MOBILE PHONE BASED DRIVER DROWSINESS DETECTION SYSTEM

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Table of Contents

[**CHAPTER ONE** 3](#_Toc143292314)

[**INTRODUCTION** 3](#_Toc143292315)

[**BACKGROUND** 4](#_Toc143292316)

[**PROBLEM STATEMENT** 8](#_Toc143292317)

[**OBJECTIVES** 9](#_Toc143292318)

[**General Objective** 9](#_Toc143292319)

[**Specific Objectives** 9](#_Toc143292320)

[**SCOPE OF THE STUDY** 10](#_Toc143292321)

[**SIGNIFICANCY OF THE STUDY** 12](#_Toc143292322)

[**CHAPTER TWO:** 13](#_Toc143292323)

[**LITERATURE REVIEW** 13](#_Toc143292324)

[**INTRODUCTION** 13](#_Toc143292325)

# **CHAPTER ONE**

## **INTRODUCTION**

Driver drowsiness is one of the major causes of road accidents, resulting in fatalities, injuries, and economic losses. [According to the National Highway Traffic Safety Administration (NHTSA), drowsy driving was responsible for 697 deaths and 91,000 crashes in 2019 in the United States1](https://www.bosch-mobility.com/en/solutions/assistance-systems/driver-drowsiness-detection/). [Moreover, a study by the American Automobile Association’s foundation for traffic safety estimated that more than 320,000 drowsy driving accidents happen each year, including 6400 fatal crashes2](https://www.mdpi.com/1424-8220/22/5/2069). Therefore, there is an urgent need to prevent and reduce the occurrence of driver drowsiness and its consequences.

One of the possible solutions is to develop a driver drowsiness detection system that can monitor the driver’s behavior and alert them when they show signs of fatigue or inattention. [Such a system can use various sensors and algorithms to detect drowsiness indicators, such as yawning frequency, eye-blinking frequency, eye-gaze movement, head movement, and facial expressions3](https://www.tomtom.com/newsroom/explainers-and-insights/driver-drowsiness-detection-systems/). However, most of the existing systems are either expensive, intrusive, or unreliable. For example, some systems require the installation of special cameras or electrodes on the driver’s head or body, which can be costly and uncomfortable. Other systems rely on subjective self-assessment or vehicle-based measures, which can be inaccurate or inconsistent.

Therefore, this project aims to develop a novel driver drowsiness detection system that can leverage the capabilities of mobile phones. Mobile phones are widely used and accessible devices that have built-in cameras, microphones, accelerometers, and other sensors that can be utilized for drowsiness detection. Moreover, mobile phones can communicate with other devices via Bluetooth or Wi-Fi, which can enable the integration of the system with the vehicle’s dashboard or audio system.

## **BACKGROUND**

Driver drowsiness is a pervasive global concern that poses a significant threat to road safety and public well-being. As individuals increasingly engage in a fast-paced modern lifestyle, the issue of drowsy driving has garnered substantial attention due to its detrimental effects on road accidents, human lives, and economies. The following comprehensive insights shed light on the prevalence and impact of driver drowsiness worldwide:

1. Magnitude of the Problem: Drowsy driving is responsible for a substantial portion of road accidents worldwide. The National Highway Traffic Safety Administration (NHTSA) reported an alarming figure of approximately 91,000 police-reported crashes associated with drowsy driving in the United States alone during the year 2017. This emphasizes the urgent need for targeted interventions to address this issue on a global scale.
2. Fatal Consequences of Fatigue-Related Crashes: Fatigue-related crashes have proven to be particularly fatal and injurious due to the impaired cognitive functions associated with drowsiness. European Union road safety reports have indicated that fatigue contributes to around 10-20% of all road accidents, underscoring the severity of its consequences in terms of human lives lost and families affected.
3. Economic Implications: The repercussions of drowsy driving extend beyond human suffering to encompass substantial economic costs. These costs include medical expenses, property damage, reduced workforce productivity, and legal expenditures. Evidently, fatigue-related crashes inflict a heavy toll on economies. Notably, a study conducted by the AAA Foundation for Traffic Safety estimated the annual economic cost of fatigue-related crashes in the United States to be a staggering $109 billion.
4. Vulnerable Groups and Risk Factors: Certain demographic groups are at a higher risk of succumbing to drowsy driving accidents. Young drivers, particularly those aged 16-24, have been identified as more susceptible due to their sleep patterns and habits. Additionally, individuals engaged in shift work or prolonged night shifts face an elevated risk due to disrupted sleep schedules.
5. Sleep Deprivation's Cognitive Impact: The cognitive impairments resulting from sleep deprivation are central to the dangers of drowsy driving. Diminished attention, delayed reaction times, and compromised decision-making faculties significantly compromise a driver's ability to navigate the road safely. Notably, staying awake for 18 hours has been likened to having a blood alcohol concentration (BAC) of 0.05%, a value that increases to 0.10% after 24 hours.
6. Mitigation Efforts and Prevention Strategies: In response to this pressing issue, public awareness campaigns and initiatives like "Drowsy Driving Prevention Week" have been launched to educate individuals about the perils of drowsy driving. Technological advancements, such as Advanced Driver Assistance Systems (ADAS), offer promising solutions by identifying signs of drowsiness and issuing alerts to drivers, potentially mitigating accidents caused by fatigue.
7. Reporting Challenges and Underestimation: It is essential to acknowledge that drowsy driving statistics might be underestimated due to the intricacies of accurately determining fatigue's contribution to accidents. This challenge necessitates a comprehensive approach to data collection and analysis, ensuring a more accurate understanding of the true extent of drowsy driving's impact.

In Europe, driver fatigue is responsible for up to 20% of road accidents and up to 25% of fatal and serious crashes. A study by the European Commission estimated that driver fatigue causes around 20% of motorway accidents in the EU, resulting in more than 1,000 deaths per year.

In Australia, driver sleepiness accounts for about 20% of fatal crashes and 15% of serious injury crashes. A survey by the Australian Transport Safety Bureau found that 29.4% of drivers admitted to having driven while fatigued in the previous year, and 20.1% reported having fallen asleep or nodded off while driving at least once in their lifetime.

In Africa, road traffic injuries are also a major public health problem and cause huge societal and financial burdens. [According to the WHO, the African region has the highest road traffic fatality rate in the world, with 26.6 deaths per 100,000 population in 20181](https://www.cdc.gov/sleep/features/drowsy-driving.html). However, there is a lack of reliable data on the prevalence and impact of driver drowsiness in Africa, as most countries do not have comprehensive systems for collecting and analyzing road crash data. Moreover, there are many factors that may increase the risk of driver drowsiness in Africa, such as poor road infrastructure, inadequate enforcement of traffic laws, high prevalence of infectious diseases (such as malaria and HIV/AIDS), and cultural practices (such as night travel and long-distance driving).

Driver drowsiness presents a critical road safety concern in Africa as well, manifesting in alarming statistics that underscore the urgent need for targeted interventions to mitigate its effects. The following comprehensive compilation of data sheds light on the prevalence, impact, and economic ramifications of driver drowsiness across the African continent:

1. High Prevalence of Drowsy Driving: Drowsy driving is a significant contributor to road accidents in Africa. According to the World Health Organization (WHO), drowsiness or fatigue is estimated to be involved in approximately 15% to 20% of road crashes on the continent.
2. Elevated Fatality Rates: Fatigue-related crashes have dire consequences in Africa due to its underdeveloped road safety infrastructure and limited emergency medical services. These crashes result in a higher proportion of fatalities compared to accidents attributed to other causes.
3. Economic Costs and Impacts: Driver drowsiness imposes substantial economic burdens on African countries. Accidents stemming from drowsy driving contribute to medical expenses, property damage, reduced workforce productivity, and increased demand for healthcare resources. The economic toll underscores the urgency of addressing this issue comprehensively.
4. Risk Factors and Vulnerable Groups: Certain demographic groups in Africa are particularly susceptible to drowsy driving accidents. Professional drivers, such as long-haul truckers, public transportation operators, and shift workers, face heightened risks due to their extended driving hours and irregular sleep patterns.
5. Limited Infrastructure for Fatigue Management: Many African nations lack comprehensive infrastructure and regulations for addressing driver fatigue. This gap hampers effective mitigation efforts, making it imperative to implement tailored strategies that consider the unique challenges faced by the continent.
6. Societal and Health Implications: Drowsy driving accidents lead to significant societal and health implications. Families are shattered, and communities are left grappling with the emotional and financial aftermath of such accidents. Moreover, the strain on healthcare systems further underscores the need for preventive measures.
7. Lack of Data and Reporting Challenges: Accurate reporting of drowsy driving incidents can be challenging in Africa due to limited data collection and reporting mechanisms. This makes it difficult to gauge the true extent of the problem and hinders the development of effective policies and countermeasures.
8. Need for Context-Specific Solutions: Drowsy driving's impact in Africa necessitates context-specific solutions that account for the continent's diverse road conditions, socioeconomic factors, and cultural norms. Effective interventions must be culturally sensitive and tailored to the unique challenges present in various regions.

Uganda, like many countries, faces a considerable challenge with drowsy driving incidents. Anecdotal evidence suggests that driver fatigue is a contributing factor in a notable proportion of road accidents in the country.

Driver drowsiness significantly contributes to the occurrence and severity of road accidents in Uganda. Fatigue-related accidents often result in greater harm due to impaired reflexes, compromised decision-making, and decreased awareness.

The economic consequences of drowsy driving accidents are substantial in Uganda. These costs encompass medical expenses, property damage, lost productivity, and increased demand for healthcare resources, impacting the nation's economy and welfare.

Long-distance drivers, commercial vehicle operators, and those engaged in night shifts are particularly vulnerable to drowsy driving incidents. Their extended hours on the road and disrupted sleep patterns contribute to increased risks.

Drowsy driving accidents have far-reaching impacts, affecting not only the individuals involved but also their families and communities. Loss of life, injuries, and property damage disrupt livelihoods and strain local resources.

Uganda's road safety infrastructure may lack comprehensive mechanisms to address driver fatigue effectively. The absence of adequate rest areas, fatigue monitoring systems, and public awareness campaigns further compounds the problem.

Accurate reporting of drowsy driving incidents in Uganda is hindered by limited data collection and reporting mechanisms. This challenge hampers the development of evidence-based policies and interventions.

Uganda's unique road conditions, driving culture, and socioeconomic factors necessitate tailored solutions for combating drowsy driving. Interventions should be culturally sensitive and aligned with the country's specific challenges.

Advocacy efforts and public awareness campaigns play a vital role in promoting safer driving practices and garnering support from stakeholders and government agencies to prioritize drowsy driving prevention.

Addressing driver drowsiness in Uganda requires collaborative efforts involving government agencies, non-governmental organizations, transport associations, healthcare providers, and road safety experts. Cooperation facilitates the sharing of knowledge, resources, and expertise to develop effective countermeasures.

Uganda urgently needs a comprehensive approach to tackle driver drowsiness and its implications. Implementing targeted interventions, enhancing road safety infrastructure, and fostering a culture of responsible driving are paramount to ensure safer roads for all.

In view of these statistics and insights, it is evident that drowsy driving presents a complex and urgent challenge globally, in Africa and Uganda to be specific. To ensure safer roads, protect lives, and bolster economic growth, concerted efforts are essential to develop and implement targeted interventions that address driver drowsiness comprehensively and account for the continent's unique circumstances.

## **PROBLEM STATEMENT**

The prevalence of driver drowsiness poses a formidable challenge to road safety and public welfare in Uganda. Despite its significant impact on road accidents, economic productivity, and human lives, there remains a critical lack of comprehensive strategies and infrastructure to address this issue effectively. The absence of data-driven interventions, context-specific awareness campaigns, and tailored regulations undermines efforts to mitigate the adverse effects of drowsy driving. Urgent action is imperative to develop evidence-based solutions that safeguard Ugandan roads, protect citizens, and contribute to the nation's economic growth.

## **OBJECTIVES**

**General Objective**: To investigate the impact of image-based and biological based measures with mobile technologies on drowsy driving.

**Specific Objectives**:

* To design and implement a mobile phone based driver drowsiness detection system that can use image-based and biological-based measures to detect drowsiness.
* To evaluate the performance and usability of the system in terms of accuracy, sensitivity, specificity, false alarm rate, user satisfaction, and user acceptance.
* To compare the system with existing driver drowsiness detection systems and identify its advantages and limitations.
* To test and validate impact of the Mobile Driver Drowsiness system on the lives of drivers worldwide.

## **SCOPE OF THE STUDY**

The proposed project aims to design, develop, and implement a comprehensive mobile phone-based driver drowsiness detection system that utilizes image-based and biological-based measures to effectively identify and mitigate instances of driver drowsiness. The scope of this study encompasses the following key aspects:

1. System Design and Development:

* Designing a user-friendly and intuitive mobile application compatible with widely used smartphone platforms (iOS and Android).
* Developing the backend infrastructure necessary to support real-time data processing and analysis for drowsiness detection.
* Integrating image-capturing capabilities, leveraging the smartphone's front-facing camera to capture the driver's facial features and monitor visual cues of drowsiness.

2. Image-Based Drowsiness Detection:

* Researching and implementing state-of-the-art computer vision algorithms to analyze facial expressions and eye movements for signs of drowsiness.
* Developing algorithms to assess key indicators such as eye closure frequency, head pose changes, and facial muscle activity indicative of drowsiness.
* Employing machine learning techniques to train the system to accurately recognize patterns associated with drowsiness and alertness.

3. Biological-Based Drowsiness Detection:

* Investigating viable biological measures, such as heart rate variability and skin conductance, to assess physiological changes related to driver fatigue.
* Developing a non-intrusive system that integrates with wearable devices or smartphone sensors to monitor these biological indicators.
* Exploring machine learning models to interpret the collected biological data and determine the likelihood of drowsiness.

4. Real-time Monitoring and Alerts:

* Implementing a real-time monitoring system that continuously assesses driver condition during the journey.
* Establishing thresholds for detecting drowsiness based on the analysis of both image-based and biological-based measures.
* Generating timely alerts to the driver through visual, auditory, and tactile signals when signs of drowsiness are detected.

5. Data Privacy and Security:

* Implementing robust data privacy protocols to ensure that sensitive information collected from users is stored and transmitted securely.
* Adhering to applicable data protection regulations and guidelines to safeguard user privacy throughout the data collection and analysis processes.

6. User Interface and Experience:

* Designing an intuitive and user-friendly interface for the mobile application, allowing users to easily interact with the drowsiness detection system.
* Incorporating features that enable users to customize alert preferences, ensuring a personalized experience.

7. Performance Evaluation:

* Conducting rigorous testing and validation of the developed system using a diverse dataset of simulated and real-world driving scenarios.
* Assessing the system's accuracy, sensitivity, specificity, and response time in detecting drowsiness across various conditions.
* Comparing the performance of image-based and biological-based measures individually and in combination.

8. Implementation and Deployment:

* Deploying the developed mobile application on a sample group of volunteer drivers for real-world testing and validation.
* Collecting feedback from users to assess the system's effectiveness, user-friendliness, and impact on driving behavior.

9. Documentation and Reporting:

* Preparing comprehensive technical documentation detailing the system architecture, algorithms, and implementation details.
* Creating user manuals and guides to facilitate the installation, configuration, and use of the mobile application.
* Compiling a detailed report summarizing the research, development process, results, and recommendations for future enhancements.

## **SIGNIFICANCY OF THE STUDY**

This project is significant for several reasons. First, it addresses a critical and prevalent problem of driver drowsiness, which is a major cause of road accidents in Uganda and globally. By developing a mobile phone based driver drowsiness detection system, this project aims to prevent and reduce the occurrence and consequences of driver drowsiness and improve road safety. Second, it contributes to the advancement of science and technology by designing and implementing a novel system that can use image-based and biological-based measures to detect drowsiness. This project will also provide a dataset of driver drowsiness images and signals collected from real driving scenarios using the system, which can be useful for future research and development. Third, it enhances the usability and accessibility of driver drowsiness detection systems by leveraging the capabilities of mobile phones, which are widely used and available devices. This project will also evaluate the performance and user satisfaction of the system and compare it with existing systems to identify its advantages and limitations. Fourth, it benefits the target population, the stakeholders, and the public interest by providing a low-cost, non-intrusive, and reliable solution to detect driver drowsiness and alert drivers when they show signs of fatigue or inattention. This project will also raise awareness and educate drivers about the risks and impacts of driver drowsiness and the importance of staying alert and attentive while driving.

# **CHAPTER TWO:**

## **LITERATURE REVIEW: INTRODUCTION**

The purpose of this literature review is to provide a comprehensive overview of the current state of knowledge on driver drowsiness detection systems. The literature review will cover the following aspects:

* The definition and measurement of driver drowsiness and its effects on driving performance and safety
* The existing methods and techniques for driver drowsiness detection using image-based and biological-based measures
* The advantages and limitations of different types of driver drowsiness detection systems
* The usability and user satisfaction of driver drowsiness detection systems
* The comparison and evaluation of different driver drowsiness detection systems

The scope of this literature review is limited to the studies that focus on driver drowsiness detection using mobile phones or similar devices. The literature review will not include the studies that focus on other factors that may influence driver drowsiness, such as medication, alcohol, or health conditions. The literature review will also not include the studies that focus on other interventions or countermeasures to prevent or reduce driver drowsiness.