous examination of the IDSERS under various scenarios. Notably, the simulation encompasses scenarios ranging from accidents to network disruptions and sensor malfunctions, providing a comprehensive testing ground for the envisioned system. This approach is invaluable in assessing the system's robustness and effectiveness in responding to a myriad of potential real-world challenges. An integral aspect highlighted in this chapter is the pivotal role played by Proteus Software and Arduino Programming in shaping a dynamic and interactive simulation platform. The discussion underscores the significance of these tools in creating a virtual space where the IDSERS functionalities can be rigorously examined and fine-tuned. Furthermore, the chapter elucidates the hardware simulation facet, where virtual sensors and actuators emulate the behavior of their physical counterparts. This emulation allows for a nuanced analysis of how the IDSERS components interact in a simulated environment, providing insights into the system's responsiveness and adaptability. As the simulation unfolds, the reader is guided through a detailed exploration of the functionalities and responses of the IDSERS components. The interaction of the Arduino-programmed IR sensors, Gas sensors, and vibration sensors is scrutinized under different simulated scenarios, providing a rich dataset for evaluating the system's performance. This meticulous examination not only contributes to validating the proposed system but also sheds light on potential areas for improvement and optimization. Moreover, the chapter elucidates on the broader implications of utilizing Proteus and Arduino in the simulation process. It accentuates how these tools not only facilitate a realistic representation of sensor behaviors but also offer a platform for iterative refinement. The iterative nature of the simulation process becomes apparent as the study refines and adjusts parameters, aiming to enhance the IDSERS's overall efficacy in mitigating emergency situations. In essence, the chapter on "Simulation and Results" is a crucial juncture in the exploration of the Integrated Driver Safety and Emergency Response System. By providing a detailed account of the simulation methodology, the significance of Proteus Software and Arduino Programming, and the nuanced analysis of system components, this chapter lays the groundwork for a thorough comprehension of the IDSERS's capabilities and its potential impact in real-world scenarios.

CHAPETR NO 4
HARDWARE IMPLEMENTATION

4.1 Introduction

The Integrated Driver Safety in Emergency Response System (IDSERS) is a critical component of the Emergency Response System (ERS) designed to ensure the safety and well-being of drivers in emergency situations. The IDSS hardware implementation aims to detect and prevent driver fatigue, distraction, and other hazardous conditions that could lead to accidents or delayed response times.

In this hardware implementation utilizes sensors to detect the drowsiness & gas. In the case of Emergency activates the ERS in emergency situations, sending alerts and notifications to dispatchers and emergency services & communication module enables real-time communication between the IDSS, ERS, and emergency services for prompt response and assistance.

By integrating these hardware components, the IDSS enhances driver safety, reduces response times, and improves overall emergency response efficiency.

4.2 Arduino Uno

In figure 16 Arduino Uno is shown, is a popular microcontroller board that’s widely used for electronics and coding projects. Here are some key details about it:

- **Microcontroller:** The Uno R3 is based on the ATmega328P microcontroller, which is a versatile and widely used chip in the Arduino family.
- **Digital I/O Pins:** It has 14 digital input/output pins, of which 6 can be used as PWM outputs (for controlling things like servos or LEDs).
- **Analog Inputs:** There are 6 analog inputs, allowing you to read analog signals from sensors or other devices.
- **Clock Speed:** The Uno R3 operates at a 16 MHz clock speed using a ceramic resonator.
- **Connectivity:** It features a USB connection for programming and communication with a computer. Additionally, there’s a power jack for external power supply and an ICSP header for in-circuit programming.

- **Reset Button:** The board includes a reset button for restarting your code or resetting the microcontroller.
- **EEPROM:** The ATmega328P also has 1 KB of EEPROM, which retains data even when powered off.
- **Replaceable Chip:** The ATmega328P is not soldered to the board, so it can be easily replaced if needed.
- **Battery Connector:** The Uno R3 has a barrel plug connector that works well with a standard 9V battery.

Figure 16 Arduino Uno

4.3 GSM Module (SIM800L)

In figure 17 GSM module SIM800L is shown, that provides microcontrollers with GSM functionality. Here are some key details about it:

4.3.1 Pinout Configuration

- **NET:** External antenna attachment pin.
- **VCC:** Power supply pin (input voltage range: 3.4V to 4.4V).
- **RST:** Reset pin (pull low for 100ms to perform a hard reset).
- **RXD:** Serial data input.
- **TXD:** Serial data output.
- **GND:** Module ground reference.
- **SPK:** Speaker differential output (pins 7 and 8).
- **MIC:** Microphone differential input (pins 9 and 10).
- **DTR:** Serial data terminal ready pin (pull high to enable sleep mode).
- **RING:** Interrupt output (active low).

4.3.2 Features and Specifications

- Full modem serial port.
- Two microphone inputs and speaker output.
- SIM card interface.
- Supports FM and PWM.

4.3.3 Equivalent Modules

- For SIM800L: SIM808.
- Other GSM Modules: SIM900, SIM908.

4.3.4 How to Use SIM800L

- The SIM800L communicates via a serial UART interface.
- It recognizes AT commands, allowing you to perform tasks like checking signal strength, getting the SIM card number, network connection status, battery state, and more.

4.3.5 Applications

In this project we use this for the emergency call & SMS.

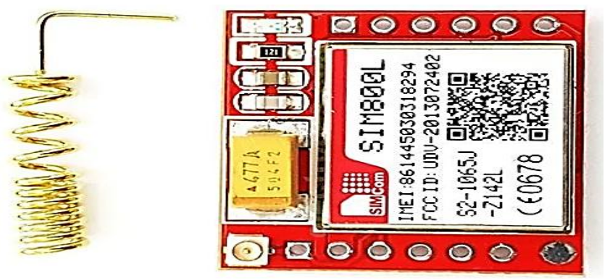

Figure 17 GSM Module (SIM800L)

4.4 GPS Module (NEO6M V2)

In figure 18 GPS module NEO6M V2 is shown, used for navigation. It checks its location on Earth and provides output data, including longitude and latitude coordinates. Here are some key features of the NEO-6MV2 module:

- **Standalone GPS Receiver**: The NEO-6MV2 is a stand-alone GPS receiver featuring the high-performance u-blox 6 positioning engines. It operates independently and doesn't require external assistance.

- **Compact Design**: The module comes in a miniature package (16 x 12.2 x 2.4 mm), making it ideal for battery-operated mobile devices with strict cost and space constraints.
- **Connectivity Options**: It offers multiple connectivity options, including UART (serial communication), SPI, I2C, and USB (by soldering pins to the chip core).
- **Fast Time-to-First-Fix**: It achieves a time-to-first-fix of under 1 second for hot and aided starts. Cold start takes 32 seconds, warm start 23 seconds, and hot start less than 1 second.
- **Receiver Type**: The NEO-6MV2 has 50 channels, operates at GPS L1 frequency, and supports SBAS (WAAS, EGNOS, MSAS, GAGAN).
- **Sensitivity**: With a sensitivity of -160 dBm, it can receive weak signals even in challenging environments.
- **Supply Voltage**: The module operates at a supply voltage of 3.6V.
- **Operating Limits**: It can handle gravity up to 4g, altitude up to 50,000 meters, and velocity up to 500 meters per second.
- **Temperature Range**: The operating temperature range is from -40°C to 85°C.
- **EEPROM with Battery Backup**: The module includes an EEPROM with battery backup for storing configuration settings.

- **Applications**: The NEO-6MV2 is popular among hobbyists and engineers working on navigation-related applications. Its accuracy is sufficient for most use cases, and its inclusion in smartphones and tablets highlights its efficiency1. To use the NEO-6MV2, you can connect it to a microcontroller via UART, set the baud rate, and read the serial data containing longitude and latitude values.

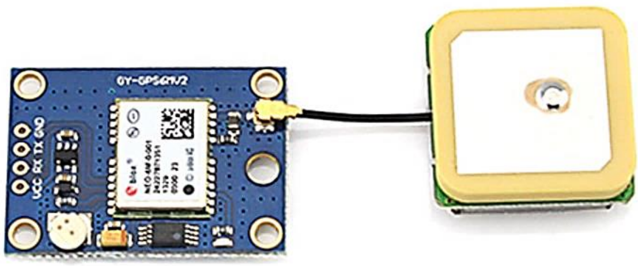

Figure 18 GPS Module (NEO6M V2)

4.5 Eye Blink Sensor (IR)

In figure 19 eye blinking sensor is shown a fascinating piece of technology used to detect eye blinks. Let me break down how it works:

4.5.1 Working Principle

- The sensor relies on the detection and tracking of eye blinks. When we open or close our eyes, unique patterns of eye movements occur, including horizontal rotations.
- These patterns form the basis for accurate sensor readings. The sensor uses light sources such as infrared LEDs or lasers to measure changes in pupil size with extreme precision over time while looking at different positions or directions.
- This technology is valuable in modern security systems, where it quickly detects unauthorized access while providing subtle protection against false accusations.

4.5.2 Hardware Components

The eye blink sensor system consists of two main hardware components:

- **Glasses:** These glasses have an infrared sensor mounted on them. Users can wear them like regular glasses.
- **Infrared Sensor:** The sensor is positioned to align with the user’s eye. It emits an infrared signal and detects blinks. When the user closes their eyes, the sensor provides an output HIGH signal.
- **The infrared sensor has three pins:**
    - **VCC:** 5V input
    - **OUT:** Output based on blink detection
    - **GND:** Ground connection
  - An onboard indicator LED alerts the user when a blink is detected.
  - For more advanced applications (e.g., tracking blink duration or frequency), a microcontroller can be paired with the system.

4.5.3 Software Requirements

- Reading data from the eye blink system is straightforward.
- The software can be simple and minimalistic.

- If additional logic is needed (e.g., recording blink duration or count), a microcontroller can process the data from the sensor.

Figure 19 Eye Blink Sensor (IR)

4.6 ESP32 Controller

The ESP32 is a series of microcontrollers designed by Espressif Systems. They are notable for their low cost, low power consumption, and integrated Wi-Fi and Bluetooth connectivity, making them ideal for Internet of Things (IoT) projects. As a mini-computer, the ESP32 can run programs and control electronic components, enabling devices to connect to the internet and communicate with other devices. Its low-power design makes it suitable for battery-powered applications. In our system, the ESP32 is utilized to remotely switch the system and monitor the level of segregated waste, leveraging its wireless capabilities for efficient and real-time communication. In figure 20 ESP32 controller is shown.

Figure 20 ESP32 Controller

4.6.1 Specifications of the ESP32 Controller

Tensilica Xtensa LX6 microprocessor with one or two cores. Clock speed of up to 240 MHz. Built-in RAM with support for additional external flash memory. Built-in Wi-Fi (supporting 802.11 b/g/n standards). Built-in Bluetooth (including Bluetooth LE). Multiple analog-to-digital converters (ADCs). GPIO pins for connecting to various sensors and components. Designed for low-power operation with various power management features.

4.7 Accelerometer Sensor

The MPU6050 3-axis accelerometer plays a pivotal role in measuring acceleration along the X, Y, and Z axes. With the ability to detect both the Earth's gravity and free-fall conditions, this accelerometer provides precise data for accident detection. Calibration adjustments further enhance accuracy, and Table II provides mathematical abbreviations for interpreting accelerometer and gyroscope values. Further detail about accelerometer sensors is as under:

4.7.1 Importance of accelerometer Sensors

- **Swift accident detection:** Accelerometers play a crucial role in detecting accidents promptly. When sudden deceleration (as in a collision) occurs, the accelerometer triggers relevant safety mechanisms.
- **Enhanced Safety:** By integrating accelerometers into vehicle safety systems, we can improve overall safety by deploying airbags, seatbelt tensioners, and other protective measures.

4.7.2 Applications of accelerometer sensors

In this project accelerometer sensors use for the accident detection.

4.7.3 Working of accelerometer sensors

Accelerometer sensors can be directly mounted on equipment or used wirelessly for monitoring. They measure displacement, velocity, or acceleration of vibration, depending on the sensor type. In figure 21 accelerometer sensor is shown.

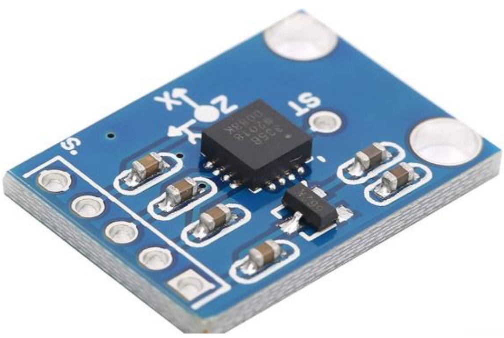

Figure 21 Accelerometer Sensor

4.8 DC-DC Buck Converter

The XL7015 is a 150 KHz fixed frequency PWM buck (step-down) DC/DC converter. It's designed to efficiently convert a higher input voltage to a lower output voltage. In figure 22 DC-DC buck converter is shown, here are some key features and details about the XL7015:

- **Input Voltage Range:** The XL7015 can handle an input voltage range from 0.3V to 100V.
- **Output Voltage:** It allows you to adjust the output voltage from 1.25V to 20V.
- **Maximum Output Current:** The converter is capable of driving a 0.8A load with high efficiency.
- **Efficiency:** It achieves an efficiency of up to 85%.
- **Switching Frequency:** The fixed switching frequency is 150KHz.
- **Duty Cycle:** The maximum duty cycle is 90%.
- **Protection Features:** It includes built-in features such as over-current protection, thermal shutdown, and output short protection.
- **Pin Configuration:**
    - **VIN:** Supply voltage input pin.
    - **SW:** Power switch output pin (supplies power to the output).
    - **GND:** Ground pin (careful layout is essential).
    - **FB:** Feedback pin (senses the output voltage and regulates it).
    - **EN:** Enable pin (drive low to turn on the device, high to turn it off).
- **Package Type:** The XL7015 comes in a TO252-5L package.

Figure 22 DC-DC Buck Converter

4.9 Piezoelectric Buzzer

A piezoelectric buzzer is an audio signaling device that can convert electrical signals into sound. It's commonly used in various applications such as timers, alarm devices, printers, and computers. More details are as under:

4.9.1 Specifications of a Typical Piezoelectric Buzzer

- **Color:** Black
- **Frequency Range:** Approximately 3,300 Hz
- **Operating Temperature:** -20°C to +60°C
- **Operating Voltage:** 3V to 24V DC
- **Sound Pressure Level:** 85 dBA at 10 cm
- **Supply Current:** Below 15 mA

4.9.2 Connection

Piezoelectric buzzers typically have two pins a positive terminal (marked with a '+' symbol or longer terminal) and a negative terminal (marked with a '-' symbol or shorter terminal). Connect the positive terminal to a 6V power supply and the negative terminal to ground (GND).

4.9.3 History

Electromechanical buzzers were invented in 1831 by American scientist Joseph Henry. They were initially used in doorbells but were later replaced by musical bells. Piezoelectric buzzers were developed in the 1970s-1980s by Japanese manufacturers. These buzzers utilize the piezoelectric effect in ceramic materials to create sound. In figure 23 piezoelectric buzzer is shown.

Figure 23 Piezoelectric Buzzer

4.10 Lithium Ion Cell 3.7V 3000mAh

Information about 3.7V rechargeable lithium-ion batteries with a capacity of 3000mAh.

4.10.1 Voltage and Chemistry

The 3.7V voltage is a crucial characteristic of lithium-ion batteries. It results from the electric reaction involving lithium. This voltage level allows efficient energy storage and usage. Lithium-ion batteries are commonly used in small electronic devices like phones, laptops, and cameras due to their 3.7V power level.

The battery's chemistry consists of several components:

- **Positive Electrode (Cathode):** Typically made of lithium cobalt oxide (LiCoO2), it determines the battery's voltage and energy density.
- **Negative Electrode (Anode):** Usually constructed from graphite, it accepts lithium ions during charging and releases them during discharging.
- **Electrolyte:** A liquid or gel-like substance containing lithium ions, facilitating their movement between the cathode and anode.
- **Separator:** A porous membrane that prevents direct contact between the electrodes, allowing lithium ions to pass while blocking electrons.
- **Electrochemical Reactions:** During charging, lithium ions move from the cathode to the anode, storing energy. During discharging, they move back to the cathode, releasing energy.
- **Voltage:** The 3.7V voltage represents the average potential difference between the cathode and anode during the battery's discharge cycle.
- **Energy Density:** Lithium-ion batteries offer high energy density, making them suitable for portable electronic devices.
- **Safety Considerations:** Consumer electronics prefer 3.7V chemistry due to safety concerns associated with higher voltages.

4.10.2 Applications

- **Consumer Electronics:** Powering smartphones, laptops, tablets, wearable devices, digital cameras, camcorders, and portable gaming consoles.
- **General-Purpose Devices:** Toys, GPS devices, drones, Wi-Fi equipment, industry tools, and CCTV cameras. In figure 24 lithium ion cell 3.7V, 300Ah is shown

Figure 24 Lithium Ion Cell 3.7V 3000mAh

4.11 9V Battery

In figure 25 9V battery is shown, a high-capacity and low-cost solution for many electronic devices. It is used with its specific battery snap, connector, or clip. The battery clip can be used to power LEDs or other devices that require a 9V battery. This pack consists of 5 X 9V HW Batteries along with 5 battery clips. If you're working on DIY projects, radios, toys, or other electronic equipment, these batteries are a reliable choice. They come sealed in their original package and have the following specifications:

- **Nominal Voltage:** 9V
- **Discharge Resistance:** 620 Ω
- **Cut-off Voltage:** 5.4V
- **Discharge Time:** 270 hours (at 620 Ω)
- **Jacket Material:** Metal

Figure 25 9V Battery

4.12 Gas Sensor (MQ2)

In figure 26 gas sensor MQ2 is shown, an electronic device used for sensing the concentration of various gases in the air. Furtherer detail is as under:

4.12.1 Working Principle

- The MQ2 sensor is a metal oxide semiconductor (MOS) type gas sensor.
- It contains a sensing material, mainly aluminum-oxide-based ceramic, coated with tin dioxide. This sensing material's resistance changes when it comes in contact with specific gases.
- When the sensor is heated, oxygen gets adsorbed on the surface of the sensing material. Donor electrons in tin oxide are attracted to this oxygen, preventing current flow.
- In the presence of reducing gases, oxygen atoms react with them, decreasing the surface density of adsorbed oxygen. As a result, current can flow through the sensor, generating analog voltage values.
- Higher voltage values indicate higher gas concentrations.

4.12.2 Applications

- The MQ2 gas sensor is commonly used to detect the presence of gases such as LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide.
- It finds applications in:
  - Air quality monitoring
  - Gas leak alarms
  - Maintaining environmental standards in hospitals

4.12.3 Technical Specifications

- **Operating Voltage:** 5V DC
- **Detectable Gases:** LPG, alcohol, propane, hydrogen, CO, and methane
- **Analog Output Voltage:** 0V to 5V
- **Digital Output Voltage:** 0V or 5V (TTL Logic)

- **Preheat Duration:** 20 seconds.

Figure 26 Gas Sensor (MQ2)

4.13 Display Module (LM016 l)

In figure 27 display module LM016l is shown. It's commonly used in various embedded projects due to its affordability, availability, and programmer-friendly features. Let's break down its pinout and features:

- **Vss (Ground):** Connects to the system ground.
- **Vdd (+5 Volt):** Powers the LCD with +5V (in the range of 4.7V to 5.3V).
- **VE (Contrast V):** Determines the contrast level of the display. Grounded for maximum contrast.
- **Register Select:** Connected to the microcontroller to switch between command and data registers.
- **Read/Write:** Used to read or write data. Typically grounded to write data to the LCD.
- **Enable:** Connected to a microcontroller pin and toggled between 1 and 0 for data acknowledgment.
- **Data Pins (0-7):** These form an 8-bit data line. They can be connected to the microcontroller to send 8-bit data. The LCD can also operate in 4-bit mode, in which case data pins 4, 5, 6, and 7 are left free.
- **LED Positive:** Backlight LED pin's positive terminal.
- **LED Negative:** Backlight LED pin's negative terminal.

HD44780 LCD Features and Technical Specifications:

- Operating Voltage: 4.7V to 5.3V
- Current Consumption (without backlight): 1mA

- Alphanumeric display: Can show both alphabets and numbers
- Consists of two rows, each capable of printing 16 characters
- Each character is built by a 5×8-pixel box
- Supports both 8-bit and 4-bit modes

Figure 27 Display Module (LM016 l)

4.14 Hardware Circuit

In figure 28 hardware circuit of IDSERS is shown. All the above pages mentioned components arrange in the circuit.

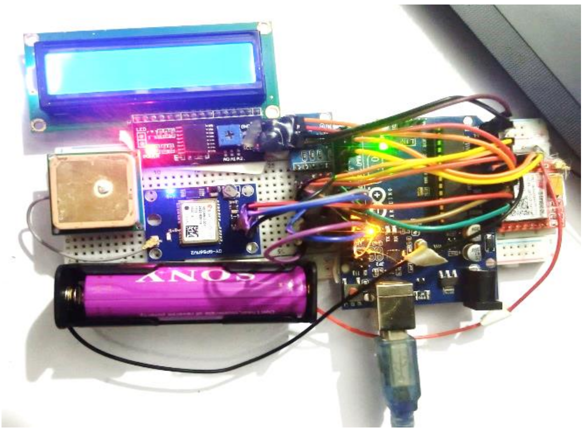

Figure 28 Hardware Circuit

4.15 Working

This system includes an ESP32 connected with an IR sensor that detects drowsiness through an eye-blink sensor. Additionally, there is a gas sensor connected to the ESP32. This is a separate setup. The IR sensor on the ESP32 detects eye-blinks and triggers a buzzer if drowsiness is detected. Similarly, if the gas sensor detects gas, the buzzer attached to the ESP32 will also beep.
The second setup involves a calling system added to an Arduino, along with a GPS system and a GSM calling system with a vibration sensor. The vibration sensor detects accidents. When an accident occurs, it triggers a call and sends an SMS. The provided code includes results showing "calling SMS sent successfully" along with the magnitude of the event. This is the second process.

4.16 Results

In figure 29 shows the final results of the IDSERS system. It gives three outputs that are: Drowsiness detected, Alcohol detected & Accident detected along with magnitude, latitude and longitude and also includes a screenshot of an SMS that has a google maps link which opens to the exact site of the accident.

Figure 29 Results

CHAPTER 5
CONCLUSION AND FUTURE WORK

5.1 Conclusion

The Integrated Driver Safety and Emergency Response System (IDSERS) developed in this thesis represents a significant advancement in the domain of vehicular safety and emergency response. The system's core functionalities—Drowsiness Detection, Accident Detection, and Automatic Emergency Calling—are meticulously designed to address critical issues associated with road safety.

The drowsiness detection component of IDSERS leverages anti-drowsiness detection goggles equipped with advanced sensors and algorithms to monitor driver alertness. This real-time monitoring system is particularly effective in low-light conditions, providing timely alerts to the driver and thereby reducing the likelihood of accidents caused by fatigue. The flexibility and efficiency of this solution mark a considerable improvement over traditional methods, offering a proactive approach to enhancing driver attentiveness.

Accident detection is another crucial feature of IDSERS, implemented through the Quick Accident Response System (QARS). By integrating Arduino Uno and crash sensors, the system can detect collisions promptly. Upon detection, QARS activates the GPS-GSM module, which automatically communicates with Emergency Response Units (ERU), providing precise location data and reducing response times. This automatic notification system is particularly valuable in scenarios where the driver is incapacitated or unable to make a call, ensuring that emergency services are promptly alerted and can respond swiftly.

The automatic emergency calling feature, facilitated by GSM technology, is the third pillar of IDSERS. This function ensures that in the event of an accident, emergency responders receive accurate location information in real time, significantly enhancing the efficiency and effectiveness of the emergency response. The integration of GPS data with GSM communication bridges a critical gap in the emergency response chain, ensuring that help arrives as quickly as possible, potentially saving lives and minimizing the severity of injuries.

Overall, IDSERS represents a holistic approach to addressing the multifaceted challenges of driver safety and emergency response. By combining these three vital components, the system offers a comprehensive solution that not only detects and responds to accidents but also proactively prevents them through drowsiness monitoring. This integrated approach underscores the transformative potential of IDSERS in revolutionizing road safety protocols.

The research and development of IDSERS highlight the importance of technological integration in enhancing road safety. The use of advanced sensors, real-time data processing, and automated communication systems demonstrates how modern technology can be harnessed to create more secure and responsive transportation environments. As traffic incidents continue to pose significant risks, solutions like IDSERS are imperative for mitigating these dangers and improving overall road safety.

In conclusion, the successful implementation of IDSERS demonstrates its potential to significantly reduce the incidence of drowsiness-related accidents, improve emergency response times, and ultimately save lives. This system sets a new benchmark in driver safety technologies, combining innovation with practicality to address some of the most pressing issues in road safety today. Future research and development can further refine and expand the capabilities of IDSERS, continuing the pursuit of safer and more reliable transportation systems.

5.2 Future Work

Advancing IDSERS for Smart Transportation Systems

5.2.1 Enhanced Drowsiness Detection

Investigate additional physiological indicators (e.g., heart rate variability) to improve drowsiness detection accuracy. Explore machine learning techniques for personalized alert thresholds based on individual driver profiles. Collaborate with eyewear manufacturers to integrate detection sensors seamlessly into everyday glasses.

5.2.2 Robust Accident Detection

Extend collision detection beyond vehicular accidents to include pedestrian collisions and near-miss events. Enhance collision severity prediction using multi-sensor fusion (e.g., accelerometer, gyroscope, lidar). Validate the system's performance across diverse road conditions (urban, rural, highways).

5.2.3 Real-Time Emergency Response Optimization

Optimize communication protocols between IDSERS and emergency services for faster response times. Investigate the feasibility of integrating IDSERS with existing traffic management systems. Explore partnerships with emergency response agencies for real-world deployment and testing.

5.2.4 Human-Machine Interaction

Conduct usability studies to assess driver acceptance and trust in IDSERS. Design intuitive user interfaces for seamless interaction with the system. Investigate potential privacy concerns related to continuous monitoring.

5.2.5 Scalability and Deployment

Evaluate the scalability of IDSERS for large-scale adoption in smart cities. Develop cost-effective deployment strategies for widespread implementation. Collaborate with policymakers and urban planners to integrate IDSERS into transportation infrastructure.

CHAPTER 6
BUSINESS PLAN

6.1 Executive Summary

The Integrated Driver Safety and Emergency Response System (IDSERS) addresses critical issues in road safety through innovative technology.

6.1.1 IDSERS integrates three core features

Drowsiness Detection, Accident Detection, and Automatic Emergency Calling via GPS-GSM. This business plan outlines the strategy for developing, manufacturing, marketing, and distributing IDSERS, aiming to enhance driver safety and reduce accident-related fatalities and injuries.

6.2 Company Overview

- **Company Name:** Safe Drive Innovations
- **Mission Statement:** To enhance road safety by leveraging advanced technology for real-time monitoring and rapid emergency response.
- **Vision Statement:** To become a global leader in vehicular safety systems, significantly reducing traffic-related fatalities and injuries.

6.3 Product Description

IDSERS integrates the following features:

6.3.1 Drowsiness Detection

- Anti-drowsiness detection goggles with sensors and algorithms.
- Real-time alertness monitoring and alerts.
- Enhanced performance in low-light conditions.

6.3.2 Accident Detection

- Quick Accident Response System (QARS) utilizing Arduino Uno and crash sensors.
- Automatic activation of GPS-GSM module upon collision detection.

6.3.3 Automatic Emergency Calling

- GPS-GSM module for precise location sharing.
- Automatic communication with Emergency Response Units (ERU).

6.4 Market Analysis

The detail of market analysis mention below in various points:

6.4.1 Target Market

- Individual vehicle owners
- Fleet management companies
- Transportation services (taxis, buses, etc.)
- Commercial vehicle operators

6.4.2 Market Need

- High incidence of accidents due to driver drowsiness and delayed emergency responses.
- Increasing demand for advanced safety features in vehicles.

6.4.3 Competitive Analysis

- Existing safety systems are often standalone and lack integration.
- IDSERS offers a unique, integrated approach, providing a comprehensive solution for driver safety and emergency response.

6.5 Marketing Strategy

6.5.1 Product Positioning

- IDSERS will be positioned as a premium safety solution with unparalleled integration and effectiveness.

6.5.2 Pricing Strategy

- Competitive pricing to attract early adopters while maintaining a margin for sustainability.

6.5.3 Promotion Strategy

- Digital marketing campaigns (social media, search engines).
- Collaborations with automobile manufacturers and fleet operators.
- Demonstrations at automotive safety and technology trade shows.

- Public relations campaigns highlighting successful case studies and testimonials.

6.5.4 Distribution Strategy

- Direct sales through online platforms and company website.
- Partnerships with automobile dealerships and safety equipment retailers.
- Bulk sales agreements with fleet operators and transportation services.

6.6 Operational Plan

6.6.1 Development

- Research and development of hardware and software components.
- Testing and refinement based on user feedback.

6.6.2 Manufacturing:

- In-house manufacturing to reduce cost and maintain high standards.
- Quality control measures to ensure product reliability and safety.

6.6.3 Logistics

- Inventory management systems to track production and sales.
- Reliable shipping partners for domestic and international distribution.

6.7 SWOT Analysis

6.7.1 Strength

The IDSS prioritizes driver safety, reducing the risk of accidents and ensuring timely response to emergencies. Continuous monitoring of driver vital signs, vehicle performance, and environmental factors enables prompt response to potential hazards. IDSS integrates with existing emergency response systems, enhancing overall efficiency and effectiveness. Reduces costs associated with accidents, injuries, and delayed response times.

6.7.2 Weaknesses

IDSERS requires sophisticated hardware and software components, potentially leading to technical issues and maintenance challenges. Handling sensitive driver data raises concerns about privacy and security. Some drivers might resist adopting IDSS due to concerns about monitoring or privacy. IDSERS relies on multiple components, increasing the risk of system failure or malfunction. Requires specialized training and ongoing support for effective implementation and maintenance.

6.7.3 Opportunities

IDSERS can be adapted for various industries, such as logistics, transportation, and healthcare. Advanced data analysis can provide valuable insights into driver behavior, vehicle performance, and emergency response optimization. IDSS can leverage emerging technologies like 5G, AI, and IoT for enhanced performance and efficiency. Governments may offer incentives for adopting IDSS, recognizing its potential to improve public safety. Collaborations with emergency services, insurance providers, and automotive companies can enhance IDSS development and adoption.

6.7.4 Threats

IDSERS is vulnerable to cyberattacks, compromising sensitive data and system integrity. IDSERS must comply with evolving regulations and standards, potentially impacting development and deployment. Negative publicity or concerns about privacy and monitoring could impact IDSS adoption. Rapidly evolving technology can render IDSS components outdated, requiring frequent upgrades. Other safety solutions or emergency response systems may compete with IDSS for market share.

6.8 Marketing communication

In the following aspects of public communications, we consider the inherent strengths and shortcomings and how they are incorporated and applied to our situation. Utilizing social and electronic media, which are currently the most powerful and effective sources for promotion and advertisement, will be key to our strategy. Our marketing communication strategy aims to effectively reach and engage our target audience, highlighting the benefits and innovative features of our Integrated Driver Safety In Emergency Response System.

6.8.1 Advertising

Advertising serves as an informal and sponsored means of educating consumers through radio, news media, online portals, etc., about our goods and services. It is one of the most commonly used marketing tactics, effectively conveying information about our business's goods and services to a broad target audience.

6.8.2 Personal Selling

Marketing involves selling our project through videos and portals. We will demonstrate to our customers how our Integrated Driver Safety In Emergency Response System can meet their needs and help make driver safety more convenient, efficient, and economical.

6.8.3 Direct Marketing

The efficacy of direct marketing can be directly measured. By leveraging this technology, businesses can use emails, faxes, and cell phones to connect with potential clients directly, without involving intermediaries.

6.9 Financial Plan

All the strategy of the financial plan is given below:

6.9.1 Revenue Streams

- Direct sales to consumers.
- Bulk sales to fleet operators and transportation companies.
- Licensing agreements with automobile manufacturers.

6.9.2 Cost Structure

Table 3.1 Cost Structure

Sr	Description	Amount (PKR)
01	Laptop (01)	PKR 45,000/-
02	Electricity (15,000 x 12)	PKR 180,000/-
03	Research and Development	PKR 100,000/-
04	Manufacturing	PKR 35,000/- per unit
05	Marketing and Promotion	PKR 100,000/-
06	Distribution and Logistics	PKR 100,000/-
Total		**PKR 560,000/-**

6.9.3 Pricing

Table 3.2 Pricing

Sr	Description	Amount (PKR)
01	Retail Price per IDSERS unit	PKR 50,000/-
02	Bulk Pricing (10+ units)	PKR 45,000/- per unit

6.9.4 Projected Sales

Table 3.3 Projected Sales

Sr	Description	Units
01	Year 1	50 units
02	Year 2	100 units
03	Year 3	150 units

6.10 Management Team

- **Founder and CEO:** WALID IRFAN KHAN

  Expertise in electrical engineering and technology innovation.

- **Chief Technology Officer (CTO):** ZUBAIR ISHTIAQ

  Responsible for overseeing the development and implementation of IDSERS.

- **Chief Marketing Officer (CMO):** M. AHMAD

  Leads marketing strategies and brand development.

- **Operations Manager:** SHAFAQAT ALI

  Manages manufacturing, logistics, and overall operations.

6.11 Risk Analysis

6.11.1 Market Risks

- Adoption rate of new technology.
- Competition from established safety system manufacturers.

6.11.2 Operational Risks

- Supply chain disruptions.
- Quality control issues.

6.11.3 Mitigation Strategies

- Continuous market research and user feedback integration.
- Strong partnerships with reliable suppliers and manufacturers.
- Rigorous quality assurance processes.

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APPENDIX

```
#include<LiquidCrystal_I2C.h>
#include <AltSoftSerial.h>
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include <math.h>
#include <LCD_I2C.h>
#include<Wire.h>
//must add i2c lcd address use i2c-scanner.ino file
LCD_I2C lcd(0x27, 16, 2);
//-------------------------------------------------------------
//emergency phone number with country code
const String EMERGENCY_PHONE = "+923134357963";
//-------------------------------------------------------------
//GSM Module RX pin to Arduino 3
//GSM Module TX pin to Arduino 2
#define rxPin 2
#define txPin 3
SoftwareSerial sim800(rxPin,txPin);
//-------------------------------------------------------------
//GPS Module RX pin to Arduino 9
//GPS Module TX pin to Arduino 8
AltSoftSerial neogps;
TinyGPSPlus gps;
//-------------------------------------------------------------
String sms_status,sender_number,received_date,msg;
String latitude, longitude;
//-------------------------------------------------------------
#define BUZZER 12
#define BUTTON 11
//-------------------------------------------------------------
#define xPin A1
```

```
#define yPin A2
#define zPin A3
//------------------------------------------------------------
byte updateflag;
int xaxis = 0, yaxis = 0, zaxis = 0;
int deltx = 0, delty = 0, deltz = 0;
int vibration = 2, devibrate = 75;
int magnitude = 0;
int sensitivity = 20;
double angle;
boolean impact_detected = false;
//Used to run impact routine every 2mS.
unsigned long time1;
unsigned long impact_time;
unsigned long alert_delay = 30000; //30 seconds
//------------------------------------------------------------

/*****************************
 * setup() function
 *****************************/
void setup()
{
  //------------------------------------------------------------
  //Serial.println("Arduino serial initialize");
  Serial.begin(9600);
  //------------------------------------------------------------
  //Serial.println("SIM800L serial initialize");
  sim800.begin(9600);
  //------------------------------------------------------------
  //Serial.println("NEO6M serial initialize");
  neogps.begin(9600);
  //------------------------------------------------------------
  pinMode(BUZZER, OUTPUT);
  pinMode(BUTTON, INPUT_PULLUP);
```

```
  //------------------------------------------------------------
  //initialize lcd screen
lcd.begin();
  // turn on the backlight
  lcd.backlight();
  lcd.clear();
  //------------------------------------------------------------
  sms_status = "";
  sender_number="";
  received_date="";
  msg="";
  //------------------------------------------------------------
  sim800.println("AT"); //Check GSM Module
  delay(1000);
  //SendAT("AT", "OK", 2000); //Check GSM Module
  sim800.println("ATE1"); //Echo ON
  delay(1000);
  //SendAT("ATE1", "OK", 2000); //Echo ON
  sim800.println("AT+CPIN?"); //Check SIM ready
  delay(1000);
  //SendAT("AT+CPIN?", "READY", 2000); //Check SIM ready
  sim800.println("AT+CMGF=1"); //SMS text mode
  delay(1000);
  //SendAT("AT+CMGF=1", "OK", 2000); //SMS text mode
  sim800.println("AT+CNMI=1,1,0,0,0"); /// Decides how newly arrived SMS should
be handled
  delay(1000);
  //SendAT("AT+CNMI=1,1,0,0,0", "OK", 2000); //set sms received format
  //AT +CNMI = 2,1,0,0,0 - AT +CNMI = 2,2,0,0,0 (both are same)
  //------------------------------------------------------------
  time1 = micros();
  //Serial.print("time1 = "); Serial.println(time1);
  //------------------------------------------------------------
  //read calibrated values. otherwise false impact will trigger
```

```
  //when you reset your Arduino. (By pressing reset button)
  xaxis = analogRead(xPin);
  yaxis = analogRead(yPin);
  zaxis = analogRead(zPin);
  //-------------------------------------------------------------
}

/*****************************
 * loop() function
 *****************************/
void loop()
{
  //-------------------------------------------------------------
  //call impact routine every 2mS
  if (micros() - time1 > 1999) Impact();
  //-------------------------------------------------------------
  if(updateflag > 0)
  {
    updateflag=0;
    Serial.println("Impact detected!!");
    Serial.print("Magnitude:"); Serial.println(magnitude);

    getGps();
    digitalWrite(BUZZER, HIGH);
    impact_detected = true;
    impact_time = millis();

    lcd.clear();
    lcd.setCursor(0,0); //col=0 row=0
    lcd.print("Crash Detected");
    lcd.setCursor(0,1); //col=0 row=1
    lcd.print("Magnitude:"+String(magnitude));
  }
  //-------------------------------------------------------------
```

```
  if(impact_detected == true)
  {
    if(millis() - impact_time >= alert_delay) {
      digitalWrite(BUZZER, LOW);
      makeCall();
      delay(1000);
      sendAlert();
      impact_detected = false;
      impact_time = 0;
    }
  }
 if(digitalRead(BUTTON) == LOW){
    delay(200);
    digitalWrite(BUZZER, LOW);
    impact_detected = false;
    impact_time = 0;
  }
  //--------------------------------------------------------------
  while(sim800.available()){
    parseData(sim800.readString());
  }
  //--------------------------------------------------------------
  while(Serial.available())  {
    sim800.println(Serial.readString());
  }
  //--------------------------------------------------------------
}

/*****************************
 * Impact() function
 *****************************/
void Impact()
{
  //--------------------------------------------------------------
```

```
  time1 = micros(); // resets time value
  //-------------------------------------------------------------
  int oldx = xaxis; //store previous axis readings for comparison
  int oldy = yaxis;
  int oldz = zaxis;
  xaxis = analogRead(xPin);
  yaxis = analogRead(yPin);
  zaxis = analogRead(zPin);
  //-------------------------------------------------------------
  //loop counter prevents false triggering. Vibration resets if there is an impact. Don't
detect new changes until that "time" has passed.
  vibration--;
  //Serial.print("Vibration = "); Serial.println(vibration);
  if(vibration < 0) vibration = 0;
  //Serial.println("Vibration Reset!");

  if(vibration > 0) return;
  //-------------------------------------------------------------
  deltx = xaxis - oldx;
  delty = yaxis - oldy;
  deltz = zaxis - oldz;

  //Magnitude to calculate force of impact.
  magnitude = sqrt(sq(deltx) + sq(delty) + sq(deltz));

//NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
  if (magnitude >= sensitivity) //impact detected
  {
    updateflag=1;
    // reset anti-vibration counter
    vibration = devibrate;
  }
```

```
//NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
  else
  {
    //if (magnitude > 15)
      //Serial.println(magnitude);         ////chang//
    //reset magnitude of impact to 0
    magnitude=0;
  }

//NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNN
}
/*******************************
 * parseData() function
 *******************************/
void parseData(String buff){
  Serial.println(buff);

  unsigned int len, index;
  //------------------------------------------------------------
  //Remove sent "AT Command" from the response string.
  index = buff.indexOf("\r");
  buff.remove(0, index+2);
  buff.trim();

//NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
  if(buff != "OK"){
    //------------------------------------------------------------
    index = buff.indexOf(":");
    String cmd = buff.substring(0, index);
    cmd.trim();
```

```
  buff.remove(0, index+2);
  //Serial.println(buff);
  //------------------------------------------------------------
  if(cmd == "+CMTI"){
    //get newly arrived memory location and store it in temp
    //temp = 4
    index = buff.indexOf(",");
    String temp = buff.substring(index+1, buff.length());
    temp = "AT+CMGR=" + temp + "\r";
    //AT+CMGR=4 i.e. get message stored at memory location 4
    sim800.println(temp);
  }
  //------------------------------------------------------------
  else if(cmd == "+CMGR"){
    //extractSms(buff);
    //Serial.println(buff.indexOf(EMERGENCY_PHONE));
    if(buff.indexOf(EMERGENCY_PHONE) > 1){
      buff.toLowerCase();
      //Serial.println(buff.indexOf("get gps"));
      if(buff.indexOf("get gps") > 1){
        getGps();
        String sms_data;
        sms_data = "GPS Location Data\r";
        sms_data += "http://maps.google.com/maps?q=loc:";
        sms_data += latitude + "," + longitude;

        sendSms(sms_data);
      }
    }
  }
  //------------------------------------------------------------
}
else{
//The result of AT Command is "OK"
```

```
  }
//NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
}
/******************************
 * getGps() Function
******************************/
void getGps()
{
  // Can take up to 60 seconds
  boolean newData = false;
  for (unsigned long start = millis(); millis() - start < 2000;){
    while (neogps.available()){
      if (gps.encode(neogps.read())){
        newData = true;
        break;
      }
    }
  }

  if (newData) //If newData is true
  {
    latitude = String(gps.location.lat(), 6);
    longitude = String(gps.location.lng(), 6);
    newData = false;
  }
  else {
    Serial.println("No GPS data is available");
    latitude = "";
    longitude = "";
  }
  Serial.print("Latitude= "); Serial.println(latitude);
  Serial.print("Lngitude= "); Serial.println(longitude);
}
```

```
/******************************
* sendAlert() function
******************************/
void sendAlert()
{
  String sms_data;
  sms_data = "Accident Alert!!\r";
  sms_data += "http://maps.google.com/maps?q=loc:";
  sms_data += latitude + "," + longitude;
  sendSms(sms_data);
}
/******************************
* makeCall() function
******************************/
void makeCall()
{
  Serial.println("calling....");
  sim800.println("ATD"+EMERGENCY_PHONE+";");
  delay(20000); //20 sec delay
  sim800.println("ATH");
  delay(1000); //1 sec delay
}
/******************************
 * sendSms() function
 ******************************/
 void sendSms(String text)
{
  //return;
  sim800.print("AT+CMGF=1\r");
  delay(1000);
  sim800.print("AT+CMGS=\""+EMERGENCY_PHONE+"\"\r");
  delay(1000);
  sim800.print(text);
  delay(100);
```

```
  sim800.write(0x1A); //ascii code for ctrl-26 //sim800.println((char)26); //ascii code for ctrl-26
  delay(1000);
  Serial.println("SMS Sent Successfully.");
}
/******************************
 * SendAT() function
 ******************************/
boolean SendAT(String at_command, String expected_answer, unsigned int timeout){
    uint8_t x=0;
    boolean answer=0;
    String response;
    unsigned long previous;
        //Clean the input buffer
    while( sim800.available() > 0) sim800.read();
    sim800.println(at_command);
        x = 0;
    previous = millis();
    //this loop waits for the answer with time out
    do{
        //if there are data in the UART input buffer, reads it and checks for the asnwer
        if(sim800.available() != 0){
            response += sim800.read();
            x++;
            // check if the desired answer (OK) is in the response of the module
            if(response.indexOf(expected_answer) > 0){
                answer = 1;
                break;
            }
        }
    }while((answer == 0) && ((millis() - previous) < timeout));
  Serial.println(response);
  return answer;
}
```