Ain Shams University
Faculty of Computer & Information Sciences
Computer Science Department

Driver Behavior Detection

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This documentation submitted as required for the degree of bachelors in Computer and Information Sciences

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Abstract

Fatigue, drowsiness, distracted driving, and failure to wear a seatbelt are all major issues that contribute to the high number of road accidents and fatalities around the world. These factors can impair a driver's ability to react quickly and make safe decisions while on the road, putting themselves and others at risk. Drowsiness has been identified as a major problem, with many accidents occurring due to drivers falling asleep at the wheel. In addition, distracted driving, which includes talking on the phone or to passengers, and failure to wear a seatbelt, are also significant factors that contribute to road accidents. It is critical to address these issues and take appropriate measures to prevent accidents, save lives, and promote safe driving practices. This includes developing advanced technologies and systems to detect and prevent drowsy and distracted driving, as well as educating drivers and enforcing laws and regulations to encourage seatbelt usage and discourage dangerous driving behaviors. Our system uses AI models to detect signs of drowsiness, distraction, or failure to wear a seatbelt, and alert the driver in real-time to prevent accidents. These systems can use a variety of cameras to monitor the driver's behavior and analyze it for signs of drowsiness or distraction. When a potential hazard is detected, the system can trigger an alarm or warning to alert the driver and encourage them to take corrective action. Such software solutions can make a significant contribution to improving road safety and reducing the number of accidents caused by human error.

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List of Abbreviations

- AI: Artificial Intelligence
- IOT: Internet of Things
- ADAS: Advanced Driver Assistance Systems
- CV: Computer Vision
- ML: Machine Learning
- CNN: Convolutional Neural Network
- ML: Machine Learning
- GPS: Global Positioning System
- RNN: Recurrent Neural Network
- GUI: Graphical User Interface

Chapter One

Introduction

1.1 Problem Definition

Drowsy or distracted driving and driving without wearing a seatbelt are Serious issues that pose a significant risk to road safety. These behaviors can lead to accidents that result in serious injury or death, making it critical to address Them effectively. According to the National Highway Traffic Safety Administration (NHTSA), Drowsy driving is a major contributor to accidents, With an estimated 100,000 crashes, 71,000 injuries, and 1,550 fatalities annually In the United States alone. This highlights the need for solutions that can detect and prevent drowsy driving in real-time to minimize the risk of accidents.[1]

Similarly, Distracted driving is a significant cause of accidents, with the NHTSA reporting that it was a factor in 8.5% of fatal crashes and 15% of injury Crashes in 2019. Distracted driving includes any activity that diverts a driver's attention from the road, including talking on the phone, texting, and eating. This Behavior can significantly impair a driver's ability to react to changing road Conditions, increasing the risk of accidents.

In addition, The NHTSA reports that seatbelt use in passenger vehicles saved an estimated 14,955 lives in 2017 alone. Despite the proven effectiveness of Seatbelts in preventing injuries and fatalities in accidents, many drivers continue to ignore this safety measure. This highlights the need for solutions that can Encourage drivers to wear their seatbelts and enforce seatbelt usage through Education and law enforcement.

The statistics on the risks of drowsy, distracted, and unrestrained driving demonstrate the urgent need for effective solutions to address these issues. AI-powered systems can be a valuable tool in this effort, providing real-time monitoring and alerts to drivers when they engage in risky behaviors. These systems can help prevent accidents and save lives by detecting and alerting drivers to the dangers of drowsy or distracted driving, as well as encouraging seatbelt usage. By addressing these issues, We can significantly improve road safety and reduce the number of accidents and fatalities caused by human error.[2]

1.2 Motivation

The motivation behind the driver behavior detection software project is to improve road safety and reduce the number of accidents caused by human error. The software is based on deep learning, that uses neural networks to analyze and interpret complex data.[12]

The software is designed to detect signs of risky driving behaviors, such as drowsiness, distraction, and failure to wear a seatbelt, which can significantly increase the likelihood of accidents and fatalities on the road. The deep learning model is trained on large volumes of data to accurately detect and classify these behaviors in real-time. When the software detects signs of risky behavior, such as closed eyes or a lack of seatbelt use, it triggers an alert to the driver. The alert can take the form of a loud sound or other visual or audio cue, alerting the driver to stay focused and avoid putting themselves and others at risk.[4],[18]

The software is designed to be user-friendly and accessible, ensuring that drivers of all skill levels can use it effectively. By providing real-time alerts and warnings, the software can help drivers stay aware of potential hazards on the road and take corrective action to prevent accidents.[15]

The motivation behind the driver behavior detection software project is to make a meaningful contribution to improving road safety and reducing the number of accidents and fatalities caused by human error. By developing a reliable and accessible software system that uses deep learning to detect and prevent risky driving behaviors, The project aims to promote safe driving practices and help drivers stay safe on the road.[12]

Overall, the project represents a significant step towards reducing the number of accidents caused by human error and saving lives. By providing accessible software solutions that can be used by drivers of all vehicles, The project aims to make a meaningful contribution to improving road safety and reducing the number of accidents and fatalities caused by distracted or drowsy driving.[1]

1.3 Objectives

The main objective of the driver behavior detection software project is to enhance road safety by developing a highly accurate and reliable system that can detect risky driving behaviors in real-time. The software is specifically designed to detect signs of drowsiness, distraction, and failure to wear a seatbelt, which are among the most common causes of accidents on the road.[1][4]

To achieve this objective, the system uses advanced algorithms based on deep learning to analyze driver behavior and identify potential hazards. For instance, the software can detect when a driver's eyes are closed for a certain amount of time, which is a clear sign of drowsiness. Similarly, the system can detect when a driver is not wearing their seatbelt or engaging in distracting activities such as using a mobile phone while driving.[1],[18]

When the system detects signs of risky behavior, it triggers an alert to the driver, such as a loud sound or other audio or visual cues. This alert is designed to immediately grab the driver's attention and encourage them to take corrective action to avoid potential accidents.

The software is designed to be user-friendly and easy to use, ensuring that drivers of all skill levels can utilize it effectively. The system can be integrated into various types of vehicles, including cars, trucks, and buses, and can be customized to meet the specific needs of different driving environments.

Overall, the project's objective is to develop a highly reliable and accurate driver behavior detection software system that can promote safe driving practices and prevent accidents caused by human error. By detecting and alerting drivers to potential hazards in real-time, the system aims to help drivers stay aware and focused on the road, reducing the risk of accidents and saving lives.

1.4 Methodology

We use many Scientific methods in our system such as:

1)**VGG16:** VGG16 is a deep convolutional neural network architecture that was developed by the Visual Geometry Group (VGG) at the University of Oxford. It consists of 16 layers and has been widely used for image classification tasks due to its simplicity and high accuracy.[13]

2) **VGG19:** VGG19 is a variation of the VGG16 architecture, which consists of 19 layers. It has a deeper architecture than VGG16 and can provide higher accuracy for image classification tasks.

3) **MobileNet:** MobileNet is a lightweight convolutional neural network architecture that was specifically designed for mobile and embedded devices. It uses techniques such as depth wise separable convolutions to reduce the number of parameters and computation required while maintaining high accuracy.[20]

4) **ResNet:** ResNet is a deep convolutional neural network architecture that introduced the concept of residual learning, which allows for the building of much deeper networks. ResNet architectures have been shown to achieve state-of-the-art performance on a wide range of image recognition tasks.[13]

5) **GoogleNet:** GoogleNet, also known as Inception-v1, is a deep convolutional neural network architecture developed by Google. It uses a combination of 1x1, 3x3, and 5x5 convolutions along with max pooling to create a network with a large number of layers while keeping the computation requirements low.[13]

6) **EfficientNet:** EfficientNet is a family of convolutional neural network architectures that were designed using a neural architecture search algorithm. It uses a combination of scaling techniques to balance model size, accuracy, and computation requirements, resulting in highly efficient and accurate models.[20]

7) **Haar cascades:** Haar cascades are a popular machine learning-based object detection algorithm used in computer vision. This algorithm is based on a set of features known as Haar features, which are used to detect edges, corners, and

other features of an object. A Haar cascade consists of a cascade of classifiers, each of which is trained to identify a specific feature of the object being detected. The Haar cascade algorithm is efficient and can be used in real-time applications, such as face detection in video streams.[15]

8) **Feature extraction:** Feature extraction is a process of identifying and extracting important features from images or other data sources. In computer vision, feature extraction involves identifying patterns or key points in an image that can be used to classify or identify objects. Common feature extraction techniques include edge detection, corner detection, and scale-invariant feature transform (SIFT). Feature extraction is an important step in many computer vision applications, such as object recognition, image search, and autonomous driving. Once features are extracted, machine learning algorithms can be trained to recognize patterns and classify objects based on those features.[7]

1.5 Time plan

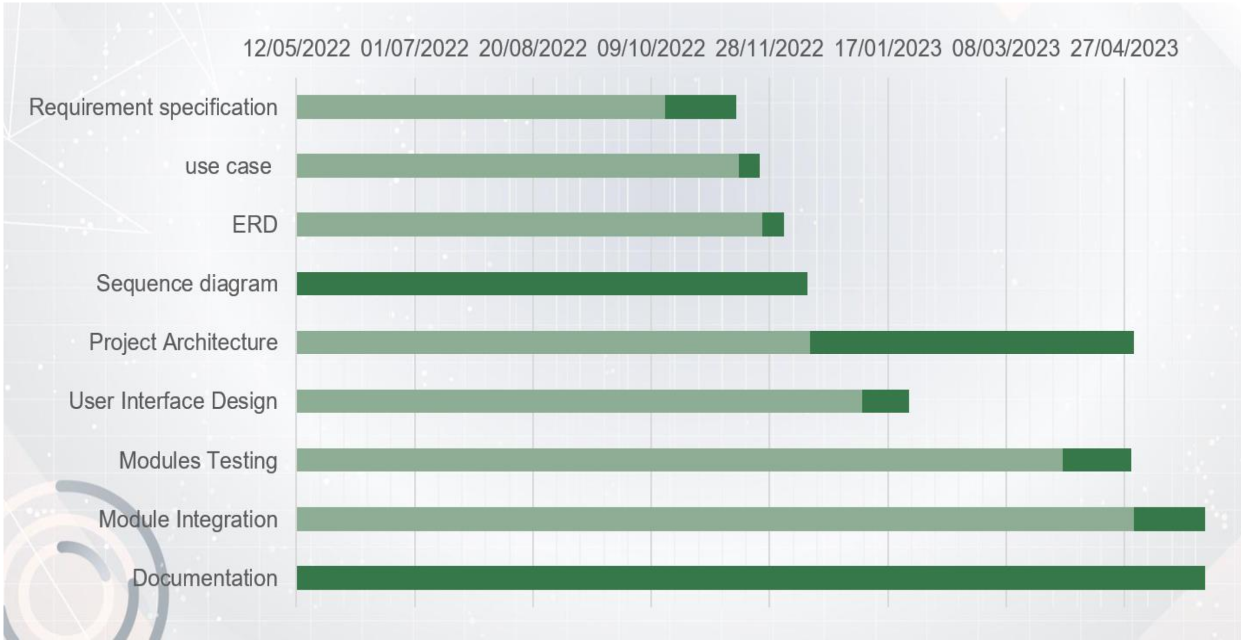


Figure 1:Time plan

Phase 1: **Requirement Specification**
Duration: 30 days (15/10/2022 - 14/11/2022)
Tasks: Search and gather information regarding the domain of the project.

Phase 2: Use Case
Duration: 9 days (15/11/2022 - 24/11/2022)
Tasks: Identify the use cases for the system.

Phase 3: ERD
Duration: 9 days (25/11/2022 - 04/12/2022)
Tasks: Create the Entity-Relationship Diagram for the system.

Phase 4: Sequence Diagram
Duration: 216 days (12/05/2022 - 14/12/2022)
Tasks: Develop the system architecture and sequence diagrams.

Phase 5: Project Architecture
Duration: 137 days (15/12/2022 - 01/05/2023)
Tasks: Design and develop the project architecture.

Phase 6: User Interface Design
Duration: 20 days (06/01/2023 - 26/01/2023)
Tasks: Design the user interface for the system.

Phase 7: Modules Testing
Duration: 29 days (01/04/2023 - 30/04/2023)
Tasks: Test the individual modules of the system.

Phase 8: Module Integration
Duration: 30 days (01/05/2023 - 31/05/2023)
Tasks: Integrate the individual modules of the system.

Phase 9: Documentation
Duration: 384 days (12/05/2022 - 31/05/2023)
Tasks: Document all aspects of the project.

1.6 Thesis Outline

The rest of the documentation is divided as follows:

Chapter 2, **Literature Review**:
presents a detailed description of the field of the project, survey of the works done in the field, and description of existing similar systems.

Chapter 3, System Architecture and Methods:
displays system architecture diagram along with detailed description of each module and the CNN models architecture in system.[3]

Chapter 4, **System Implementation and Results**:
describes in detail all functions, techniques and algorithms implemented in the system. The chapter explains libraries used in project implementation, datasets and the preprocessing for each dataset, models building, training and performance, project classes, system integration, UI design and finally, the testing.

Chapter 5, **Run the Application**:
presents a complete user guide showing how to operate the project along with the required third-part program.

Finally, chapter 6, **Conclusion and Future Work**:
provides a complete summary of the whole project along with the results obtained, and ideas of what can be done in the future to improve the performance of the project.

Chapter Two

Literature Review

2.1 Introduction about the project.

The development of driver behavior detection technology has the potential to revolutionize road safety and save countless lives. By detecting signs of distracted, drowsy, or unsafe driving behaviors, this technology can alert drivers in real-time, helping them to stay focused on the road and avoid accidents.[1]

Distracted driving is a growing concern on our roads today. With the rise of smartphones and other mobile devices, drivers are increasingly at risk of becoming distracted while behind the wheel. In 2018 alone, Distracted driving claimed the lives of 2,841 people, according to the National Highway Traffic Safety Administration. By detecting when drivers are using their phones or engaging in other distracting activities, driver behavior detection technology can help prevent accidents and save lives.

Drowsy driving is another significant issue that contributes to accidents on our roads. The National Sleep Foundation estimates that drowsy driving causes up to 6,000 fatal crashes each year. By detecting when drivers are becoming drowsy and alerting them to take a break or switch drivers, driver behavior detection technology can help prevent accidents caused by fatigue.[2]

Drinking, and talking on the phone are also common distractions that can contribute to accidents. By alerting drivers when they are engaging in these activities, driver behavior detection technology can help them stay focused on the road and avoid accidents.[4][7]
One of the most effective ways to capture the driver's attention and ensure that they take corrective action is with a loud alert. This technology can be integrated into existing safety systems like seat belts and airbags, providing an extra layer of protection for drivers and passengers.

Overall, the development of driver behavior detection technology is a critical step towards improving road safety and reducing the number of accidents caused by human error. By alerting drivers in real-time to potential hazards and unsafe driving behaviors, this technology has the potential to save countless lives and make our roads safer for everyone.[15]

2.2 Background

2.2.1 Artificial Intelligence

2.2.1.1 Artificial Intelligence

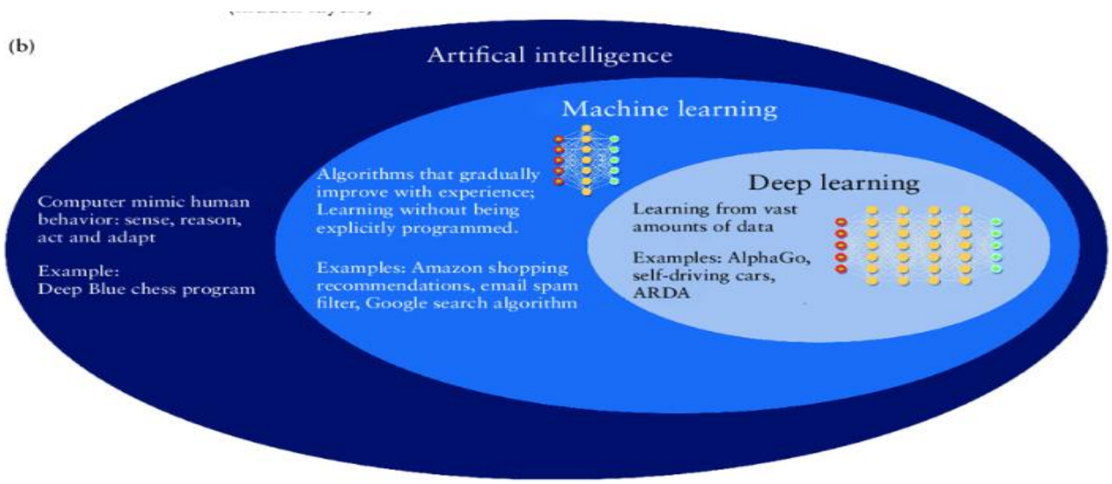


Figure 2.2: Artificial Intelligence

Artificial intelligence, or AI, involves creating machines that can simulate and replicate human intelligence by performing tasks that typically require human cognitive abilities. This can include learning, problem-solving, and decision-making. The term can also be used to describe any machine that displays characteristics commonly associated with human thinking, such as the ability to learn and solve problems.[21]

2.2.1.2 Applications for artificial

Artificial intelligence has limitless possibilities when it comes to its applications in various sectors and industries. In healthcare, AI is currently being experimented with and utilized for tasks such as customizing drug dosages and treatments for individual patients, as well as assisting with surgical procedures in the operating room.[21]

2.2.1.3 Types of Artificial Intelligence

Artificial Intelligence can be broadly divided into two categories: AI based on capability and AI based on functionality. Let’s understand each type in detail.[21]

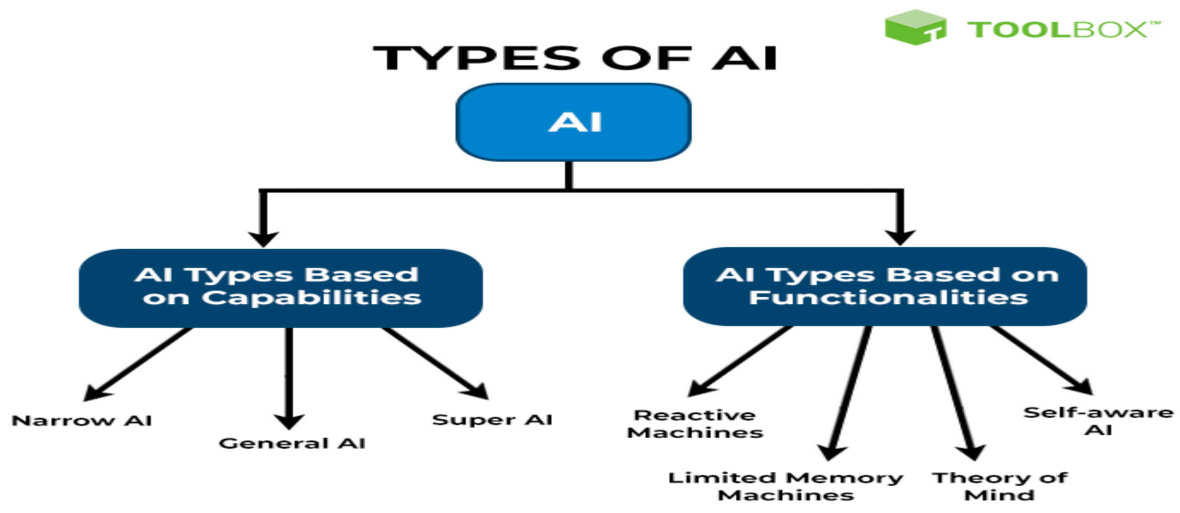


Figure 2.2: Types of AI

Let’s first look at the types of AI based on capability.

1. **Narrow AI**

   Narrow AI, also known as weak AI, is designed to perform specific tasks and operate within a limited and predefined set of parameters, constraints, and contexts. The machine intelligence that we see around us today is a form of narrow AI, which includes Apple's Siri and IBM's Watson supercomputer. Examples of narrow AI applications include Netflix recommendations, purchase suggestions on e-commerce sites, autonomous cars, and speech and image recognition.[21]

2. **General AI**

   General AI refers to an AI system that can perform any intellectual task with the same efficiency as humans. The goal of general AI is to create a system that can think for itself, like humans. However, developing such a system is still under research, and scientists are working to enhance machines' cognitive capabilities.[21]

3. **Super AI**

   Super AI is an AI system that has the ability to perform any task better than humans and surpasses human intelligence. Machines with super AI possess advanced capabilities such as independent thinking, reasoning, problem-solving, decision-making, learning, and communication. Currently, super AI is a hypothetical concept, but it represents the future of AI.[21][25]

4. **Reactive machines**

   Reactive machines are a fundamental type of AI that do not store past experiences or memories for future actions. These systems focus on current scenarios and respond to them based on the best possible action. Examples of reactive machines include IBM's Deep Blue and Google's AlphaGo.[21]

5. **Limited memory machines**

   Limited memory machines are capable of storing and utilizing past experiences or data for a brief period of time. A self-driving car, for instance, can store relevant information such as the speeds of vehicles in its vicinity, their distances, speed limits, and other pertinent data to navigate through traffic.[21]

6. **Theory of mind**

   Theory of mind is an AI concept that involves the ability to comprehend human emotions, beliefs, and social interactions, similar to humans. However, this type of AI has yet to be developed and is a topic of discussion for the future.[21]

7. **Self-aware AI**

   Self-aware AI pertains to super-intelligent machines that possess consciousness, emotions, sentiments, and beliefs. These systems are anticipated to be more intelligent than the human mind and potentially surpass us in assigned tasks. Although self-aware AI remains a distant reality, research efforts are underway in this direction.[21]

2.2.1.4 AI works:

The first step in an AI system is to receive input data in various forms, such as speech, text, or images. This data is then processed using algorithms and rules to interpret, predict and take action based on the input. The system then produces an output, either indicating success or failure in processing the input data. This output is further analyzed, explored and evaluated to provide feedback. Finally, the system uses this feedback to refine its input data, rules, algorithms, and target outcomes.[21]

2.2.1.5 Key Components of AI

Artificial Intelligence (AI) is composed of several key components, which include Machine Learning, Deep Learning, Neural Networks, Cognitive Computing, Natural Language Processing (NLP), and Computer Vision, as depicted in Figure 2.2.

Machine learning is an AI application that learns and improves automatically from previous experiences without requiring explicit programming. Deep learning is a subset of machine learning that processes data using artificial neural networks. Neural networks are computer systems modeled on neural connections in the human brain and enable deep learning.[7]

Cognitive computing aims to recreate the human thought process in a computer model and seeks to improve the interaction between humans and machines by understanding human language and image meaning. NLP is a tool that enables computers to recognize, interpret, and produce human language and speech.

Computer vision uses deep learning and pattern identification to interpret various image contents, such as graphs, tables, PDF pictures, and videos.

2.2.2 Deep Learning:

2.2.2.1 Deep Learning definition

Deep learning is a specialized form of machine learning that involves neural networks with three or more layers. These networks are designed to simulate the behavior of the human brain, although they are far from being able to match its full capability. By working with vast amounts of data, deep learning enables the network to "learn" and identify patterns and trends.[7][12]

A neural network with a single layer can still provide approximate predictions. However, the addition of hidden layers improves the accuracy of the network by optimizing and refining the learned information.

2.2.2.2 Deep Learning Neural Network Architecture

Figure 2.2.2 illustrates the typical architecture of a neural network, which comprises multiple layers. The first layer is referred to as the input layer, which receives the input data x that the neural network uses to learn. For example, in the case of classifying handwritten numbers, x would represent the images of the numbers, where each entry in the vector x is a pixel.

The number of neurons in the input layer is equal to the number of entries in vector x, and each input neuron corresponds to one element in the vector. The output layer, on the other hand, generates a vector y that represents the neural network's outcome, with each neuron in the last layer representing a different class in the classification problem.

The hidden layers between the input and output layers perform mathematical operations that allow the neural network to learn from the input data. The connections between these layers determine the information flow through the network.

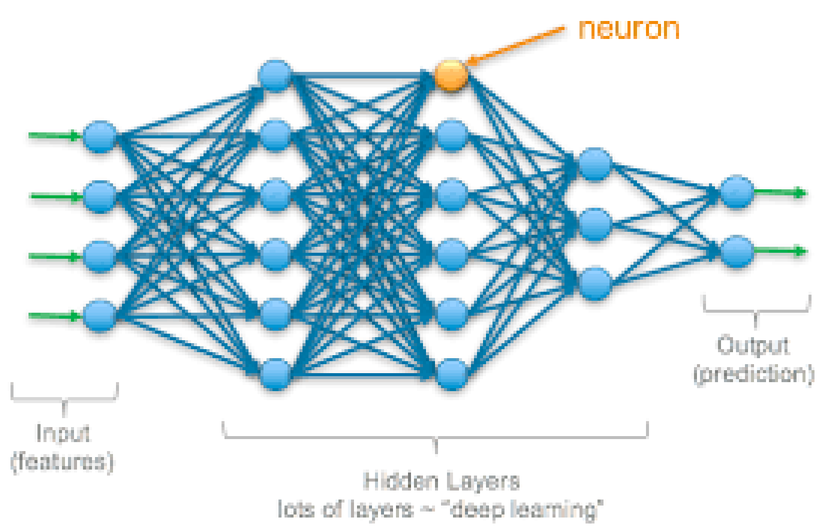


Figure 2.3: Deep Learning Neural

2.2.3 Convolution Neural Network (CNN):

2.2.3.1 Introduction Of CNN:

Over the past few decades, Deep Learning has demonstrated its potency in handling massive amounts of data. It has surpassed traditional techniques in pattern recognition, primarily due to its ability to utilize hidden layers. Among the most well-known deep neural networks is the Convolutional Neural Network (CNN) in deep learning.

CNNs were first developed and employed in the 1980s, primarily for recognizing handwritten digits, particularly in the postal industry for reading zip codes and pin codes. However, the significant drawback of CNNs at that time was their requirement for a large amount of data to train and extensive computing resources to function, which limited their usage to the postal sector only, preventing them from entering the world of machine learning.[3]

In 2012, Alex Krizhevsky recognized the need to revive the branch of deep learning that employs multi-layered neural networks. The availability of vast datasets, specifically the ImageNet datasets that contain millions of labeled images, and an abundance of computing resources enabled researchers to revitalize CNNs.[3][12]

2.2.3.2 CNN:

Is a Convolutional Neural Networks (CNNs) are a type of artificial neural network widely used in deep learning to process and analyze visual imagery recognition. Unlike traditional neural networks, CNNs are specifically designed to scrutinize pixel data, making them more effective and efficient in image processing and natural language processing. They find application in various computer vision tasks such as image and video recognition, image classification, image segmentation, medical image analysis, as well as time series and brain-computer interfaces.[3][11]

2.2.3.3 Applications of Convolutional Neural Networks:

1)Medical imaging

CNNs are a valuable tool in medical imaging for achieving higher accuracy in identifying tumors or other anomalies in X-ray and MRI images. By analyzing previously processed images with CNN networks, models can scrutinize an image of a human body part, such as the lungs, and accurately pinpoint the location of a tumor or other anomalies, such as broken bones in X-ray images.[3]

Similarly, medical images like CT scans and mammograms play a significant role in diagnosing cancer. CNN models compare the image of a patient with database images that contain similar features to determine whether any indicators within the picture indicate malignancy or damage to cells due to hereditary or environmental factors, such as smoking habits.[3]

2) Document analysis

Convolutional Neural Networks (CNNs) have a notable impact on document analysis, in addition to their usefulness in handwriting analysis. When processing someone's writing and comparing it to an extensive database, a machine must execute approximately a million commands per minute. CNN networks can help recognize words and phrases associated with the document's subject by utilizing both textual and visual data, leading to a better understanding of the written content.[3][11]

3) Autonomous driving

Convolutional Neural Networks (CNNs) are widely used to model spatial information in images. They are considered universal non-linear function approximators because of their exceptional capability to extract features from images, including obstacles and street signs. As the depth of the network increases, CNNs can detect a wide range of patterns. For instance, the initial layers of the network will capture edges, while the deeper layers will identify more complex features, such as the shape of an object, like leaves in trees or tires on a vehicle. Consequently, CNNs are the primary algorithm employed in self-driving cars.[3][11]

4) Biometric authentication

Convolutional Neural Networks (CNNs) are employed in biometric identification of user identity by identifying specific physical traits associated with a person's face. By training CNN models on images or videos of individuals, specific facial features such as the distance between the eyes, the shape of the nose, the curvature of the lips, and more can be identified. In addition, CNN models have demonstrated the ability to recognize various emotional states, such as happiness or sadness, based on images or videos of people's faces. CNNs can also determine whether the subject is blinking in a photo and assess the overall shape of multiple-frame facial images. [3][11]

2.3 About the field of the project

Driver behavior is a critical factor in determining road safety for all road users. The way a driver behaves on the road can have a significant impact on the safety of themselves, their passengers, and other road users, including pedestrians, cyclists, and other drivers. Poor driver behavior can lead to a range of risks, problems, and negative effects, including:

1. Distracted driving: One of the most common problems associated with driver behavior is distracted driving. This can include anything that takes a driver's attention away from the road, such as using a mobile phone, drinking, or even talking to passengers. Distracted driving can significantly increase the risk of accidents.

Figure 3.4: Distracted driving

2. Aggressive driving: Aggressive driving is another common problem that can lead to increased risks on the road. This can include behaviors such as speeding, tailgating, weaving in and out of traffic, and failing to yield to other drivers. Aggressive driving can lead to road rage, accidents, and even fatalities.
3. Impaired driving: Driving under the influence of drugs or alcohol is a significant risk factor that can lead to accidents and fatalities. Impaired drivers have reduced reaction times, impaired judgment, and decreased motor skills, which can make it difficult to drive safely.

4. Fatigued driving: Drivers who are fatigued or sleepy can also be a significant risk on the road. Fatigue can impair driving ability, reduce reaction times, and increase the likelihood of accidents.

5. Speeding: Excessive speeding is a significant risk factor that can lead to accidents and fatalities. Drivers who exceed the posted speed limit have less time to react to hazards and are more likely to lose control of their vehicle.

The effects of poor driver behavior can be far-reaching and can include physical injuries, property damage, emotional trauma, and even death. Accidents caused by poor driver behavior can also result in significant financial costs, including medical expenses, property damage, and legal fees.

In conclusion, driver behavior is a crucial factor in determining road safety, and poor driver behavior can lead to significant risks, problems, and negative effects. Drivers must take responsibility for their behavior on the road and ensure they are always driving safely and responsibly. By promoting safe driving practices and using effective strategies to address poor driver behavior, we can work towards a safer and more sustainable transportation system for all road users.

2.4 All the scientific background related to the project.

the scientific background related to the project of driver behavior detection, focusing on machine learning, deep learning, and Flutter:

1. Machine learning: Machine learning is a branch of artificial intelligence that focuses on developing algorithms that can learn and make predictions based on data. In the context of driver behavior detection, machine learning algorithms can be used to analyze large amounts of data from sensors and cameras, identify patterns, and predict behavior. [7]

2. Deep learning: Deep learning is a subfield of machine learning that focuses on developing algorithms that can learn from large and complex datasets. In the context of driver behavior detection, deep learning algorithms can be used to analyze images and video data, identify patterns, and classify behavior. For

example, deep learning algorithms can be used to detect when a driver is using their phone while driving, based on data from a camera.[12]

3. Flutter: Flutter is an open-source mobile application development framework developed by Google. It allows developers to build high-performance, cross-platform mobile applications using a single codebase. In the context of driver behavior detection, Flutter can be used to develop mobile applications that can collect data from sensors and cameras, analyze the data using machine learning or deep learning algorithms, and provide real-time feedback to the driver.

Overall, the scientific background related to driver behavior detection is multidisciplinary, drawing on research in machine learning, deep learning, and mobile application development frameworks such as Flutter. By integrating these scientific concepts and techniques, researchers and developers can build more effective and reliable driver behavior detection systems, which can help to improve road safety for all road users.[7]

2.5 Survey about the work done in this field.

Driver behavior analysis and monitoring is a rapidly growing field that has seen significant research and development in recent years. The goal of this field is to improve road safety by monitoring and analyzing driver behavior, providing feedback to drivers, and helping to prevent accidents on the road.

One area of research focuses on using machine learning algorithms to analyze and predict driver behavior. These algorithms can analyze data from various sensors, including GPS, accelerometers, and cameras, to identify patterns and predict risky behavior, such as speeding or distracted driving. This research has resulted in the development of several predictive models that can accurately predict driver behavior, allowing for the early identification of potential risks.

Another area of research focuses on using smartphone sensors, such as GPS and accelerometer, to monitor driver behavior. Several mobile apps have been developed that use these sensors to track driver behavior, provide real-time feedback, and encourage safe driving habits. These apps are becoming increasingly popular among drivers and can help to reduce the risks associated with distracted driving and other risky behaviors.

Many companies with commercial vehicle fleets have implemented driver behavior monitoring systems to improve safety and reduce costs associated with accidents. These systems can track vehicle speed, location, and other data, as well as monitor driver behavior, such as harsh braking or acceleration. They can also provide real-time feedback to drivers and generate reports for management. This research has resulted in the development of several commercial driver behavior monitoring systems that are now widely used by companies with commercial vehicle fleets.[15]

As autonomous vehicles become more prevalent, researchers have also explored ways to monitor driver behavior in these vehicles. This includes using sensors and cameras to detect driver behavior, such as fatigue or distraction, and alerting the driver if necessary. This research has important implications for the future of autonomous vehicles and can help to ensure that they are operated safely and efficiently.[4][8]

Finally, some studies have focused on monitoring driver behavior for elderly and disabled drivers, who may have difficulty driving safely. These systems can monitor driver behavior and provide feedback to help these drivers improve their driving skills and stay safe on the road. This research has important implications for the health and safety of elderly and disabled drivers, as well as for their families and caregivers.

Overall, the research and development in the field of driver behavior analysis and monitoring is making it easier to monitor driver behavior and provide real-time feedback to drivers, which can help to reduce the risks associated with poor driving behavior. As new technologies continue to emerge, it is likely that this field will continue to grow and evolve, leading to even more advanced and effective driver behavior monitoring systems in the future.

2.6 Similar existing systems that help drivers.

There are several driver behaviors monitoring systems that users can download and use on their personal devices. Here are some examples:

1. **LifeSaver**: LifeSaver is a mobile app that uses GPS to monitor and prevent distracted driving. It can detect when a user is driving and automatically disables their phone's ability to send or receive text messages and phone calls. The app also rewards safe driving behavior with points and badges.

2. **SafeDrive**: SafeDrive is another mobile app that uses GPS to monitor driver behavior. It rewards users for safe driving by giving them points, which can be redeemed for discounts at partner retailers. The app also includes features such as leaderboards and challenges to encourage safe driving.

3. **TrueMotion**: TrueMotion is a mobile app that uses smartphone sensors to track driver behavior, such as speeding, hard braking, and phone use while driving. It provides users with a score based on their driving behavior and offers tips and advice to help them improve their score.

4. **Drivemode**: Drivemode is a mobile app that provides a simplified, voice-activated interface for users while driving. It allows users to control their phone's functions hands-free, reducing the risk of distracted driving. The app also includes features such as voice-activated navigation and music controls.

5. **DriveSafe.ly**: DriveSafe.ly is a mobile app that reads text messages and emails aloud to users while driving, reducing the need for users to take their eyes off the road. The app is compatible with several messaging and email apps and is available in multiple languages.

Overall, this driver behavior monitoring systems are designed to help users improve their driving behavior and reduce the risk of accidents on the road. Each system has its own unique features and capabilities, and users should choose the system that best meets their needs and preferences.

2.7 Examples of the technologies used in this field.

There are several technologies used in the field of driver behavior analysis and road safety, including:

1. **Bluetooth**: Bluetooth technology is commonly used in hands-free phone systems and in-car entertainment systems. It can also be used to track driver behavior, such as monitoring the use of mobile phones while driving.[23]

2. **GPS**: Global Positioning System (GPS) technology is used for navigation and tracking purposes. It can be used to track vehicle speed, location, and route taken. GPS can also be used to monitor and analyze driver behavior, such as speeding or reckless driving.[23]

3. **Telematics**: Telematics is a technology that combines GPS, cellular communication, and on-board diagnostics to track and analyze vehicle data. This technology can be used to monitor driver behavior, such as fuel consumption, acceleration, and braking patterns. It can also be used to provide real-time feedback to drivers to improve their behavior on the road.[15][23]

4. **Cameras**: Dash cameras and other on-board cameras can be used to record driver’s behavior and provide evidence in the event of an accident. They can also be used to monitor driver behavior, such as checking for distracted driving or drowsiness.[9][17]

5. **Sensors**: Sensors can be installed in vehicles to detect driver behavior, such as sudden braking or swerving. These sensors can be used to provide feedback to drivers to improve their behavior on the road.

Overall, these technologies can be used to improve road safety by monitoring and analyzing driver behavior, providing feedback to drivers, and helping to prevent accidents on the road.[23]

Chapter Three

System Architecture and Methods

3.1 System Architecture:

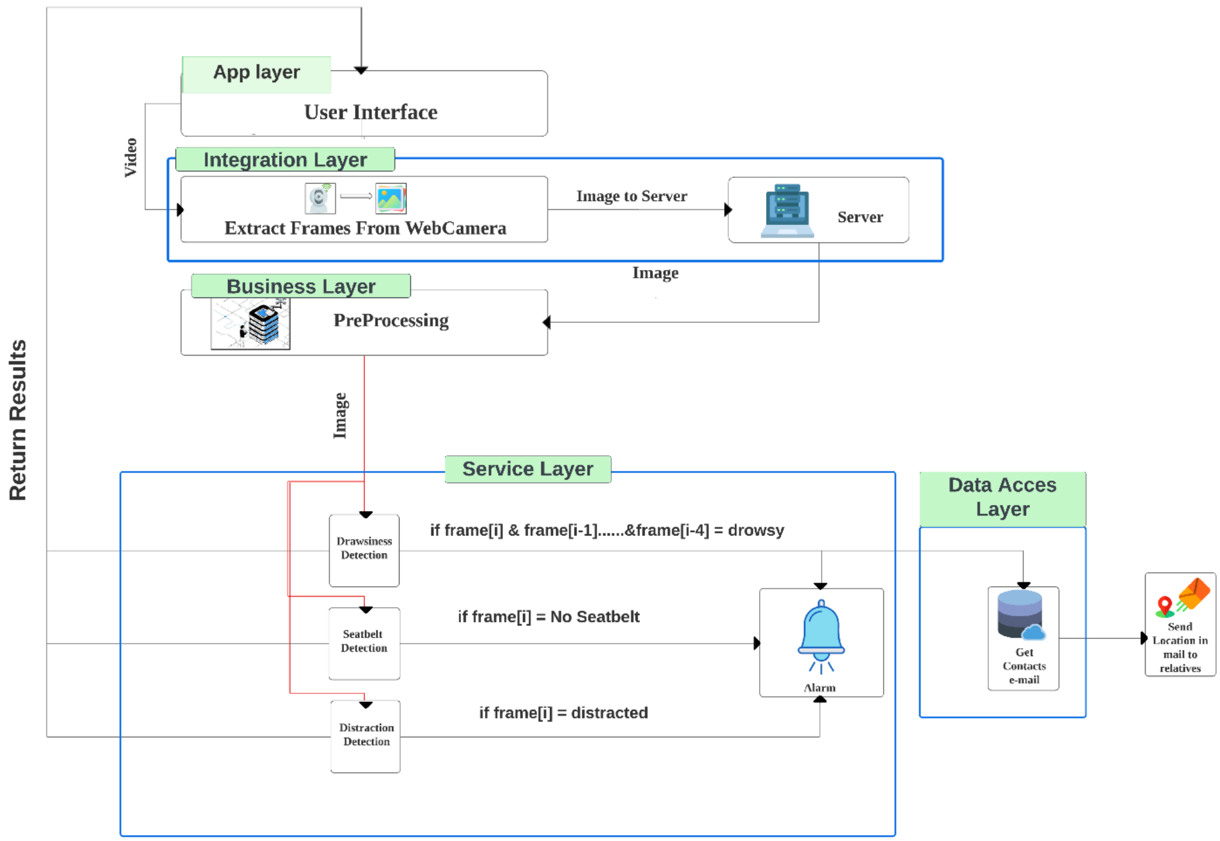


Figure 4.1: System Architecture

3.2 Methods

VGG16: VGG16 is a convolutional neural network architecture developed by the Visual Geometry Group at the University of Oxford. It consists of 16 layers, including multiple convolutional and pooling layers, followed by three fully connected layers. The network architecture is relatively simple and easy to understand, with a uniform structure throughout the entire network. VGG16 has been used for tasks such as image classification, object detection, and segmentation. It has achieved state-of-the-art performance on a variety of image recognition tasks and has been used as a benchmark for comparison with other deep learning models.

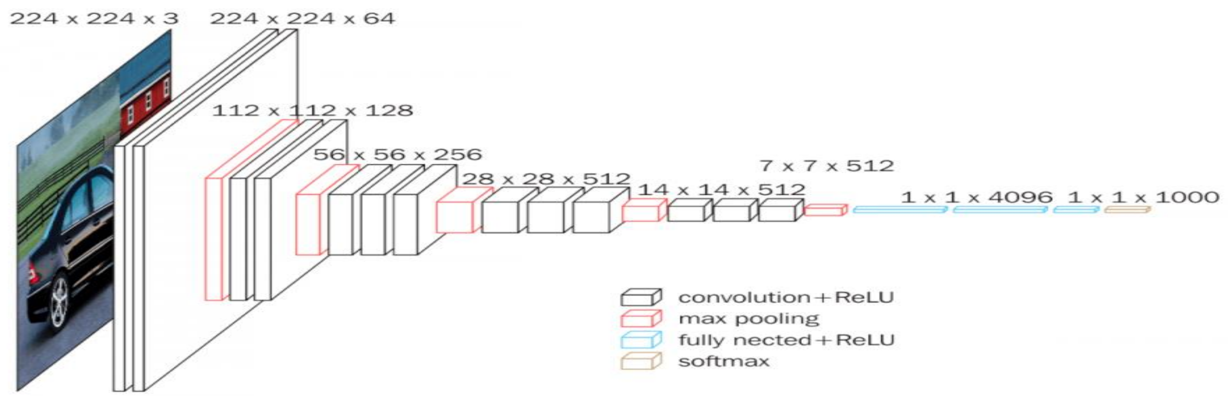


Figure 3.2: VGG16 Architecture

VGG19: VGG19 is a variant of the VGG network architecture, also developed by the Visual Geometry Group at the University of Oxford. Like VGG16, it consists of multiple layers of convolutional and pooling layers, but with a deeper architecture that includes 19 layers. The network architecture is relatively simple and easy to understand, with a uniform structure throughout the entire network. VGG19 has been widely used for tasks such as image classification, object detection, and segmentation. It has achieved state-of-the-art performance on a variety of image recognition tasks and has been used as a benchmark for comparison with other deep learning models.

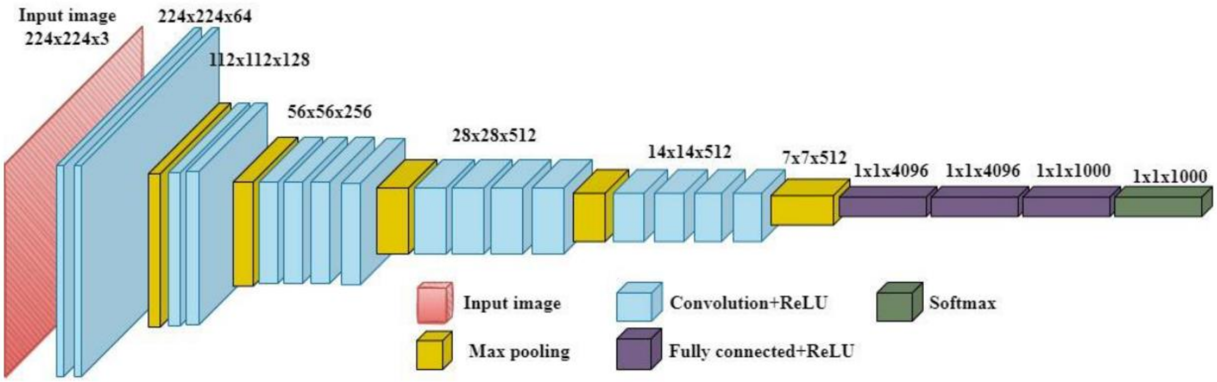
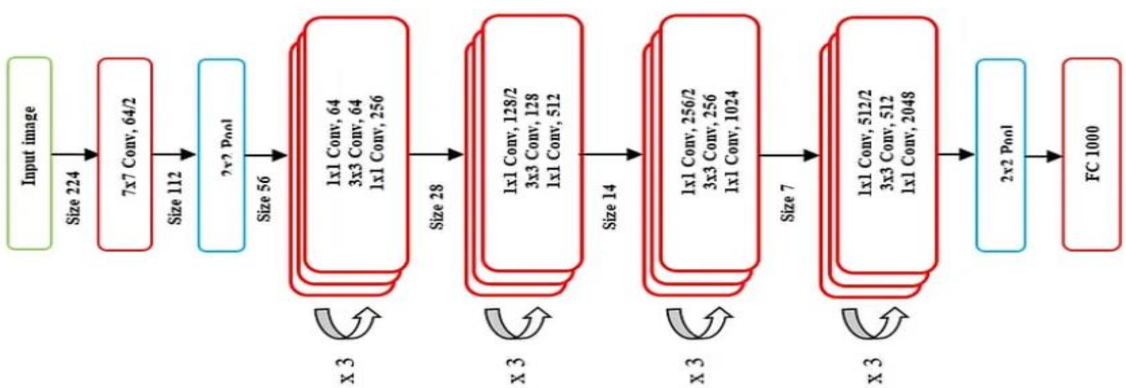


Figure 3.3: VGG19 Architecture

ResNet50: ResNet50 is a variant of the ResNet architecture developed by Microsoft Research. It consists of 50 layers, including convolutional layers, pooling layers, and fully connected layers. The key innovation in ResNet50, as well as other ResNet variants, is the use of residual blocks, which allow the network to learn residual mappings instead of attempting to directly learn the underlying mapping. This helps to prevent the problem of vanishing gradients and allows for the training of much deeper neural networks. ResNet50 has been used for tasks such as image classification, object detection, and semantic segmentation. It has achieved state-of-the-art performance on a variety of computer vision tasks and has been widely adopted in many real-world applications.



ResNet-50 architecture

Figure 3.4: ResNet50 Architecture

MobileNet: MobileNet is a neural network architecture designed for mobile and embedded devices with limited computational resources. It uses depthwise separable convolutions, which separate the standard convolution operation into two separate operations, reducing the number of parameters and computational complexity of the model.

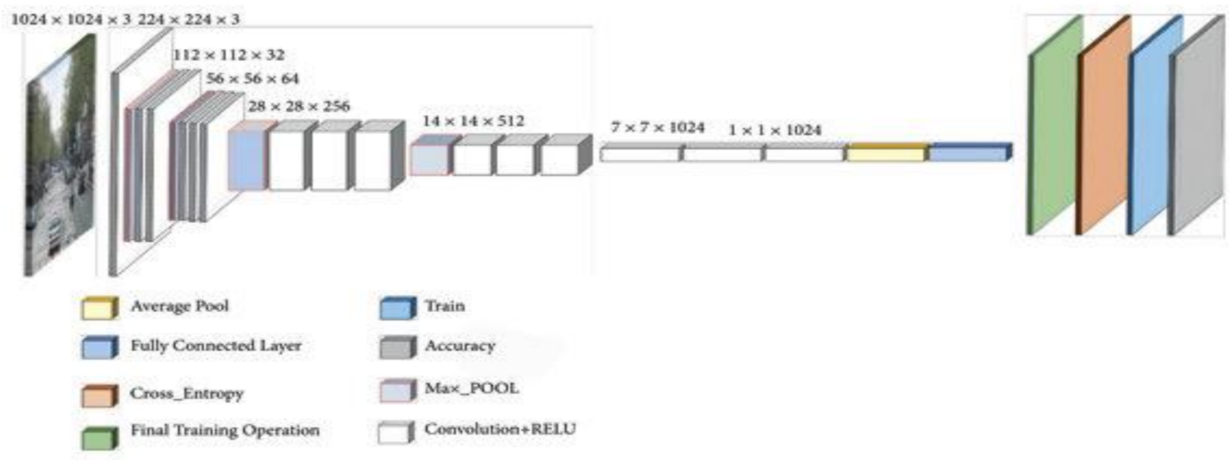


Figure 3.5: MobileNet Architecture

EfficientNet: EfficientNet is a family of neural network architectures developed by Google that achieves state-of-the-art performance on image classification tasks while using fewer parameters and less computation compared to other models. The architecture uses a compound scaling method to balance the number of layers, width, and resolution of the network.

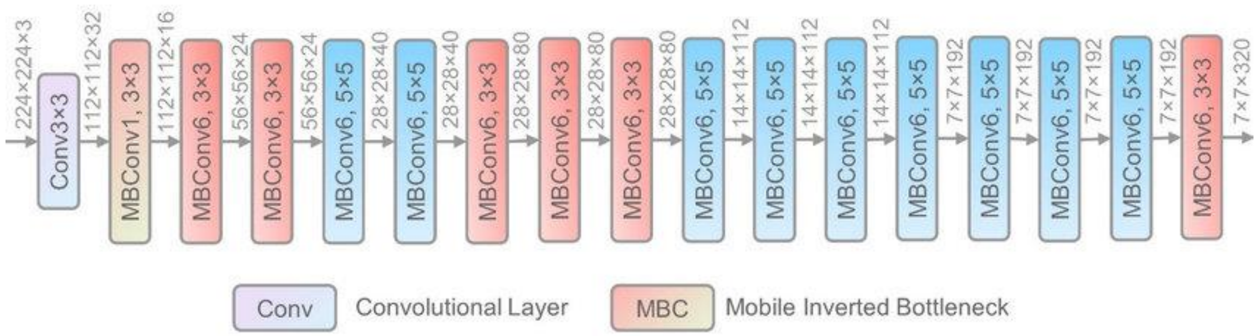


Figure 3.6: EfficientNet Architecture

Haar Cascade: Haar Cascade is a machine learning-based object detection algorithm developed by Viola and Jones in 2001. It uses Haar-like features and a cascade classifier to detect objects in images. The algorithm has been used for face detection, pedestrian detection, and other object detection tasks.

Chapter Four

System Implementation and Results

The driver behaviour detection project is aimed at identifying unsafe driving habits and alerting the driver in real-time. The project uses three different models, each specifically designed to predict a different driving behaviour.

4.1 Dataset

4.1.1 The first model is a seat belt detection model, which uses deep learning techniques to detect whether the driver is wearing a seat belt or not. This model is important because seat belts are a critical safety feature in vehicles that can significantly reduce the risk of injury or death in the event of an accident. The model predicts whether the driver is wearing a seat belt or not and alerts the driver if they are not wearing one.

The dataset of the seat-belt model was obtained from multiple sources, including Kaggle's State Farm Distracted Driver Detection, Roboflow, and self-collected images from various locations. The data was labelled for the presence or absence of a seatbelt and was categorized into two classes: seat belt and without seat belt.

The training set contains 7,017 images, which were stored in 439 batches, with each batch containing 16 images. The test set consists of 1,600 images, which were divided into about 100 batches, with each batch containing 16 images.

This dataset appears to be suitable for training and evaluating models for seatbelt detection.

We made a visualization that represent the relationship between the training, testing, and validation sets with epochs in in the Seatbelt model.

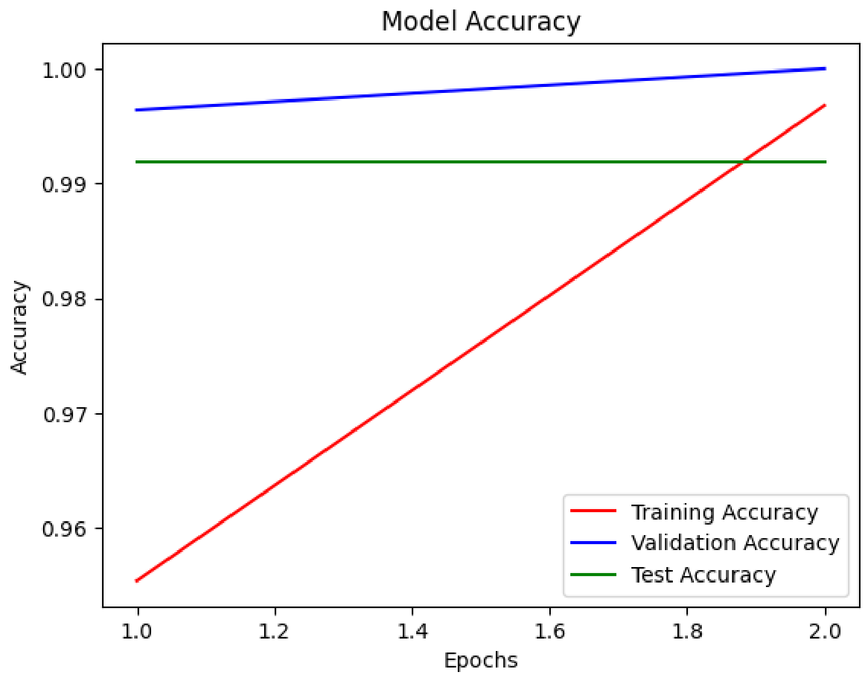


Figure 4.1: Seatbelt Plot

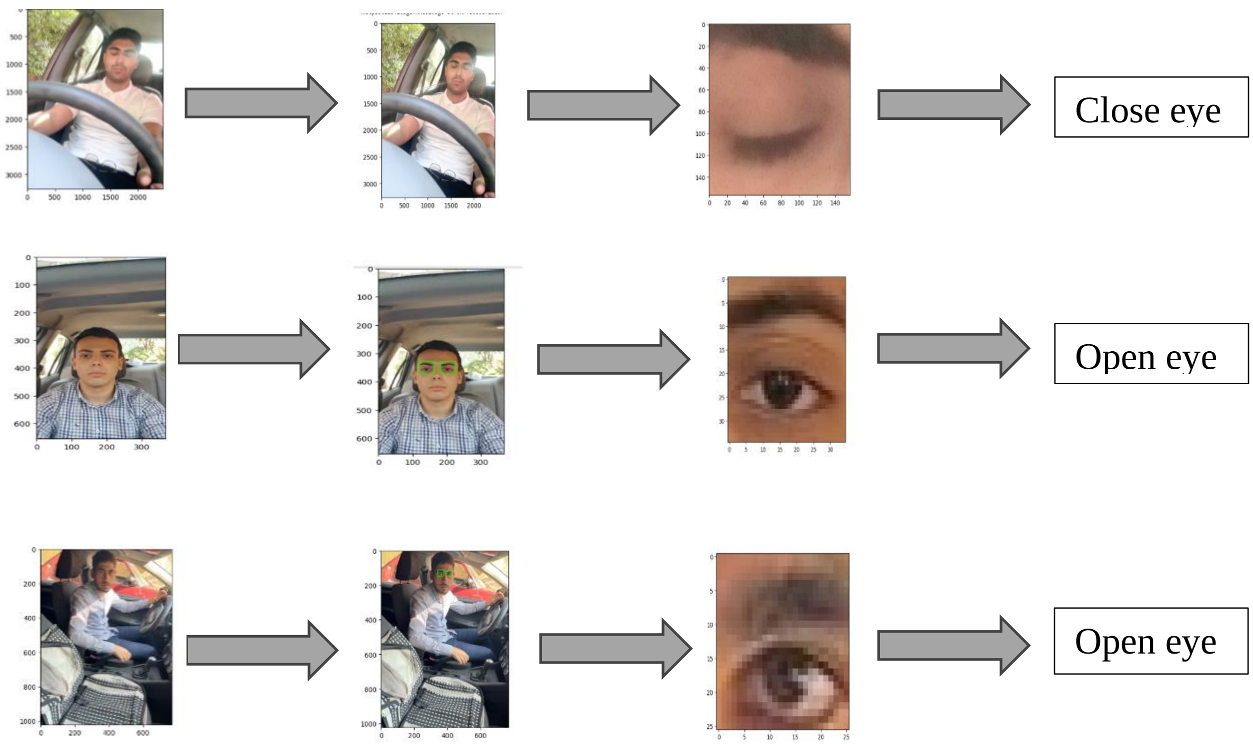
4.1.2 The second model is a drowsiness detection model, which uses deep learning techniques to detect whether the driver is drowsy or not. This model is important because drowsy driving can be just as dangerous as driving under the influence of drugs or alcohol. The model predicts whether the driver is drowsy or not and alerts the driver if they are showing signs of drowsiness.[1], [18]

The model can identify the driver's eyes and determining whether they are open or closed. This is achieved through a series of steps:

1) The model takes an image of the driver's face as input.
2) The model focuses on the area around the driver's eyes and applies a green bounding box to this region.
3) The model crops the eyes from the image using the bounding box as a guide.

Finally, the system analyses the cropped image and predicts whether the driver's eyes are open or closed.

By following these steps, the system can quickly and accurately detect the driver's eye state, which can be useful for applications such as driver monitoring and alert systems. However, it is important to note that such a system should never be relied upon as a substitute for safe driving practices and responsible behaviour behind the wheel.



The Drowsiness Datasets were compiled from two sources: Kaggle and Roboflow. The dataset, known as the "Drowsiness_dataset," includes four distinct classes: Drowsy, Not Drowsy, Open Eyes, and Closed Eyes.[1] ,[18]

The first two classes, Drowsy and Not Drowsy, were further subdivided based on the presence or absence of Yawns, which were obtained through frame extraction from over 130 self-collected 22-second videos. The dataset comprises 4,503 images for each class in the training dataset, and 1,150 images in the test dataset.

We made a visualization that represent the relationship between the training, testing, and validation sets with epochs in the Drowsy model.

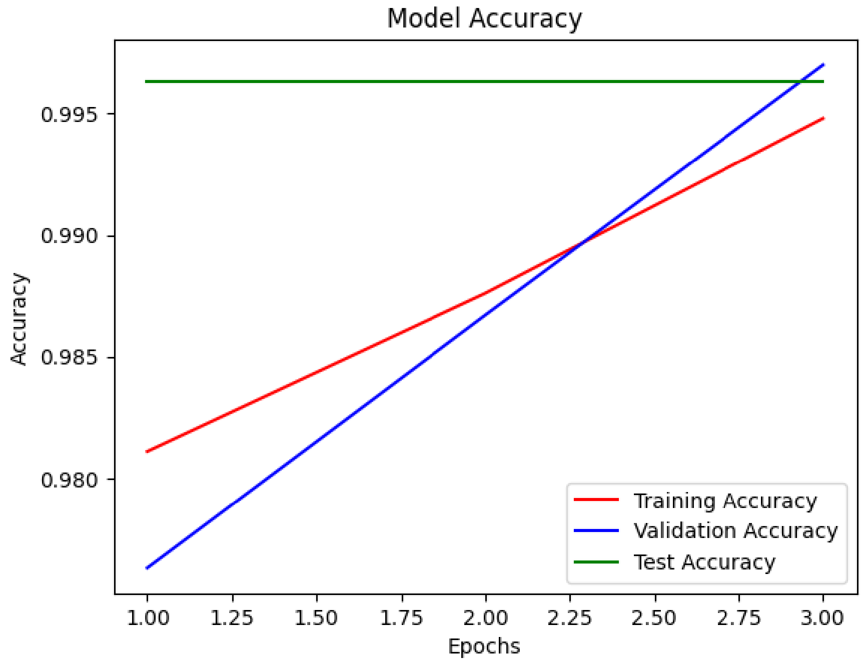


Figure 4.2: Drowsiness Plot

4.1.3 The third model is a multi-class classification model, which uses deep learning techniques to classify the driver's behaviour into one of ten different categories, such as texting while driving or using a mobile phone while driving. This model is important because it can provide insights into the different types of unsafe driving behaviours that drivers engage in and can help to identify patterns or trends in those behaviours. The model predicts the driver's behaviour based on real-time video or image data and can alert the driver or send notifications to relevant authorities if unsafe behaviours are detected.[16]

The multi-class dataset, obtained from Kaggle's State Farm Distracted Driver Detection, comprises approximately 2,400-3,000 labelled images per category for training and approximately 7,000 unlabelled images for testing. The data was manually labelled to ensure accuracy.

To facilitate machine learning model development, the labelled data was divided into batches. The training set contains 1,670 batches, with each batch consisting of 16 images, while the test set contains 432 batches, also with 16 images per batch.

After labelling, the dataset was reduced to eight categories, with texting (Left & Right) and talking on the phone (Left & Right) combined into a single class.
We made a visualization that represent the relationship between the training, testing, and validation sets with epochs in the Distraction model.

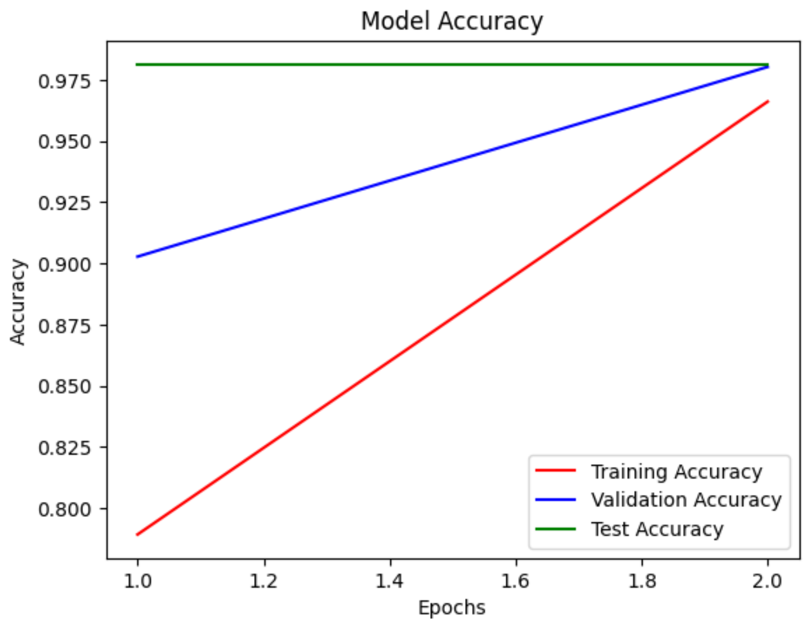


Figure 4.3: Multi-Class Plot

4.1.4 We made some visualization for our dataset.
Initially, we present a visualization that displays the number of datasets for each class in the training dataset.

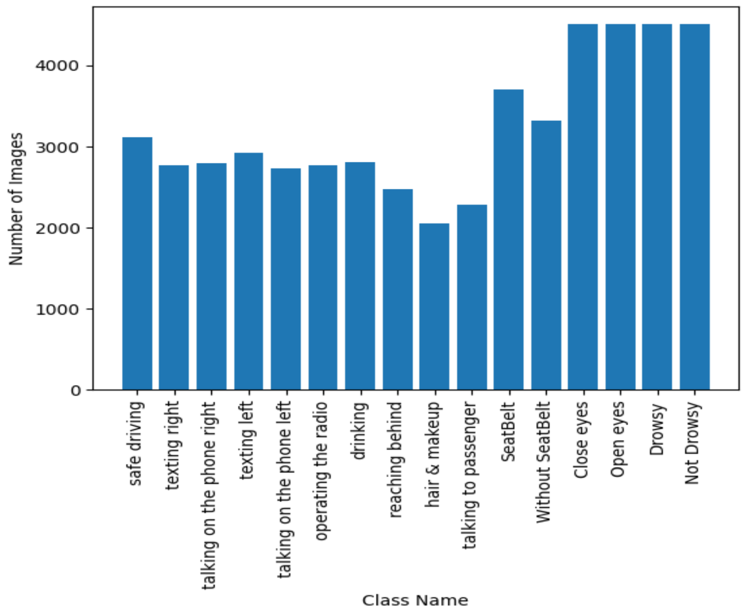


Figure 4.4: Number of training images

Next, we showcase a visualization that presents the number of datasets for each class in the testing dataset.

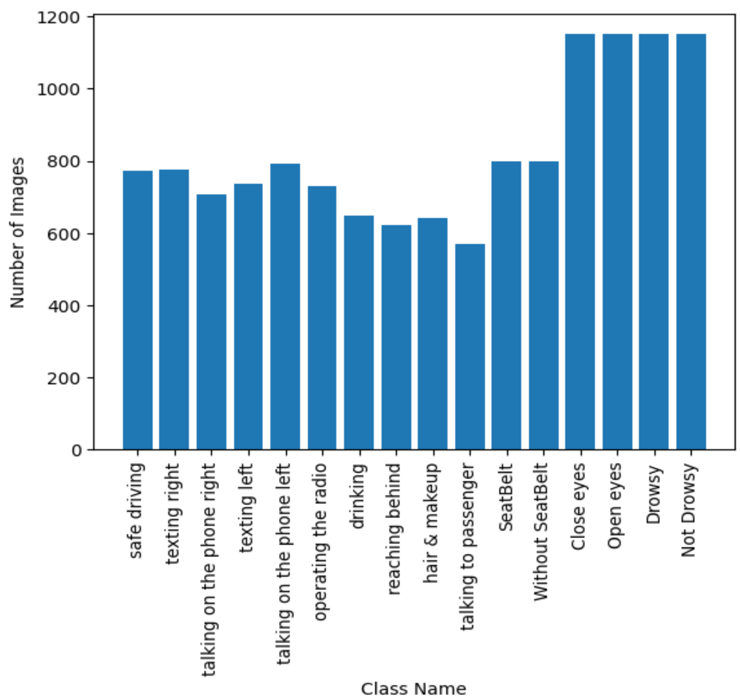


Figure 4.5: Number of testing images

4.2 Description of programs used:

Flutter is a mobile application development framework that enables developers to create high-performance, visually appealing, and user-friendly applications for both Android and iOS platforms. In this case, a Flutter software application has been developed specifically for driver behaviour detection using deep learning models.[16]

The main objective of this application is to detect different driver behaviours while driving using advanced deep learning algorithms. The application uses the camera to capture images of the driver's face and analyze them in real-time to detect any potential distractions or unsafe behaviour. The deep learning models used in this application are trained on a large dataset of images to accurately detect various actions being performed by the driver.[6][8]

The Flutter application is designed to detect a range of different driver behaviours, including drinking, not wearing a seat belt, talking on the phone, and any other distracting action that may put the driver and other road users at risk. The application works by analysing the driver's facial features and movements to identify any actions that may indicate distracted or unsafe driving.

If the application detects any unsafe behaviour, it will alert the driver with a warning message or an alarm, depending on the severity of the situation. This alert can be customized to be visual, audible or haptic, depending on the driver's preference.

The deep learning models used in this application are trained on a large and diverse dataset of images, which allows the application to accurately detect driver behaviour in a range of different lighting and environmental conditions.
The application is also designed to work in real-time, enabling it to quickly detect any unsafe behaviour and alert the driver before an accident occurs and If the driver is in danger, we will send a message containing a short message and their location to their relative's Gmail account.

Overall, the Flutter software application for driver behaviour detection using deep learning models is an innovative solution that aims to improve road safety by detecting and alerting drivers of any unsafe behaviour while driving. The app is user-friendly and easy to use, making it accessible to drivers of all levels of experience and education.

4.3 Setup Configuration (hardware)

In our graduation project, we utilized several key components of computer hardware to build and train deep learning models. These components included the GPU, CPU, RAM, and memory.

In short, GPU is a specialized processor for graphics tasks, memory is storage space for data accessed by CPU, RAM is a fast type of primary memory, and CPU is the central processing unit that executes instructions and performs calculations.

The hardware setup for the Flutter software application for driver behaviour detection is very simple and straightforward. The application is designed to work on any smartphone with a camera, which means that the user does not need to purchase any additional hardware or equipment to use the app.

To use the application, the user simply needs to download it from the app store onto their smartphone. Once the app is downloaded and installed, the user can open it and start using it immediately to detect and monitor their driving behaviour.

The application uses the front-facing camera on the user's smartphone to capture images of the driver's face and analyse them in real-time using advanced deep learning models. The camera on most modern smartphones is of high enough quality to capture clear and accurate images of the driver's face, even in low light conditions.[15]

Additionally, the application does not require any external sensors or devices to be installed in the car. This means that the user can easily use the application in any vehicle, without the need for any additional hardware or setup.

Overall, the hardware requirements for the Flutter software application for driver behaviour detection are very minimal, making it accessible to a wide range of users with different types of smartphones. The user simply needs a smartphone with a front-facing camera and sufficient storage space to download and install the application, which makes it a convenient and cost-effective solution for improving road safety.

4.4 Experimental and Results

- **Seat belt model**

Feature	Trained model	Training accuracy	Testing accuracy	Training images	Testing images	Epochs	LR
Seat belt	VGG16	99%	95.5%	7017 image 439 (Batch) 352 (batch for train) 87 (batch for validation)	1600 Image 100 (batch)	2	0.001
	VGG16	92%	88%			3	
	VGG19	99.4%	85.5%			5	
	VGG19	85%	80%			3	
	MOBILE NET	98%	93%			5	
	RESNET 50	98%	83%			3	
	Efficient Net	78%	72%			2	
	Efficient Net	67%	61.5%			5	

Table 1 seat belt model

- **Drowsy Model**

Feature	Trained model	Training accuracy	Testing accuracy	Training images	Testing images	Epochs	LR
Drowsiness	VGG16	97.03%	88.66%	18012 Image 1126 (batch)	4600 Image 288 (batch)	10	0.001
	VGG16	94.5%	88%			5	
	VGG19	24.34%	15.55%			5	
	VGG19	56%	52%			3	
	MOBILE NET	99.37%	96.63%			3	
	MOBILE NET V2	99.64%	93.75%			3	
	Efficient Net	88%	77%			5	
	Efficient Net	91%	81%			2	

Table 2 Drowsy model

- Multi-class Model

Feature	Trained model	Training accuracy	Testing accuracy	Training images	Testing images	Epochs	LR
Multi-Class	VGG16	98.7%	97.5%	30k	7k	2	0.001
	VGG16	93%	90%			3	
	VGG19	96.5%	93%			5	
	MOBILE NET V2	88.6%	80.8%			3	

Table 3 multi-class mode

Chapter Five

Run the Application

- **Requirements for running the application:**
  - Software
    The application can run on any smart phone.
  - Hardware
    Any camera stable in the car.
- **The following steps describe in detail the flow of the driver behavior detection application.**

Splash screen: show the logo and the name of the application.

Figure 5.1: Splash screen

Login screen: the user should be logged in to the application so he can use it.

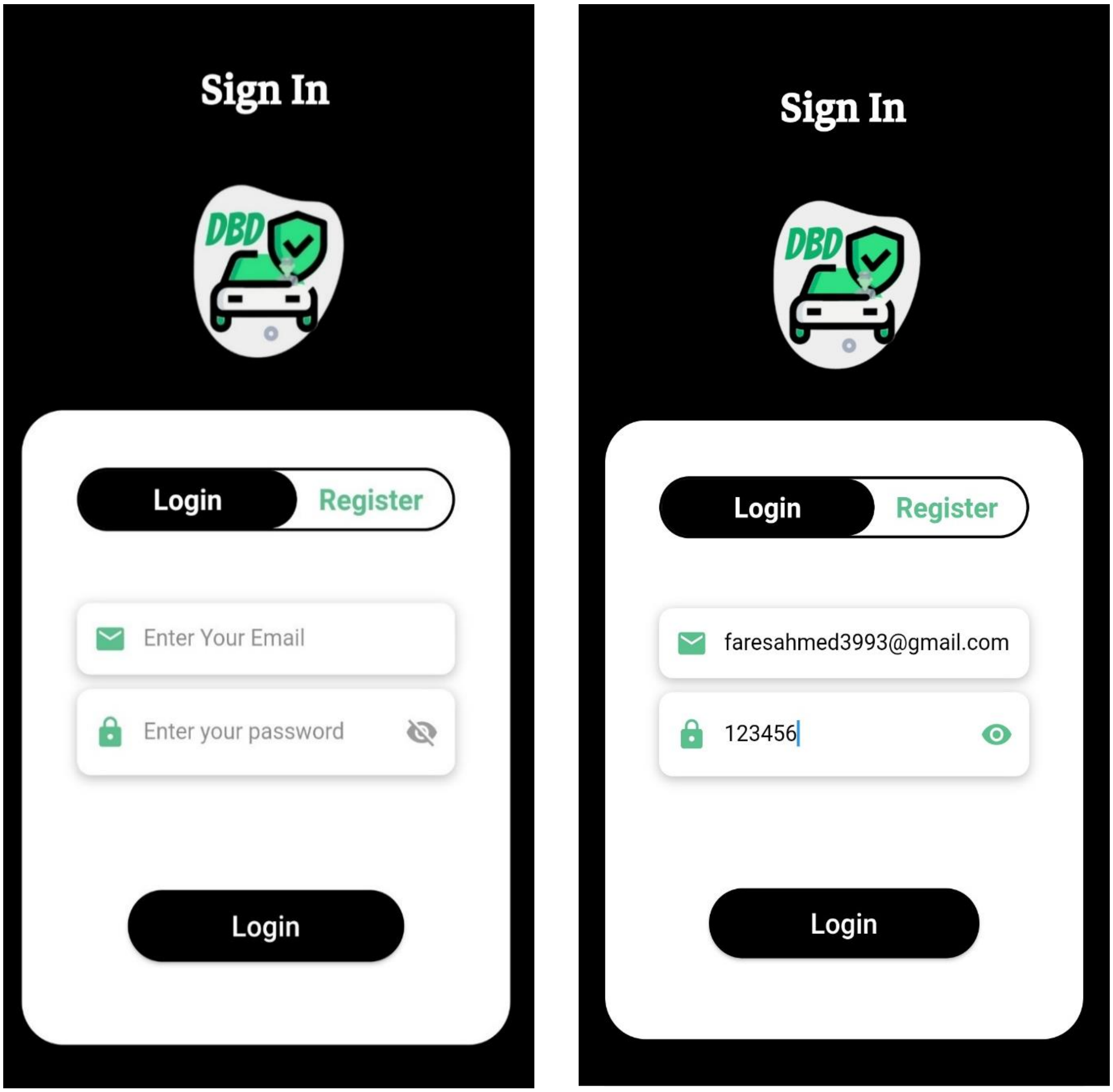


Figure 5.2: Sign in

Note:

- He/ She must enter valid email and correct password.

If the user entered invalid email or wrong password, he fails to login

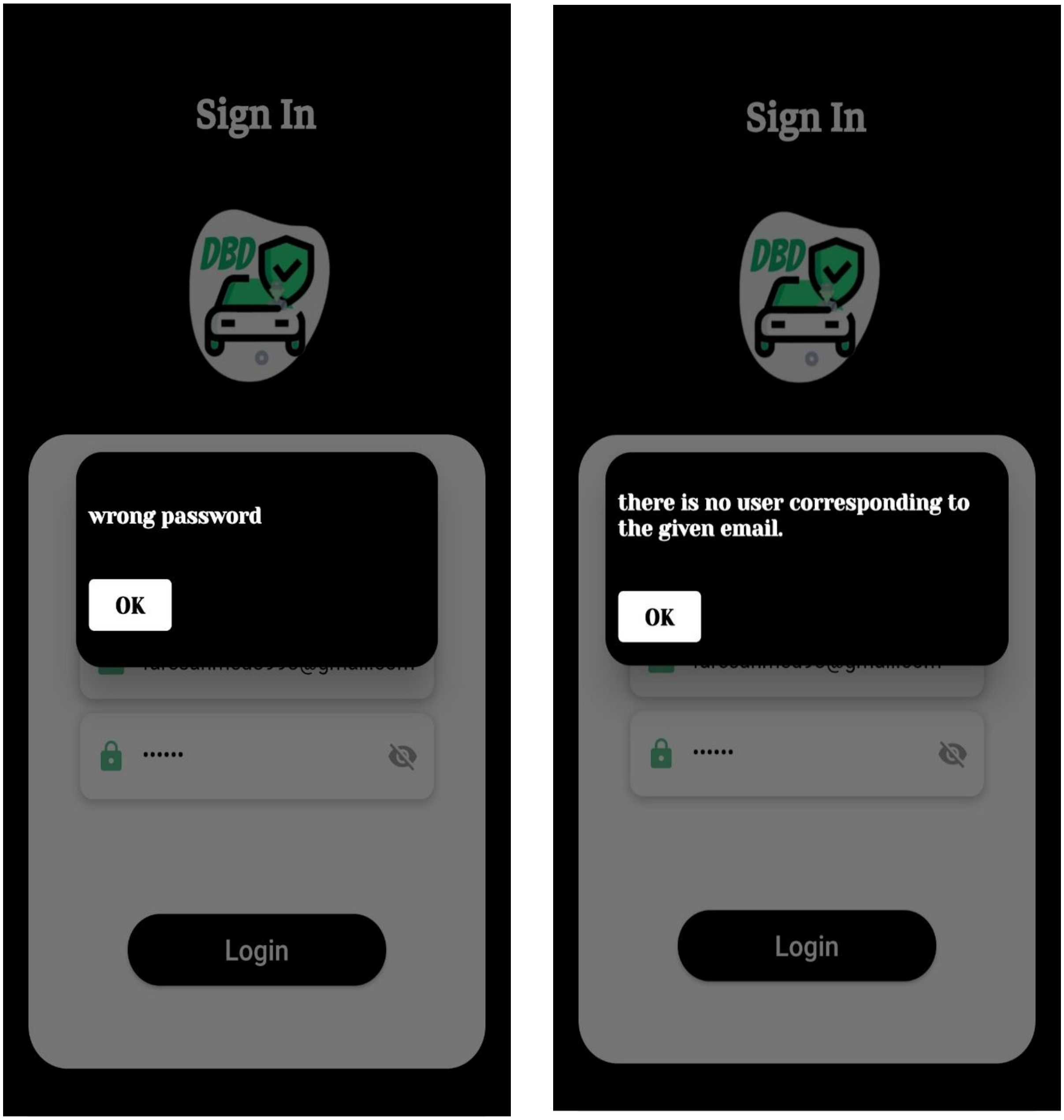


Figure 5.3: Invalid input sign in

If the user tries to login without email or password, he fails to login

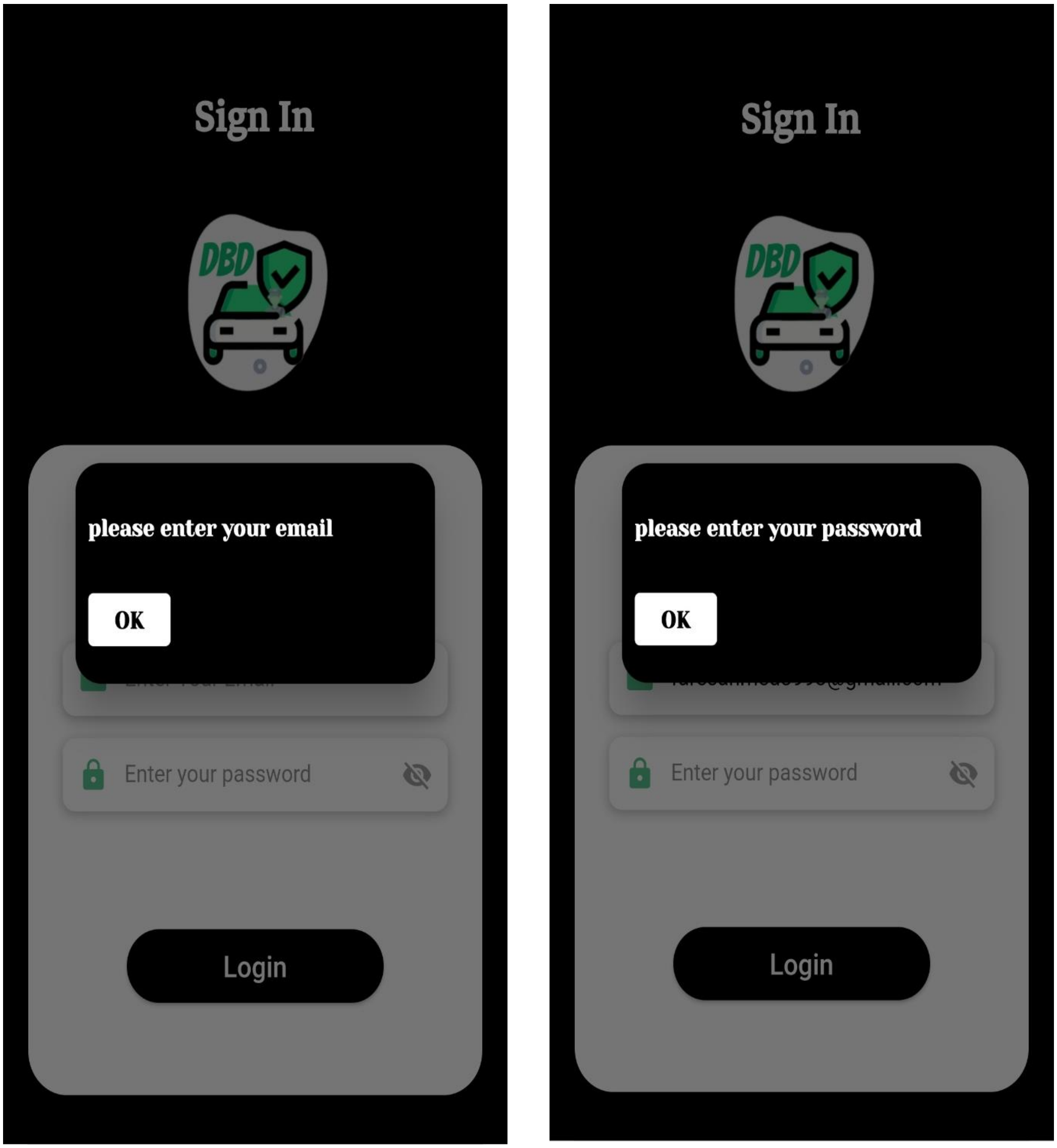


Figure 5.4: No input Sign in

If the user doesn't have an account, he should create account

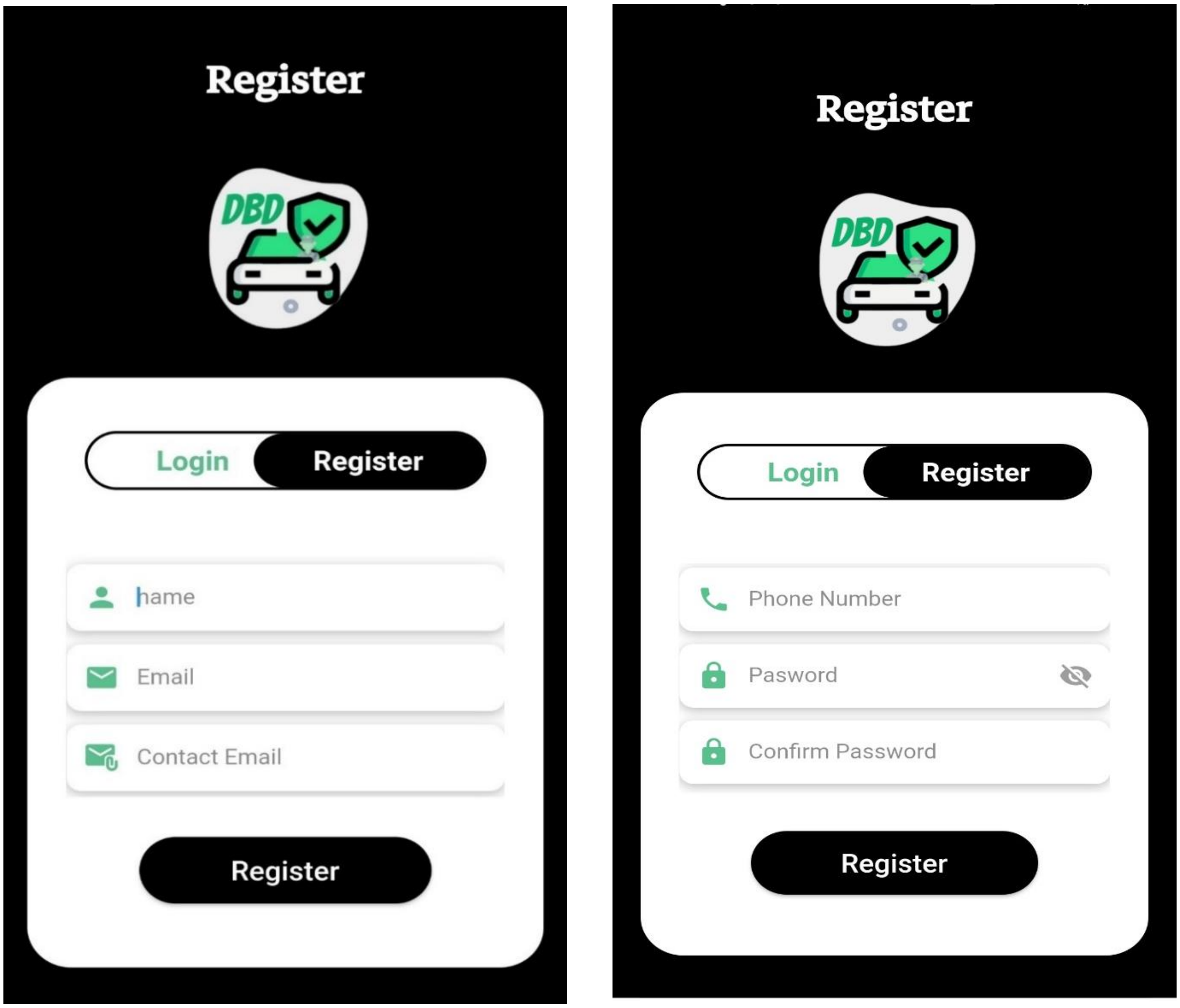


Figure 5.5: Register

If the user try to register without contact email or email or phone number or password

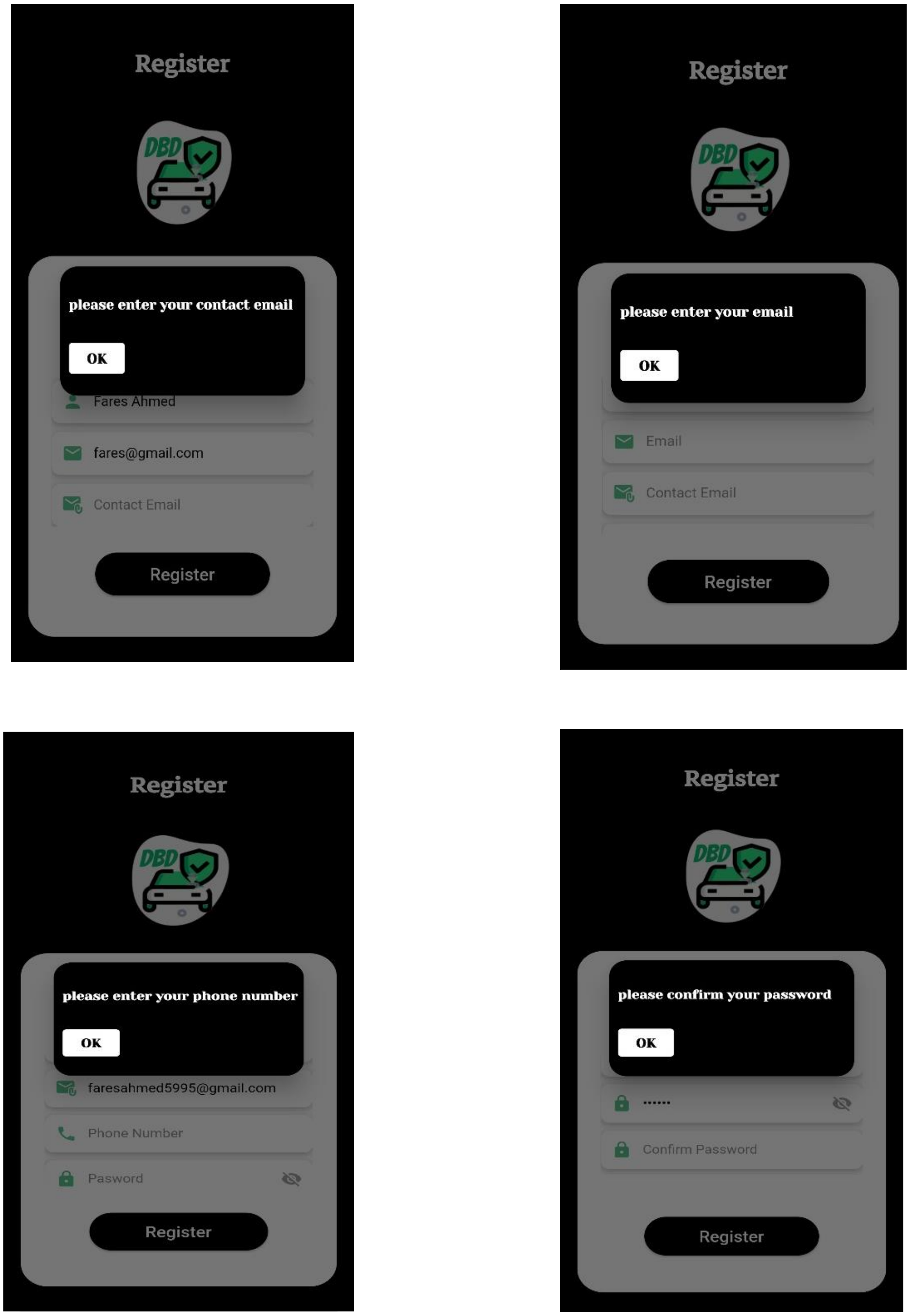


Figure 5.6: No input Register

Note:

- If the user enter a confirm password that doesn't match with the password
- If the user enter an exist an email address
- If the user enter an invalid email address
- If the user enter a not strong enough password

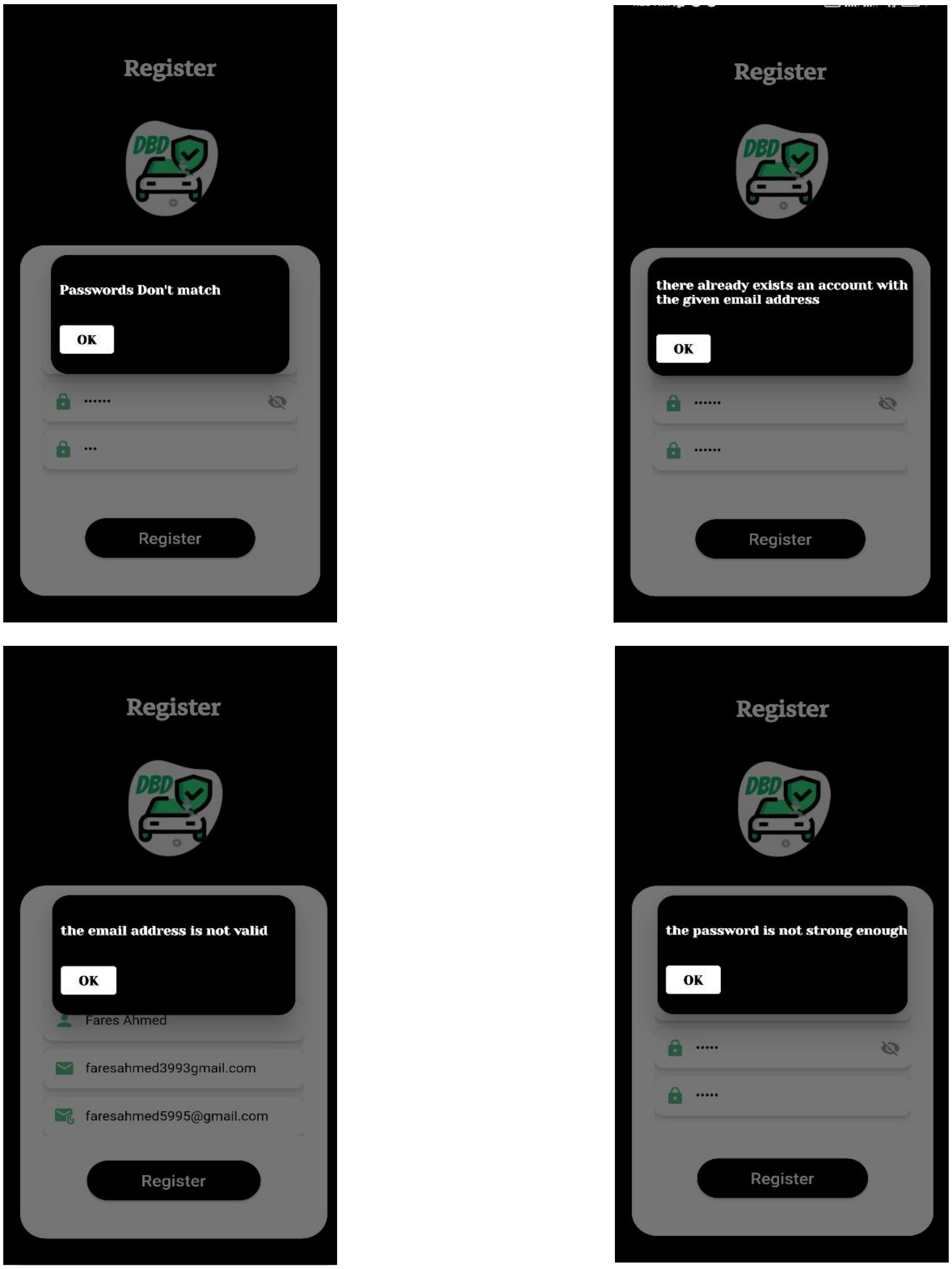


Figure 5.7: Invalid Register

Overview screens: initial screens after the user logged in or registered that let the user learn about the capabilities of the application, and those are optional, user can skip them.

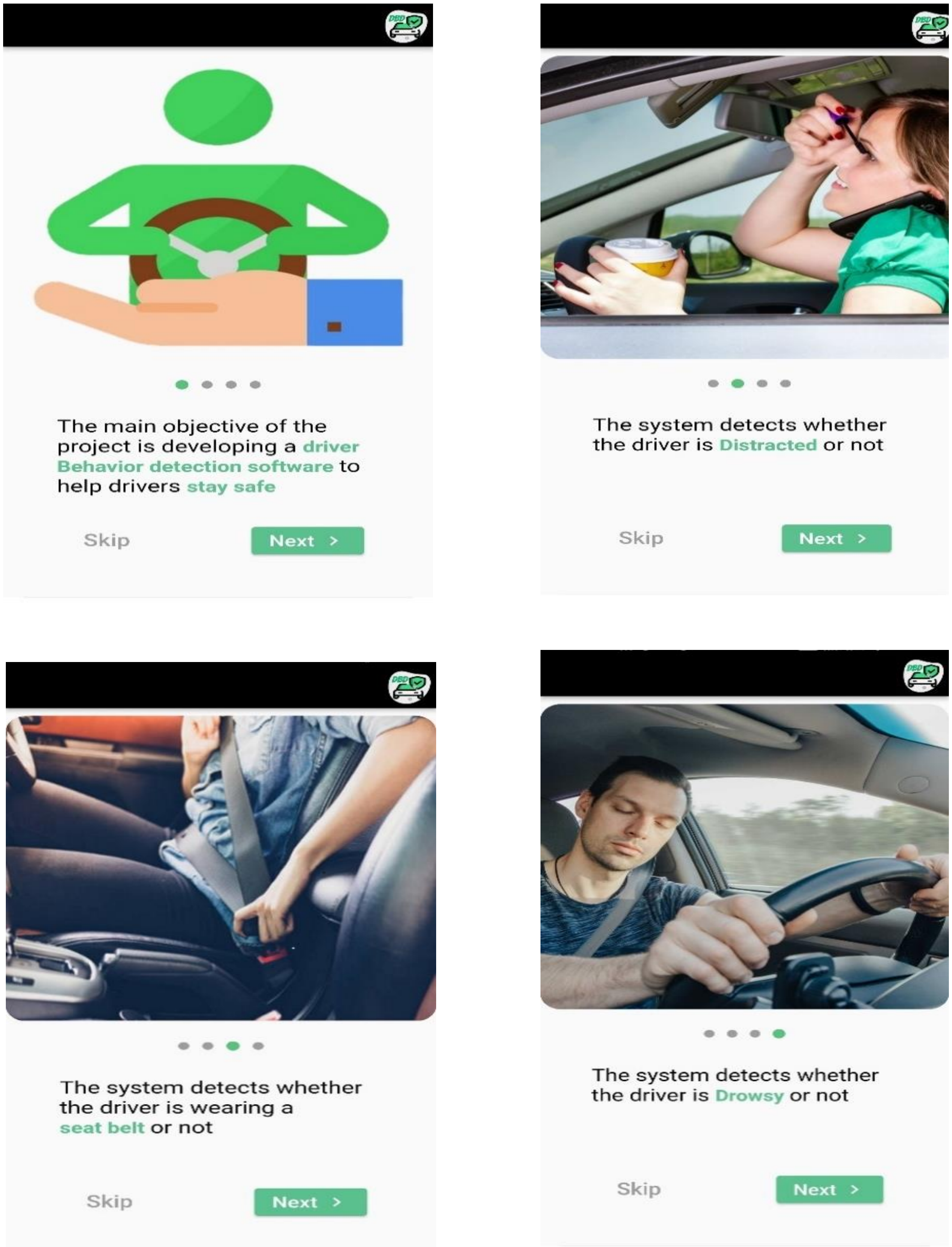


Figure 5.8: Overview

Welcome screen: the user can start his journey by pressing on the "open the camera" button.

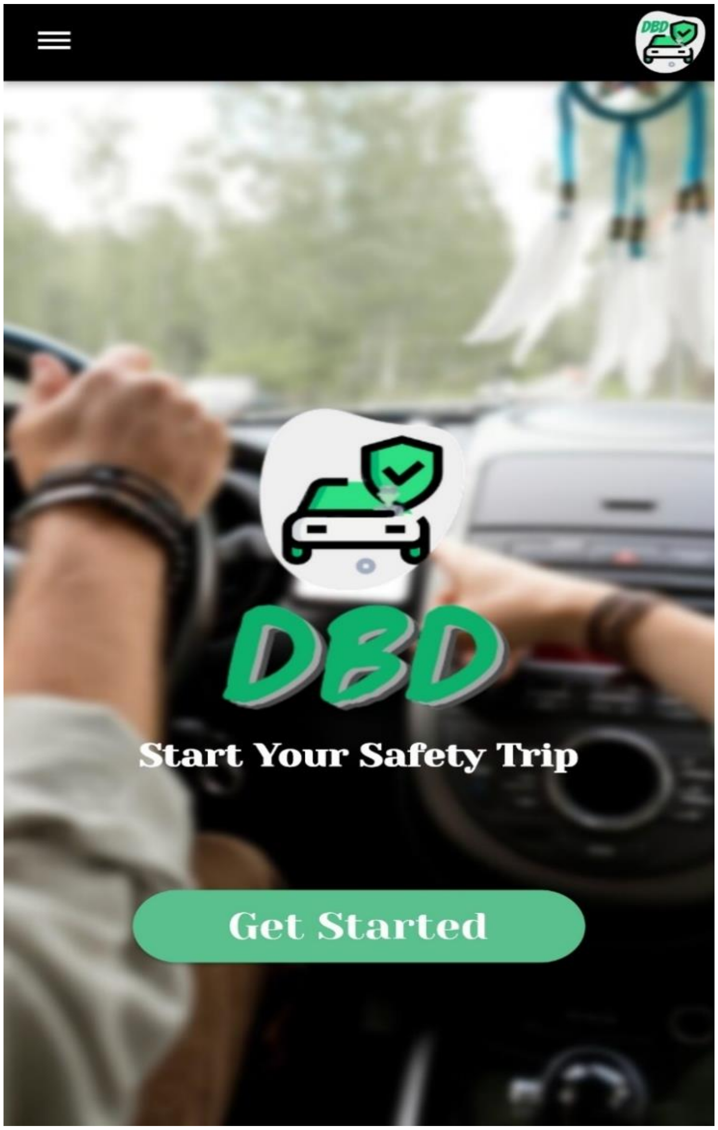


Figure 5.9: Welcome screen

3- Recording screen: the user started his journey, and the camera will detect his face and his seat belt, the model will alert the user if he is:
   - Drowsy.
   - Not wear his seat belt.
   - And any other situation of the 10 situations of the distraction detection model except not distracted.
   - The alert disappears if the user wears his seat belt/open his eyes and focus on the road.

   And the system sends email to his contact contains his current location and his image to help him.

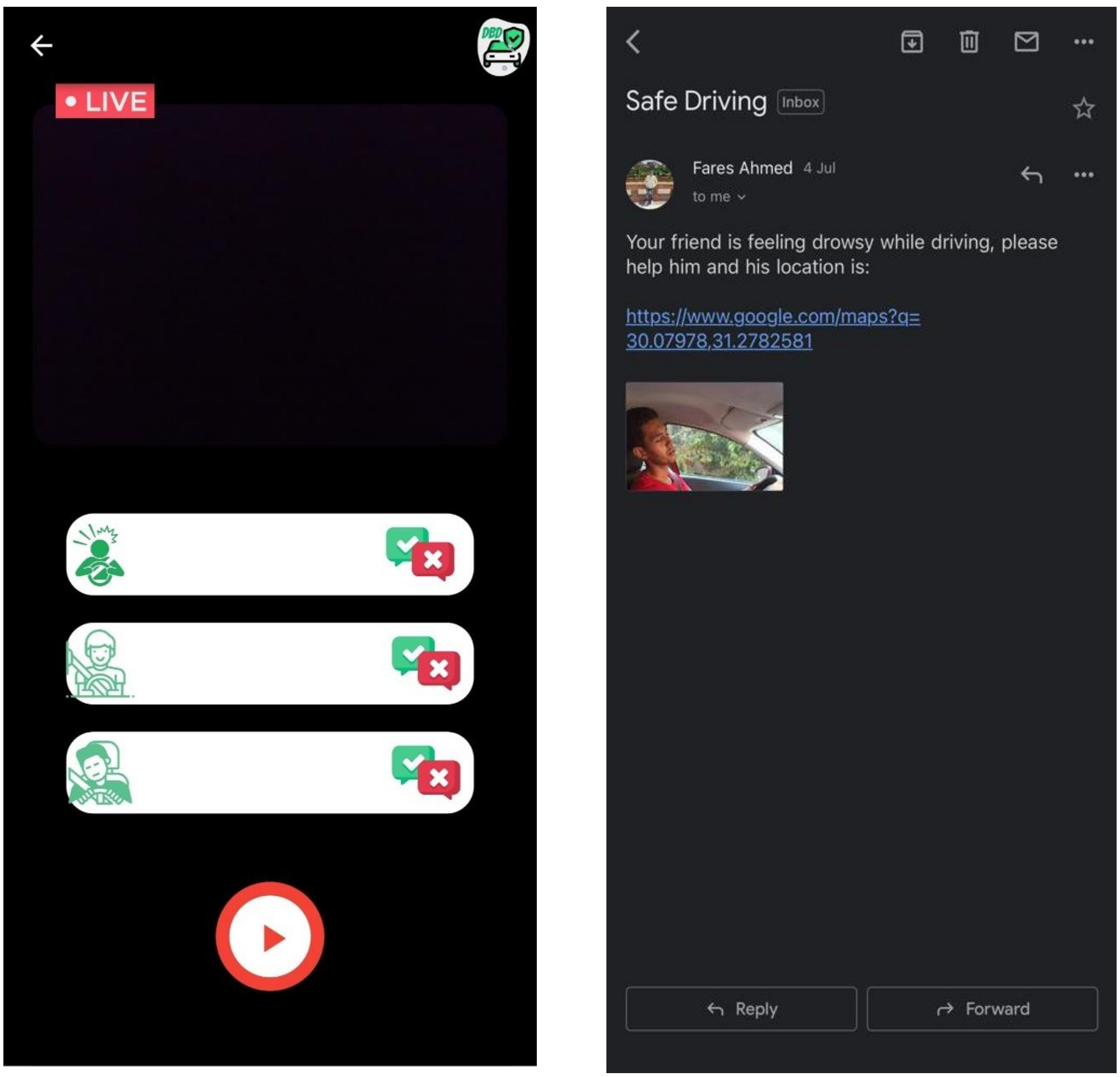


Figure 5.10: Result screen and email screen

Note:

Refer to safe driving

Refer to dangers driving

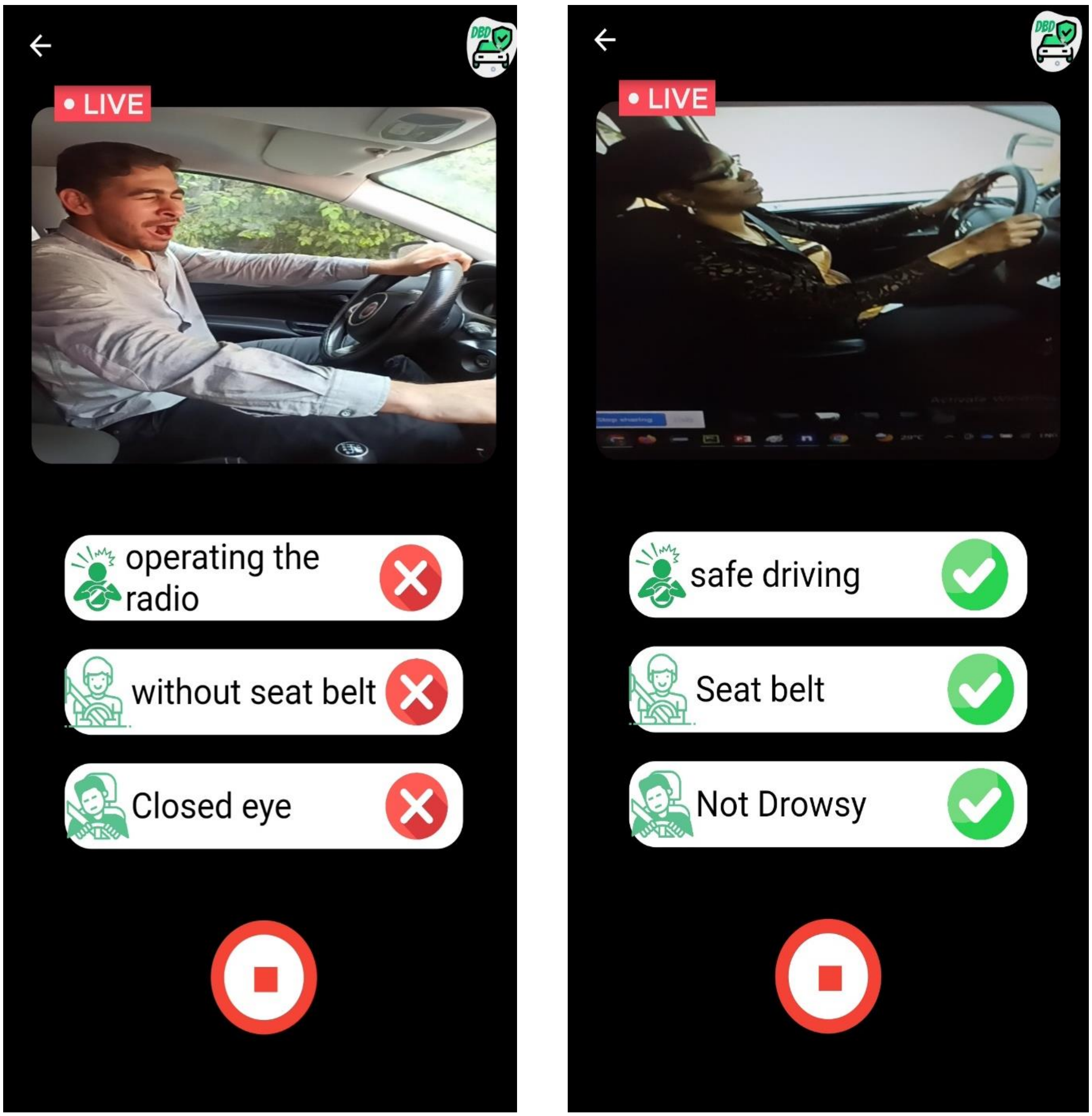


Figure 5.11: Output Screen

4- Option screen: the available features for the application.

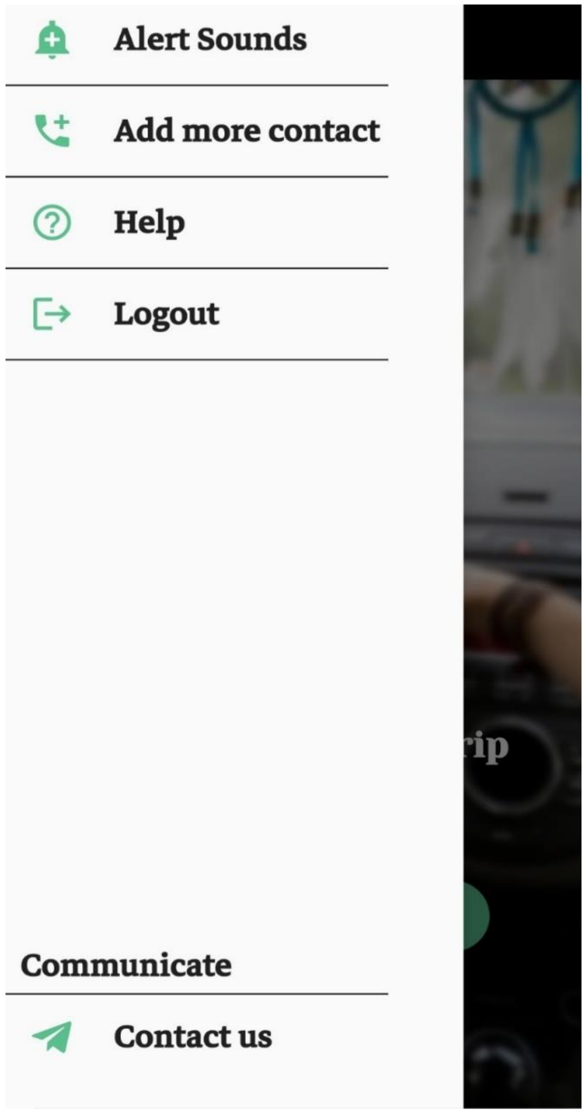
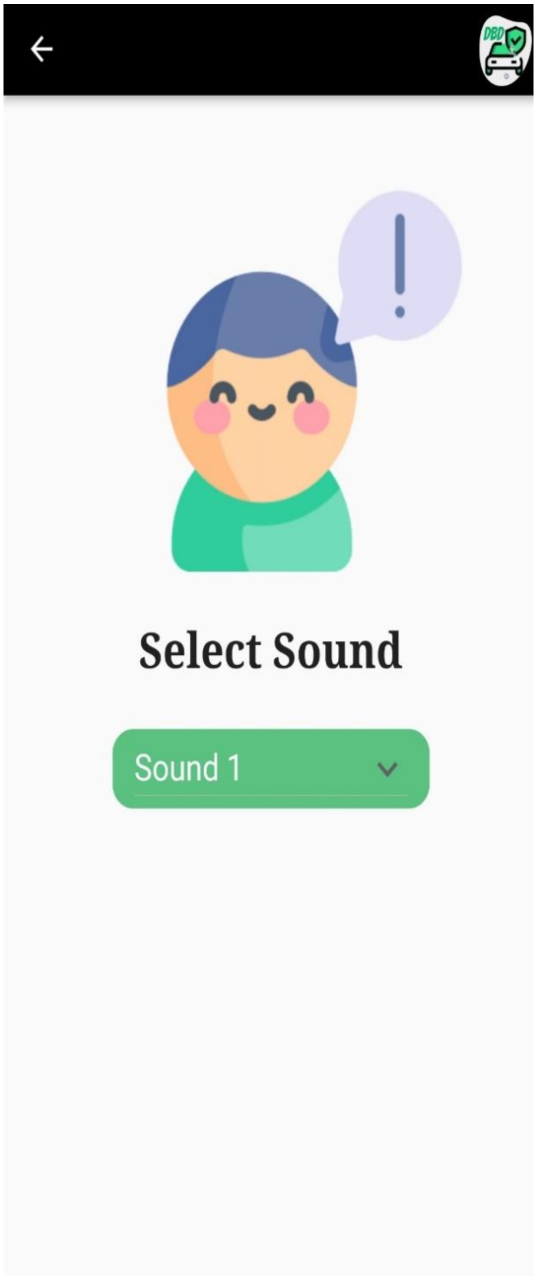
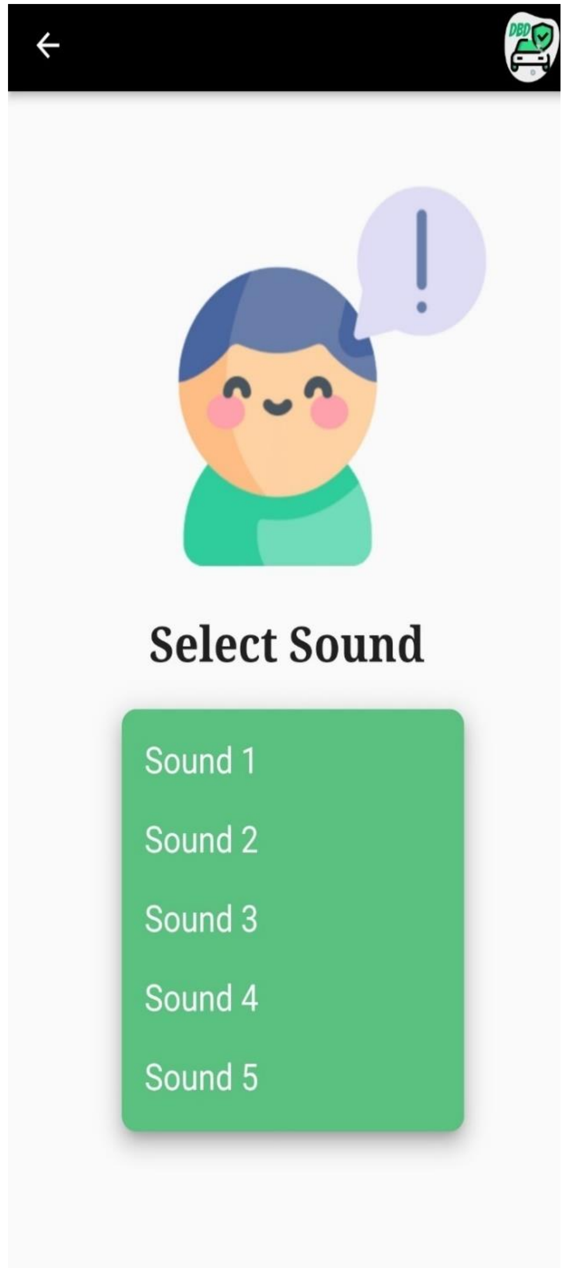


Figure 5.12: Option Screen

Alert sounds screen: the user can choose the alert sound that he wants
The all sounds are noisy enough to alert the user





Figures 5.13: Alert sound screens

Increase safety screen: this screen contains the feature that allows to the user to add more contacts of the close people to be safer.

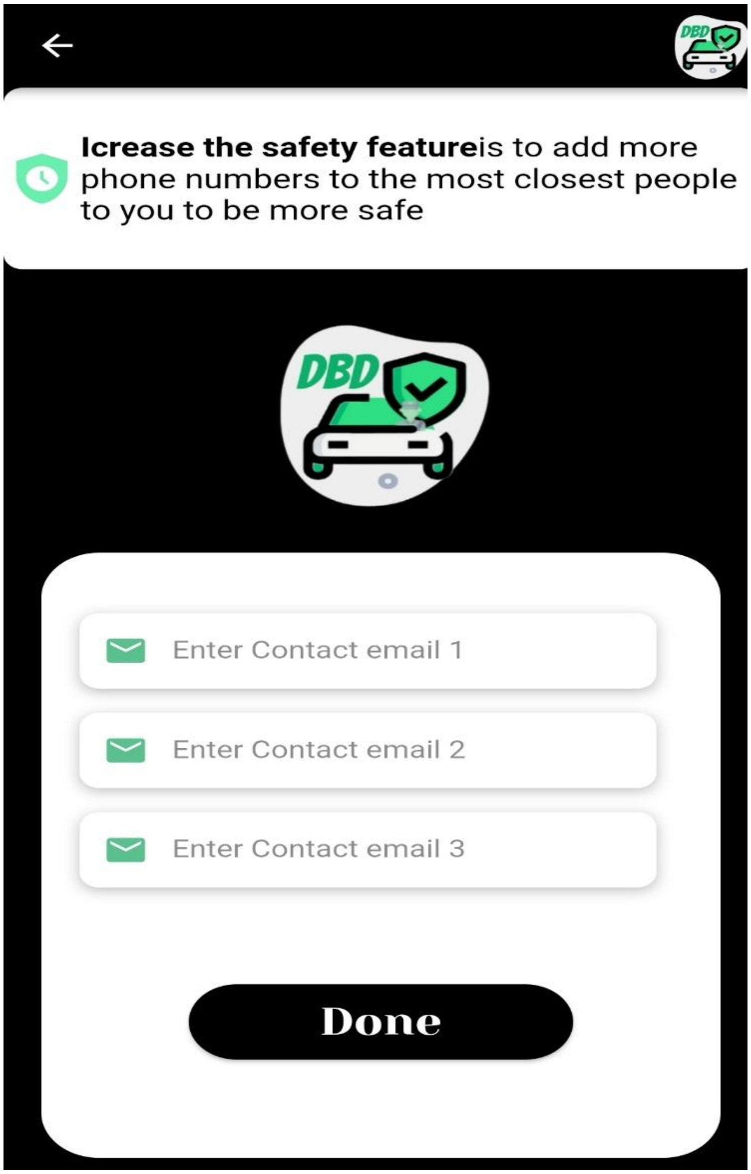


Figure 5.14: Safety screen

Help screen: help the user to understand the features of the application.

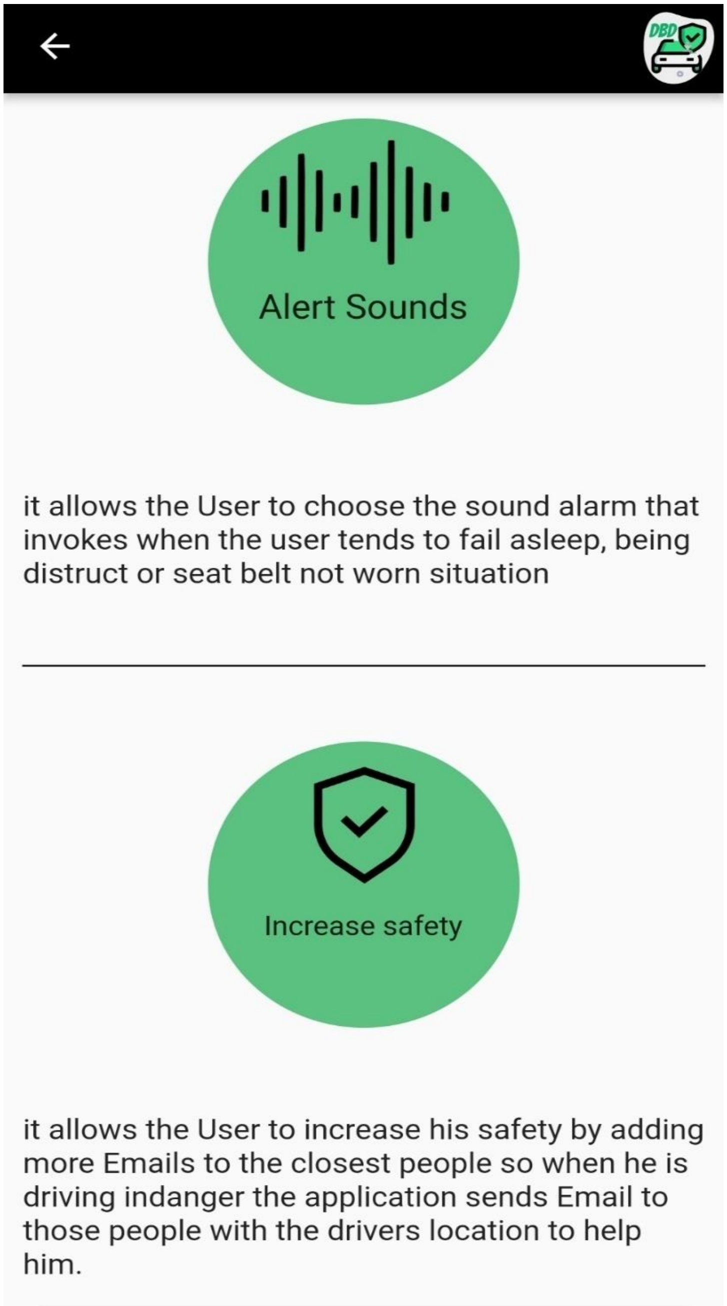


Figure 5.15: Help screen

Contact us screen: this screen contains the contact details of the team.

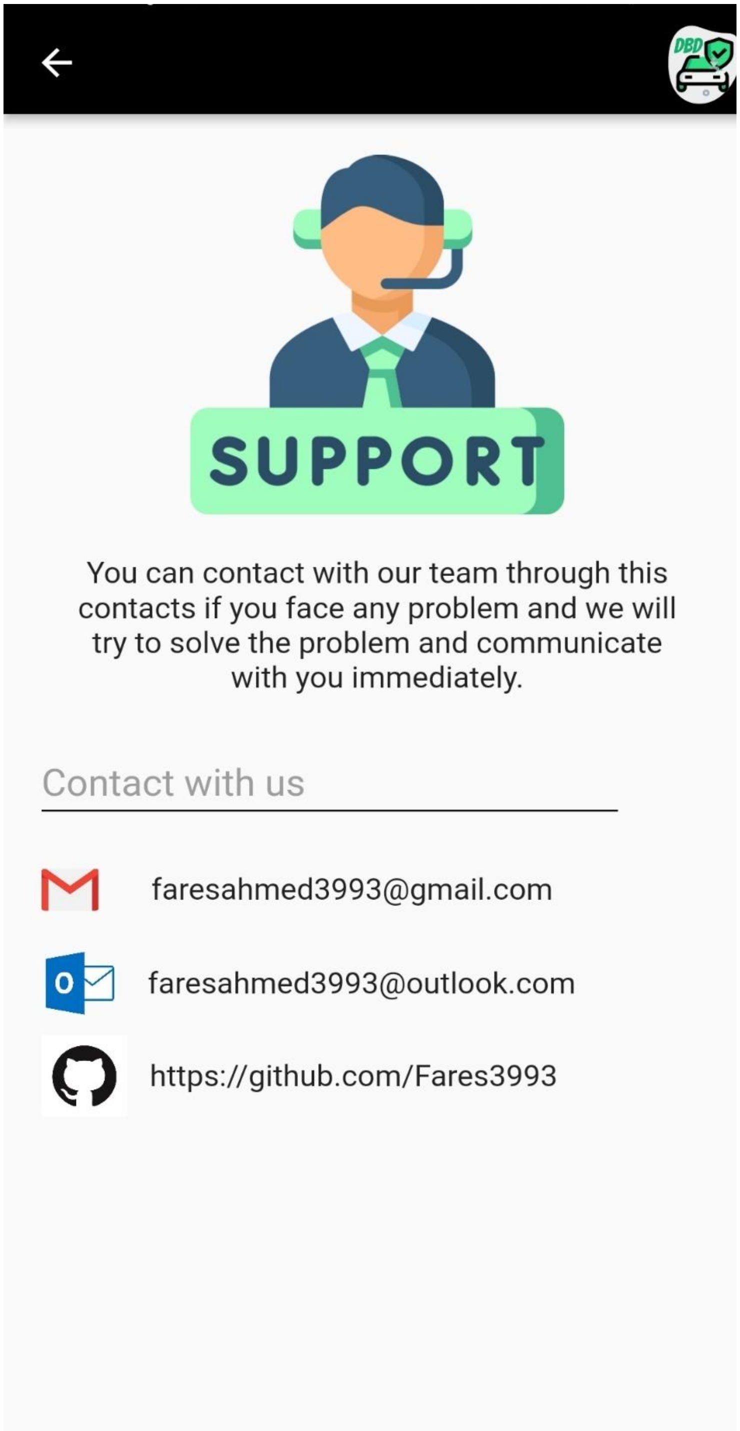


Figure 5.16: Contact Screen

Chapter Six

Conclusion and Future Work

Chapter Six: Conclusion and Future Work

6.1 Conclusion

The driver behavior detection project using deep learning models and the Flutter software application is an innovative solution that aims to improve road safety by detecting and alerting drivers of any unsafe behavior while driving. The project uses three different models, each specifically designed to predict a different driving behavior, including seat belt detection, drowsiness detection, and multi-class classification of driver behavior. The project uses a large and diverse dataset of images to accurately detect driver behavior in a range of different lighting and environmental conditions. The hardware requirements for the application are very minimal, making it accessible to a wide range of users with different types of smartphones. Overall, this project has the potential to significantly reduce the number of accidents caused by unsafe driving habits and improve road safety for all.[12][16]

This System is a significant step towards improving driver safety by detecting drowsiness, distraction, and seatbelt usage using various deep learning techniques. The implementation of an alarm system provides a timely alert to the driver, which can potentially save lives by reducing the occurrence of accidents caused by driver behavior.[6][8]

The use of convolutional neural networks and recurrent neural networks has resulted in accurate detection of different features. The project has the potential to be applied in various industries that involve driving, such as transportation and automotive industries. Further research and development can lead to the development of more advanced and sophisticated driver safety systems.[11][20]

As the project continues to evolve, there is a need to address potential challenges, such as false alarms and privacy concerns, to ensure that the system is effective and reliable. The project's integration with other technologies, such as autonomous vehicles and smart city infrastructure, can further enhance its capabilities and impact on road safety.

Furthermore, the driver behavior detection project has the potential to be applied in various industries that involve driving, such as transportation and logistics, where driver safety is critical. The project can also be extended to include driver education programs that provide feedback and suggestions on how to improve driving skills, which can further reduce the number of accidents caused by unsafe driving behavior.

In conclusion, the driver behavior detection project using deep learning models and the Flutter software application is an innovative and promising solution that can significantly improve road safety. With continued research and development, this project has the potential to save lives, reduce accidents caused by unsafe driving habits, and make roads safer for everyone.[12]

Overall, this project has demonstrated the potential of machine learning in addressing real-world problems. It highlights the importance of integrating technology in enhancing safety measures and reducing the risk of accidents. This project serves as a foundation for future research and development in the field of driver safety, and it is hoped that it will contribute towards creating a safer environment for all road users.[7]

6.2 Future work

In the future, there are several areas that could be explored to further improve the driver behaviour detection project. One potential avenue for future work is to incorporate additional sensors, such as GPS or accelerometers, to provide more comprehensive data on driver behaviour. This could improve the accuracy of the models and enable more sophisticated analysis of driver behaviour.[24]

Multi-modal detection: The project focuses on detecting drowsiness, distraction, and seatbelt usage from visual cues. A potential future work can be to incorporate other modalities, such as audio signals and sensor data, to improve the accuracy of detection and reduce false positives.[6][8]

Large-scale deployment: The project can be scaled up to a large-scale deployment, where it can be integrated into existing driver safety systems in different industries. This can help reduce the occurrence of accidents caused by driver behavior and improve overall road safety.

Driver profiling: The project can be extended to develop driver profiles based on their behavior. This can help identify patterns of behavior that are associated with road accidents and develop targeted interventions to improve driver safety. Personalized alerts: The current project alerts the driver through a generic alarm system. A potential future work can be to develop personalized alerts based on the driver's behavior patterns and preferences. This can help improve the effectiveness of the alert system and reduce false alarms.

Emotion detection: The project can be extended to detect the driver's emotions, such as stress, anxiety, and anger. This can help identify emotional states that affect driving behavior and develop interventions to improve driver safety.[5]

Data collection and analysis: The project can be expanded to collect and analyze a large dataset of driving behavior, including different driving conditions and environments. This can help improve the accuracy of the ML models and develop targeted interventions for specific driving scenarios.

Multilingual support: The project can be extended to support multiple languages, making it suitable for different regions and countries. This can help improve the project's usability and accessibility.

Integration with insurance companies: The project could be integrated with insurance companies to provide incentives for safe driving. This could involve developing algorithms that can detect safe driving behaviors and provide discounts on insurance premiums for drivers who exhibit these behaviors.

Privacy and security: As the project collects sensitive data on driver behavior, it is crucial to ensure the privacy and security of this data. Future work could involve developing robust privacy and security protocols to protect the data from unauthorized access or misuse.

develop more advanced deep learning models: that can detect a wider range of driving behaviours and adapt to changes in driving conditions. This could involve exploring new deep learning techniques or incorporating other types of machine learning, such as reinforcement learning.[12]

developing more user-friendly interfaces for the Flutter application: such as voice-activated commands or integration with other in-car technologies. This could make the application more accessible and appealing to a wider range of drivers.

Finally, it would be valuable to conduct further testing and validation of the models, both in controlled environments and in real-world driving situations, to assess their effectiveness and identify areas for improvement. This could involve collaboration with automotive manufacturers or government agencies to integrate the driver behaviour detection project into existing safety systems or regulations.

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