# TED UNIVERSITY

## CMPE491

## Senior Design Project I

# SAFE AWAKE

## -DROWSINESS DETECTION & ALERTING SYSTEM-

**Project Specifications Report**

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**SUPERVISOR:**
Yücel ÇİMTAY

**JURY MEMBERS:**
Gökçe Nur YILMAZ
Venera ADANOVA

**Team Members:**

Başak DEĞERLİ basak.degerli@tedu.edu.tr

Özge AYDIN ozge.aydin18@tedu.edu.tr

Büşra TOMBAK busra.tombak@tedu.edu.tr

Kemal GEVGİLİ kemal.gevgili@tedu.edu.tr


**PROJECT URL:** https://safeawake.github.io/

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# 1. Introduction

Nowadays, many traffic accidents occur due to various reasons. For example, the data announced by TÜİK shows that a total of 1 million 232 thousand 957 traffic accidents occurred in 2022. In addition, according to the data published by the Traffic Department of the General Directorate of Security, it has been determined that road traffic accidents cause the death of 1.2 million people on average every year, or 3242 people every day. Based on this data, we conclude that traffic accidents cause serious consequences such as putting human lives at risk. It can be said that traffic accidents mostly occur due to the negligence of the driver. It can be said that one of the reasons is driving while drowsiness. Based on this problem, we wanted to develop a project that could help reduce traffic accidents in our senior project. In the project, we determined our main users to be long-distance truck, intercity bus drivers or professional drivers who are prone to drowsiness. In this project, we will develop an advanced “Drowsiness Detection and Alerting System" called SAFE AWAKE by using Raspberry Pi. This system aims to accurately detect signs of drowsiness by monitoring the driver's facial expressions and eyelid movement using "image processing" techniques and "machine learning" algorithms. In this way, our project will contribute to drivers having a safer driving experience and preventing traffic accidents.

## 1.1. Description

Our aim in this project is to increase road safety by preventing accidents caused by drowsy driving. Based on this purpose, we will use "image processing" and "machine learning" techniques in our project.

First of all, we need to teach the system how to understand drowsiness and wakefulness from facial expression and eyelid movement. For this reason, we will get support from the “machine learning” algorithm. As the first step of this, data collection phase will be carried out. Images representing sleepy and awake states will be collected and selected. Once the data is collected, a labeling process will be performed to determine whether each image is “sleepy” or “awake.” These labels are important for the model to perform correct classification. The collected data will be pre-processed to make it suitable for training the model. This stage includes adjusting image sizes, making color corrections, and so on. The model training process will be carried out using the prepared data. The artificial intelligence model will learn to distinguish "sleepy" and "awake" states by analyzing the images. The trained model will be tested on validation data and its performance will be evaluated. The success of the model will be measured by the percentage of correct classification or other metrics. In the final stage, the successfully trained model will be available in our project.

Secondly, we will also include "image processing" techniques in our project. Thanks to these techniques, we will be able to analyze the driver's facial expression and eyelid movement. For this analysis, we will use Raspberry Pi which is the hardware component. We aim to connect a camera with the Raspberry Pi to help us monitor the driver's facial expressions and eyelid movements in real time.

As a result, the system will constantly evaluate the driver's drowsiness and warn the driver with an alarm system in case of signs of drowsiness, allowing driver to regain driver’s attention and focus on the road. Thanks to this alarm system, it will help prevent possible accidents caused by drowsy driving.

## 1.2. Constraints

**Time Constraint**

Since this project is a senior project of TED University Computer Engineering department, it must be completed and implemented at the end of the 2-semester academic period. In this context, the determined tasks will be uploaded to the LMS system before their deadlines and sent to the course coordinator, supervisor and jury members via e-mail.

**Economic Constraints**

Economic constraints can be examined as implementation cost and affordability. Development and deployment of the SAFE AWAKE system includes costs associated with acquiring hardware (Pi Camera Module, Raspberry Pi, Buzzer, Micro USB Cable), and software. In addition, it is important to ensure that the system remains affordable so that it can have a wide range of users. However, although we will ensure that the system keeps up with new technologies, it will be difficult to ensure that it is cost-effective.

**Ethical Constraints**

Our system uses image processing techniques to detect whether drivers are "sleepy" or "awake" and records this data. Therefore, the system must operate with the consent and knowledge of the people being monitored. Collected personal data cannot be used for other purposes without the person's consent. Collecting and using this information without the person's consent poses a risk to data privacy.

### Health and Safety Constraints

When drowsiness is not detected, the system can give a false alarm, which may cause distraction and stress for the driver. Therefore, it will be ensured that the alarm system is designed to minimize false alarms. In addition, alarms used to warn drowsy drivers may frighten the driver and cause safety problems. Therefore, alarms will be designed with attention to these situations.

### Environmental Constraints

During the development and repair of this system, many electronic devices will be used. Disposal of old or unusable components will also continually create e-waste. Therefore, it is important to follow proper recycling and disposal procedures. Additionally, the operation of the SAFE AWAKE system depends on external factors and the lighting inside the vehicle. Changes in lighting conditions, such as changing from day to night, can affect the system's ability to accurately monitor facial expressions and eyelid movement. External factors such as grime and dust on the camera lens also reduce the performance of the system and deteriorate the image clarity.

### Legal and political constraints

We plan to make agreements with companies such as long-haul truck and intercity bus companies to distribute our system. The SAFE AWAKE system must provide all legal requirements and standards of these companies so that its distribution is not hindered by legal issues. Additionally, as mentioned in the "Ethical Constraints", ensuring the protection of driver data is necessary to prevent possible legal consequences.

### Manufacturability constraints

In this project, our main goal is to protect people from accidents and minimize accidents that occur due to drowsy and concentration problems. Therefore, we aim for this project to be adaptable to various vehicle types. In case of mass production, SAFE AWAKE's manufacturability, consistency and quality control must be ensured.

### Sustainability Constraints

Sustainability is not just about protecting the environment, it is about protecting the lives and resources of future generations. Based on this, we aimed to use the vehicle battery as the power source of the system in the SAFE AWAKE system, not only to contribute to safer roads, but also to minimize energy consumption and reduce material usage. Thus, we created a holistic approach to sustainability.

## 1.3. Professional and Ethical Issues

The development of the SAFE AWAKE which is “Drowsiness Detection and Alerting System” offers significant potential for enhancing road safety. However, it also raises a set of professional and ethical issues that must be addressed. Adhering to the **“ACM Code of Ethics and Professional Conduct”** and **“IEEE Code of Ethics”** will help us navigate these issues and ensure the responsible design, deployment, and use of this technology to benefit society while maintaining ethical standards.

**Public Interests**

According to the definition of **ACM Code of Ethics and Professional Conduct**, the Code contains principles formulated as statements of responsibility based on the understanding that the public interest is always the primary concern. Therefore, the system should prioritize the public interest. Designed to serve the greater good by reducing traffic accidents, our system must be made accessible and affordable to those who need it, especially long-haul commuters or professional drivers who are prone to drowsiness.

**Privacy and Data Security**

Another primary ethical concern in developing the SAFE AWAKE system is privacy and data security. Our system uses image processing techniques to monitor the driver's facial expressions and eyelid movements. To align with the **ACM Code of Ethics**, which emphasizes respecting privacy, it is crucial to ensure that data is collected and stored securely, and that the system operates with the consent and knowledge of the individuals being monitored. The **IEEE Code of Ethics** also underlines the importance of safeguarding privacy and maintaining data integrity. Thus, collected personal data cannot be used for other purposes without the person's consent.

**Accuracy and Reliability**

Our system relies on image processing and machine learning algorithms for drowsiness detection. It is essential to ensure the accuracy and reliability of these algorithms. Ethical rules must be followed to minimize false alarms and protect users from unnecessary alerts. The system needs to be tested and verified frequently to maintain its integrity. Any issues that may result in major risks must be reported to the relevant institution, organization or person.

**Transparency and Accountability**

The operation of the SAFE AWAKE system should be well-documented and its decision-making processes should be explainable. Users must be able to comprehend the system's warnings and be informed about how their data is used. According to the **ACM Code of Ethics and Professional Conduct**, all relevant system capabilities, limitations, and potential problems must be fully disclosed. In case of system failure or incorrect drowsiness detection, responsibility for any negative consequences must be assumed, adhering to the principles of professional responsibility and accountability.

**Safety and Well-being**

The main purpose of the SAFE AWAKE system is to enhance road safety by preventing accidents resulting from drowsy driving. Both the **ACM** and **IEEE codes of ethics** emphasize the importance of safety and well-being as paramount concerns. Accordingly, the system has an obligation to ensure that warnings are reliable, timely, and effective in preventing accidents. Any design or operational flaws that could compromise safety must be addressed promptly.

# 2. Requirements

The following section describes the requirements for the SAFE AWAKE which is “Drowsiness Detection and Alerting System" project, which aims to reduce the risks related to drowsy driving in order to increase road and passenger safety.

## 2.1 Functional Requirements

**Drowsiness Detection**

- The system must monitor the driver's movements of the eyelids and facial expressions in real time by using “image processing” techniques.
- The system should use “machine learning” methods to correctly identify the signs of drowsiness.
- Drowsiness detection should be made with a high level of accuracy to minimize false alarms.

**Data Acquisition**

- The system should be equipped with a camera capable of capturing high-quality images.
- The camera must provide a clear view of the driver's face and eyes from a proper angle.
- The camera must be compatible with embedded equipment (e.g., Raspberry Pi).
- Regular intervals should be set for the system to continuously capture photographs for analysis.

**Real-Time Processing**

- The Raspberry Pi should serve as the central processing unit.
- The system should have sufficient processing power to handle the processing load without significant delays.
- Image processing and machine learning algorithms must run in real-time to ensure timely drowsiness detection.

**Drowsiness Alerting**

- The device needs to warn the driver by sounding an audible alarm when it notices symptoms of tiredness.
- The volume of the alarm should be high enough to draw the driver's attention without being uncomfortable.
- The system should also provide a visual alert if possible (e.g., flashing lights on a display).

## 2.2 Non-Functional Requirements

**Accuracy**

- The system's drowsiness detection algorithms should have a high accuracy rate to minimize false negatives and false positives.

**Real-Time Responsiveness**

- The system must respond to sleepiness signs, ensuring timely alerts to the driver.

**User-Friendly Interface**

- The user interface of the system should be simple to use and intuitive.
- Alerts should not be overly distracting or disturbing for the driver.

**Robustness and Reliability**

- The system needs to be reliable enough to function in a variety of lighting scenarios, on a variety of types of roads, and with drivers that have varying physical attributes.

**Scalability**

- The system should be developed with scalability in mind in order to allow for future upgrades or interaction with other safety systems.

**Data Privacy and Security**

- The system needs to follow the best practices for data security and protect driver privacy.
- Any collected data should be kept securely and deleted when no longer it is needed.

**Environmental Considerations**

- The system should be resilient to vibrations and shocks commonly experienced in a vehicle.
- The system should operate within the specified temperature and humidity range for various vehicles without performance degradation.

**Regulatory Compliance**

- The system is required to comply by all applicable safety and traffic laws regulations in the regions where it is deployed.
- The system should not interfere with the proper operation of the vehicle or other safety systems.

**Technical Documentation**

- The system should provide technical documentation for troubleshooting and future maintenance, and keep up-to-date technical documentation for hardware, algorithms, and system components.

The "Drowsiness Detection and Alerting System" project's requirements serve as its foundation, assuring the development of a workable and dependable solution to lower the hazards connected with drowsy driving.

# 3. References


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