ÇANKAYA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report

Version 1

CENG 408

Innovative System Design and Development II

P2019-11
FATIGUE DETECTION

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Abstract

In recent years, road accidents caused by the driver have increased significantly as the studies that conducted each year shows. We can deduct from our research driver fatigue is one of the major causes of these traffic accidents. Fatigue increases the risk of injuries or other accidents. Also, fatigue can reduce drivers' attention, ability to make decisions, and it can result in the inability to keep themselves awake, increased errors in judgment, etc. Accidents involving fatigued drivers tend to be particularly serious since the driver does not have a quick enough reaction time and is too slow to attempt to avoid an accident. Due to these situations, giving drivers early warning that they need to take a break is vital for safe travel. Hence, there is a requirement for a system to evaluate the fatigue level of the driver and alert him when he/she feels sleepy to avoid accidents caused by this evitable cause.

Key words: Fatigue, fatigue detection for drivers, drowsiness, real-time drowsiness for drivers

Özet

Son yıllarda trafik kazaları önemli ölçüde arttı. Sürücünün yorgun olması, bu trafik kazalarının en önemli nedenlerinden biri. Yorgun halde trafiğe çıkmak, yaralanma veya diğer kaza riskini artırır. Ayrıca, sürücülerin dikkatini, karar verme yeteneğini azaltabilir ve uyanık kalamama, yargılamada hatalar vb. ile sonuçlanabilir. Yorgun sürücülerin neden olduğu kazalar, sürücünün yeterince hızlı tepki gösteremediği ve olası kazadan kaçınamadıkları dolayı ciddi olma eğilimindedir. Bu durumlar nedeniyle, sürücülere mola vermeleri konusunda erken uyarı vermek güvenli bir seyahat için çok önemlidir. Bu nedenle, sürücünün yorgunluk seviyesini ölçmek ve kazaları önlemek için uykulu hissettiğinde onu uyarmak amaçlı bir sisteme ihtiyaç vardır.

Otomatik görme tabanlı sürücü yorgunluğu tanıma sistemleri, yüz ifadesi analiz etme teknolojisine dayanan, ileriye dönük ticari uygulamalardan biridir. Orijinal sürücünün yüz görüntülerinden etkili bir yüz konumu elde etmek, başarılı bir yorgunluk tespitinde yüz ifadesi tanıma hayati bir adımdır.

Anahtar Kelimeler: Yorgunluk, sürücüler için yorgunluk tespiti, uykulu olma, sürücüler için gerçek zamanlı uykulu olma

1. Introduction

Fatigue is normally defined as a feeling of the absence of energy and motivation that can be physical or perceptual. In general, fatigue affects task performance: a reduction in alertness, longer reaction times, poorer psychometric coordination, and less efficient information processing [13]. Fatigue leads to decreased actual performance and decreased motivation to perform any task needs focusing. Fatigue has specific and inevitable consequences of driving behavior. To draw from these results, driver fatigue is a major cause of traffic accidents. We plan to adopt more than one approach to describe and normalizing facial expression images. We are aiming to find a crucial solution to save passenger lives due to that is the major cause of traffic accidents. Accidents involving sleepy drivers tend to be particularly serious since the sleepy driver does not have a quick enough reaction time and is too slow to attempt to avoid an accident. Giving drivers early warning that they need to take a break is vital for safe travel. We are planning to place two cameras into the car and check the face expression, road lines at the same time while drivers are driving. According to these inputs, the system will give a result that can referred to as the fatigue level of the driver.

1.1 Problem Statement

There are many preventable traffic accidents caused by drivers who are tired and have a long response time. Vehicle collisions lead to significant death and disabilities as well as significant financial cost to both security and individual due to the driver impairments. In addition, the environmental loss is one of the disadvantages of the accident. These accidents result in human as well as nonhuman loss. The driver can be warned before possible accidents occur and can stop and rest as a result. Our aim is to find a solution to prevent these accidents.

1.2 Solution Statement

We plan to build a system that monitors and analyzes the movements of the vehicle and the driver. This system will fetch data from cameras that monitor driver and car behavior. When it receives the necessary information, the system will decide whether drivers need to take a break or not based on the results of the evaluation of the input from the cameras. It will combine multiple symptoms to have a reliable result.

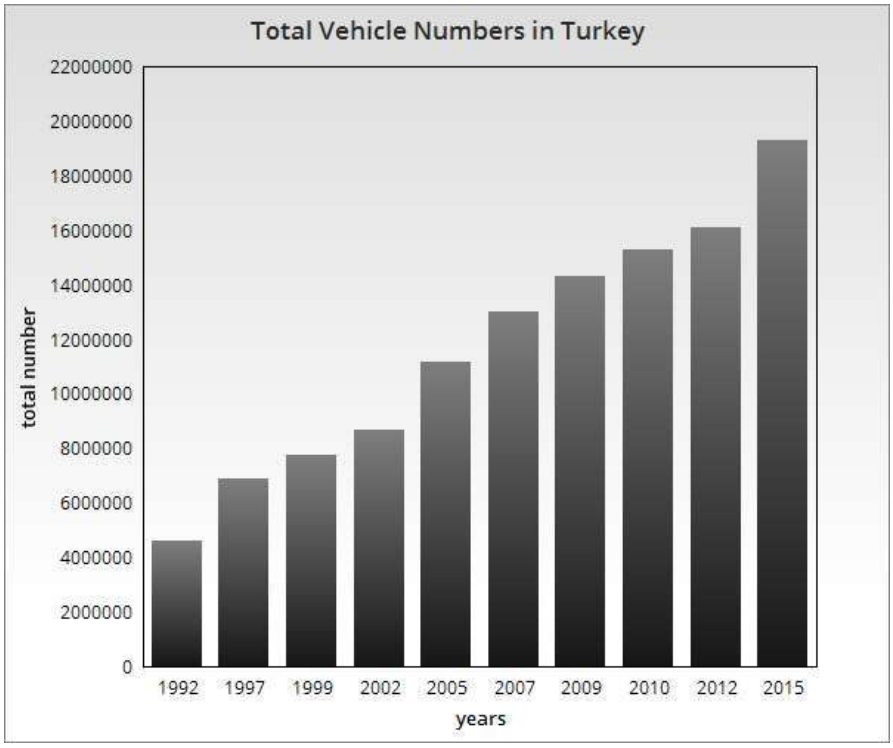
1.3 Related Work

To improve traffic safety, and to lessen the number of traffic accidents caused by the driver, numerous universities, automotive and governments are impacting to the development of Advanced Driver Assistance System for driver analysis. In this sense, the use of visual information to know the driver's tiredness state and understand their behavior is a still active research area. This problem involves the recognition of human actions when in a state of fatigue through the analysis of eyes, mouth, and head. In same systems they also add the driver pulse or brain waves to have more accurate outcomes. Overall, this is not an easy job, even for humans because there are many aspects engaged, such as changing illumination conditions and a selection of possible face poses.

2. Literature Search

2.1 Introduction

According to TÜİK, at the end of the December of 2018, there are 22 million vehicles registered in Turkey, 54.2% automobile, 16.4% van, 14% motorcycle, 8.3% tractor, 3.7% truck, 2.1% minibus, 1% bus and 0.3% constituted special purpose vehicle. Over the year's vehicle numbers increased steadily as you see down below.



The rapid increase in vehicles in traffic causes an increase in accidents that take place in our country. People who are responsible for these accidents 89.5% are the drivers. One of the main causes of these accidents is fatigued driving.

There are some already made fatigue detection systems based on lane position, steering wheel movements, pedal use and brain signals (by using a sensor attached to the skin). They are for analyzing the behavior of the driver on the road. Also, another type of fatigue detection system that is based on face recognition which depends on analyzing the gestures of the driver. It is for detecting symptoms listed below;

- blinking frequency
- yawn detection
- head nod
- fixed gaze
- etc.

If any of these symptoms are detected frequently, the system will alert the driver. When drivers are fatigued, their alertness level and response time reduces which can cause an accident.

In our report, we will be focusing on how to detect fatigue levels of the drivers and warn them based on their results. In our system, we will use image processing, machine learning and statistics in necessary areas.

2.2 Real Time-based Fatigue Detection Systems

Drivers' fatigue detection is a car safety technology that helps them for preventing possible accidents caused by the fatigued driver. Several manufacturers, such as Audi, Volvo, and Mercedes, currently come with fatigue detection systems that monitor a vehicle's movements. When fatigue is detected, drivers are warned both as in sound and visual.

2.3 Face Recognition

2.3.1 What is Face Recognition?

Facial recognition system is a developing technology that can identify or verify a person's face from an image or digital video etc. As compared with other systems using fingerprint and iris etc. face recognition has distinctive benefits because of its contact-free process. The images can be caught from a distance without any necessary. These systems became very popular in recent years. The facial recognition market is currently expected to grow to $7.7 billion in 2022 from $4 billion in 2017 according to researchers that worked in this field. That is why facial recognition has all kinds of commercial applications. It can be used for everything from security to advertising.[2]

2.3.2Some Examples of Face Recognition Algorithms

This section contains information about facial recognition algorithms that are used for fatigue detection previously in the projects we came across while searching for our literature review document:

2.3.2.1 Hidden Markov Model

HMM is used to encode facial features. It is aimed to find fatigue by supporting environmental and biological factors. At different times, the level of fatigue is found and compared by considering the same factors. [3]

2.3.2.2 Active Appearance Model

With the AAM (Active Imaging Model) algorithm, fatigue is found in eye and head movements. AdaBoos algorithm is also used while facial and head movements are found. Conditions of the eyes are taken into account. Open and closed situations are important. Determinations are made by taking these situations into consideration. The basis of the algorithm is to obtain statistical data with the help of views and shapes. [4]

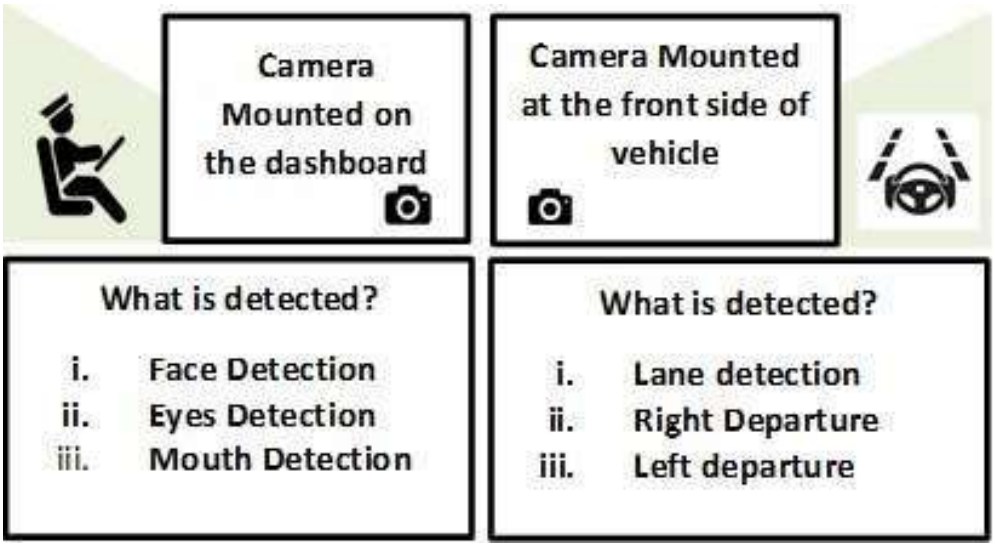
2.3.2.3 Procedural Content Generation

Procedural Content Generation (PCG) is the automation of media production. This media can be anything a human would usually poetry, paintings, music, architectural drawings or film PCG algorithm is one that either produces a large amount of content for a small investing of input data, or one that adds structure to random noise.[5]

2.3.2.4 Linde, Buzo and Gray

The real name of LGB (Linde, Buzo and Gray) algorithm is GLA (Generalized Lloyd Algorithm). The aim is to define the face through quantization. The LBG algorithm is tested for different image energy percentage. The vector is used for quantization. The obtained data is transferred to the database and evaluations are made. [6]

2.4 How to Detect Fatigue Symptoms



2.4.1 Detecting the symptoms of fatigue with Driver Behavioral Measures

Fatigue is a term used to describe an overall feeling of lack of energy. Fatigue is also known as tiredness, reduced energy, physical or mental exhaustion, or lack of motivation caused by various reasons. Causes of fatigue can be psychological, physiological, and physical. There some warning signs that are seen on a fatigued person.

- Tired eyes, legs
- Stiff shoulders
- Whole-body tiredness
- Trouble concentrating
- Boredom or lack of motivation
- Nervousness, anxiety, or impatience
- Exhaustion, even after sleeping
- Irritability
- Weakness or malaise

2.4.2 Detecting the symptoms of fatigue with Vehicle-Based Measures

Other than drivers' appearance we can measure the fatigue based on the driving performance which forms on the way the driver controls the vehicle. These measures include steering wheel movement (SWM), speed variability and standard deviation of lateral position [7]. Car manufacturers such as Mercedes and Volvo use this technique to evaluate driver drowsiness. These symptoms usually occur during the later stage of fatigue. Furthermore, these measures are highly dependent on road geometry and are effective in a limited range of conditions which means circumstances of environment are determinant. When exposed to real environments with considerable variation, these systems often fail to function efficiently.[8]

2.5 Technology Used

In this fatigue detection system, we will be using a variety of different libraries. For preprocessing and machine learning we will use OpenCV [9]. For GUI (Graphical User Interface) we will use wxpython [10]. These libraries are supported by Python. Due to this, we will be using Python language for preprocessing, machine learning and GUI part of the project.

3 Software Requirements Specification

3.1 Introduction

3.1.1 Purpose

This document is an SRS for a fatigue detection system that we will work on. The researches show that, road accidents risen undoubtedly. One of the key reasons for these accidents, is the driver's fatigue. Accidents involving sleepy drivers tend to be particularly serious since the sleepy driver does not have a quick enough reaction time. Hence, there is a requirement for a technique to calculate the fatigue level of driver and warn him when he or she feels drowsy to prevent accidents. The aim of our project is to detect the user 's face and observe the change in facial characteristics to prevent any accidents caused by fatigue driving. The features described below are used to monitor the level of fatigue. One of the most important features is that it warns drivers that they need to take an early break. [11]

3.1.2 Scope of Project

At the beginning of the project, our aim is to minimize traffic accidents. We know that fatigue has a major impact on the occurrence of accidents. In order to prevent these accidents, we aimed to create a system that stimulates fatigue to a certain level.

We will thoroughly examine the differences in the users' face and eyes constantly and, we will consider road lanes too. The researches show that the proximity of the user to the lanes on the road is an important factor. Deviations will have a great effect on fatigue warnings. Because as the fatigue level of the users' increases, their attention and concentration on the road will decrease.

We will develop our project by adding new ideas parallel to our consultant considering face, eye and road control. Our document research and previously developed projects will help us to use new ideas and methods.

3.1.3 Glossary

Table 1 Glossary of SRS

Term	Definition
User	The driver.
UI	User interface.
OpenCV	Open Source Computer Vision Library
Software Requirements Specification (SRS)	A document that completely describes all of the functions of a proposed system and the constraints under which it must operate. For example, this document.
Symptom	A physical or mental feature is regarded as indicating a condition of disease, particularly such a feature that is apparent to the patient.

3.1.4 Overview of Document

This document has three main parts. The first part, "Overall Description" contains the product perspective, features, user characteristics, and constraints. In the second part, "Requirements Specification" contains external interface requirements, functional requirements, performance requirements and software system attributes.

3.2 Overall Description

3.2.1 Product Perspective

The fatigue detection system will process the images of the user and generate a result based on both user behavioral measures and vehicle-based measures. Users' behavioral measures can be tired and closing eyes, constant yawning, trouble concentrating, etc. Vehicle- based measures can be an unsafe lane change. Using these measurements, the system will produce a result and according to that result, the system will alert the user if s/he needs to take a break or not.

3.2.2 Product Features

The fatigue detection system will constantly measure the behaviors that we have mentioned above. The system will measure any data that can lead to increased fatigue levels. According to these results, the system will alert the user.

3.2.3 User Characteristics

The user does not need any skill or knowledge to use the fatigue detection system. The system constantly measures the behaviors that we have mentioned, and it automatically alerts the user if necessary. The system cannot be activated or deactivated manually; it runs as the engine of the car runs.

3.2.4 Design and Implementation Constraints

1. Hardware limitations;

   The fatigue detection system should have two cameras. (Camera 1: Will be used for monitoring drivers' behavior, Camera 2: Will be used for lane tracking.)

2. Parallel operation;

   The fatigue detection system will take input from both camera 1 and camera 2. These cameras should work parallel in order to provide a solid result.

3.3 Requirements Specification

3.3.1 External Interface Requirements

3.3.1.1 User Interfaces

Since the fatigue detection system does not require sign up or login options, when the system starts working the main screen should pop up. In this screen, when the input is given to the system, the outputs will appear.

3.3.1.2 Hardware Interfaces

To be able to obtain inputs in this system the user will need two different cameras:

- Camera 1: It will be used for monitoring drivers' behavior.
- Camera 2: It will be used for lane tracking.

3.3.1.3 Software Interfaces

The machine that will be used for this fatigue detection system should have these libraries:

- OpenCV
- Dlib
- Imutils

3.3.1.4 Communications Interfaces

This fatigue detection system that we are working on does not require internet connection.

3.3.2 Functional Requirements

The system will run when the user starts the car. If the face detection camera can recognize users' face, the system will process the images and it will compare the results as time goes by. Since there are two cameras, the system will interact with both and the system will combine the data obtained from both cameras. If multiple symptoms occur, the system will give alert to the user after the analyze of the symptoms. However, only one of the symptoms occurs the system will decide whether that symptom is important or not. According to these results, the system will determine fatigue level and it may give an alert if the symptom is important.

3.3.3 Safety Requirements

Functional safety is the correct operation of the system in response to its inputs. When functional safety has been met, that system has eliminated all unacceptable risks and create no threat of injury to occupants. This means such a failure in our system can be fatal. Our system should provide an accurately diagnosed fatigue of the user based on symptoms.

3.3.4 Software System Attributes

3.3.4.1 Accuracy

The fatigue detection system should be able to know the difference between a fatigued driver and a normal driver.

3.3.4.2 Functionality

This system will work as intended and detect a certain level of fatigued drivers.

3.3.4.3 Portability

If this system will be used in a real car, this fatigue detection system should be adjusted according to the new operating system.

5 Software Design Description

5.1 Introduction

5.1.1 Purpose

The purpose of this SDD is to describe the implementation of the Fatigue Detection System. The Fatigue Detection System is designed for drivers to detect their fatigue level.

5.1.2 Design Goals

In recent years studies shows that the road accidents have increased significantly. Accidents involving sleepy drivers tend to be particularly serious since the sleepy driver does not have a quick enough reaction time. Therefore, there is a need for a system to measure the fatigue level of the driver. Afterward, according to these measurements, the system alerts the driver when he/she feels drowsy to avoid accidents. The aim of our project is to detect the users' face and observe the change in facial characteristics to prevent any accidents caused by fatigue driving. One of the most important features is that the system warns drivers that they need to take an early break.

5.1.3 Glossary

Table 2 Glossary of SDD

Term	Definition
SDD	Software Design Document
User	The driver
UI	User interface

5.1.4 Overview of document

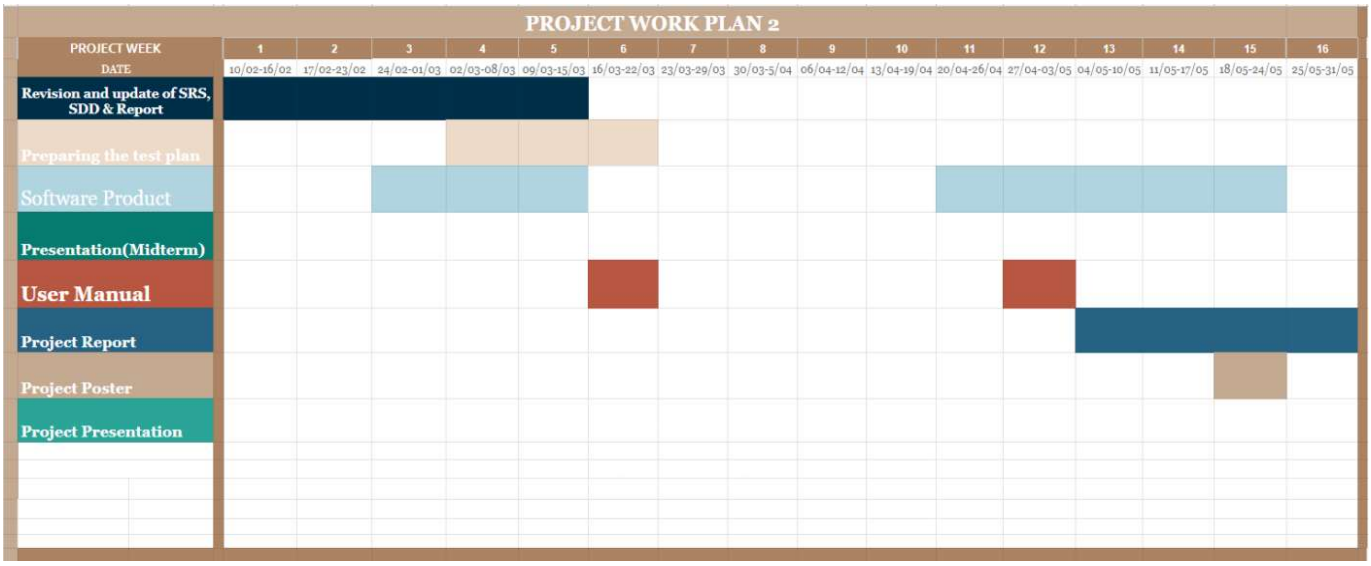
This document contains ‘Architecture Design’ and ‘System Architecture’ topics. ‘Architecture Design’ contains ‘Simulation Design Approach’, ‘Use Case Diagram’, ‘Activity Diagram’ and ‘Interface Design’ subheadings and ‘System Architecture’ contains ‘Data Management’, ‘Hardware/Software Mapping’ and ‘Access Control and Security’ subheadings.

5.2 Architecture design

5.2.1 Simulation Design Approach

While developing this system, we used Scrum. Scrum is reiterative. In scrum, the main work is separated into sprints which should be finished within a certain period. Iteration length of every sprint must be equal because scrum is an active development methodology. Every Sprint contains tasks that have its own story and risk points. Also, the development team should have a regular meeting every morning. There are some benefits of Scrum. The first benefit is that it is easier to deal with changes because of short sprints periods and constant feedback. Also, Scrum makes it possible to obtain quality products at planned times. [13] Our work plan was designed according to this guide.

Figure 1 Work Plan



5.2.2 Use case diagram

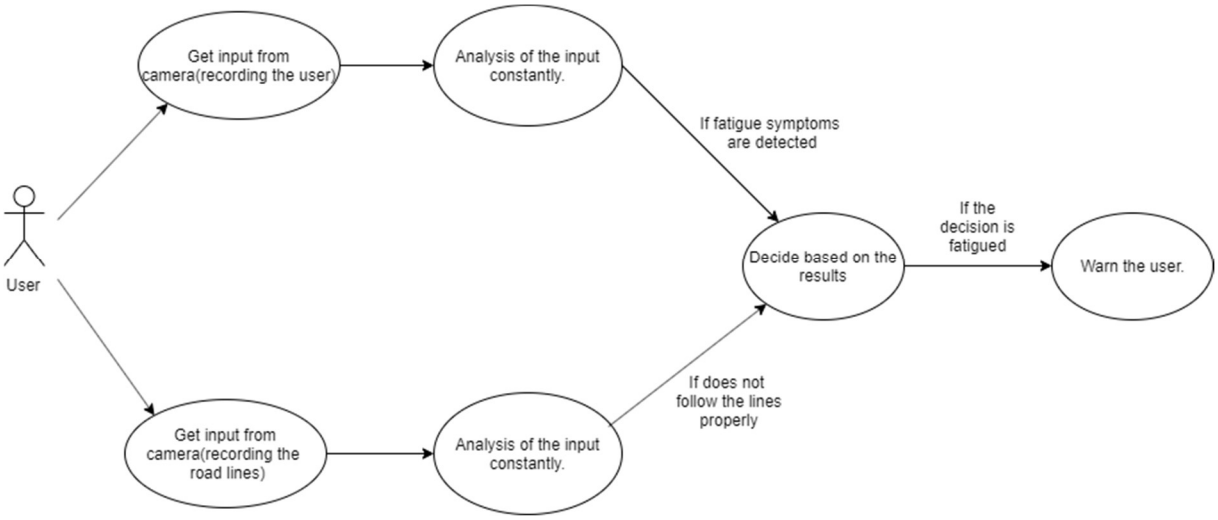


Figure 2 Use Case Diagram

Description:

Figure 2 shows the use case diagram when the driver starts the system. When the user starts the engine, two cameras start to record. While one of them records the users' face, the other one records the road lanes. Each input gets analyzed and the system will check for fatigue symptoms.

If the recorded symptoms are exceeding the specified limit system will warn the user.

Initial Step-By-Step Description:

1. The system starts to get input from cameras.

    1.1. The dashcam starts recording the driver.

    1.2. Front cam starts recording the road lanes

2.Analysis of the inputs from the cameras

    2.1. If there are any fatigue symptoms on the users' facial expressions, it will record it as a symptom.

    2.2. If the user does not follow the road lanes it will be recorded as a symptom

3. If recorded symptoms exceed a certain level warn the user.

5.2.3 Activity Diagram

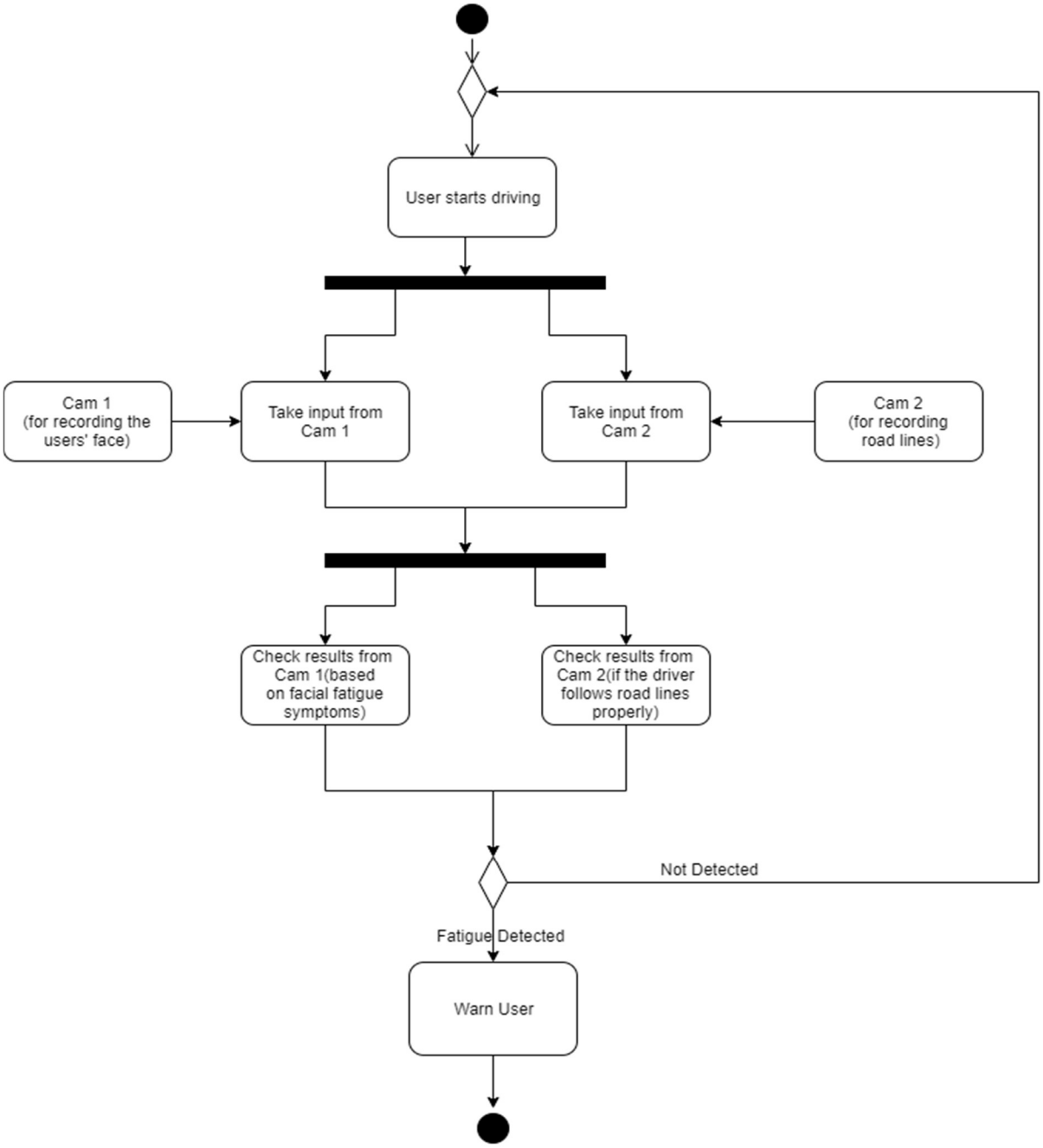


Figure 3 Activity Diagram

Fig3 shows the flow of the system. When the system starts working, it will get inputs from two different cameras simultaneously (dashcam and front cam) and analyze it for fatigue symptoms. This process repeats as long as the system is on or until fatigue is detected.

5.2.4 Interface design

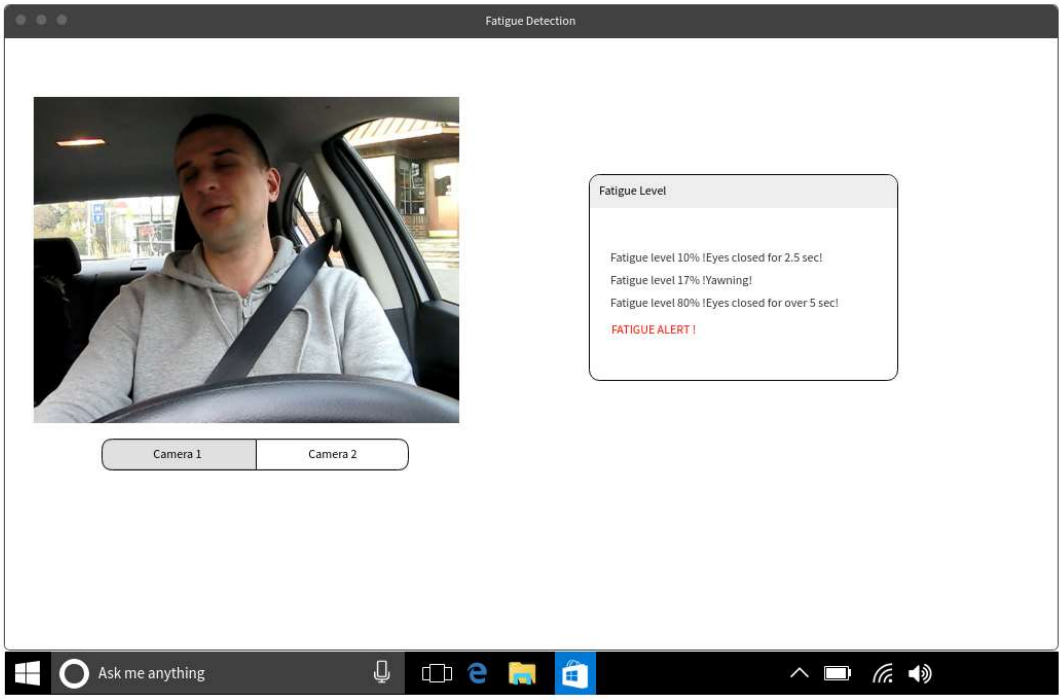


Figure 4 Testing UI 1

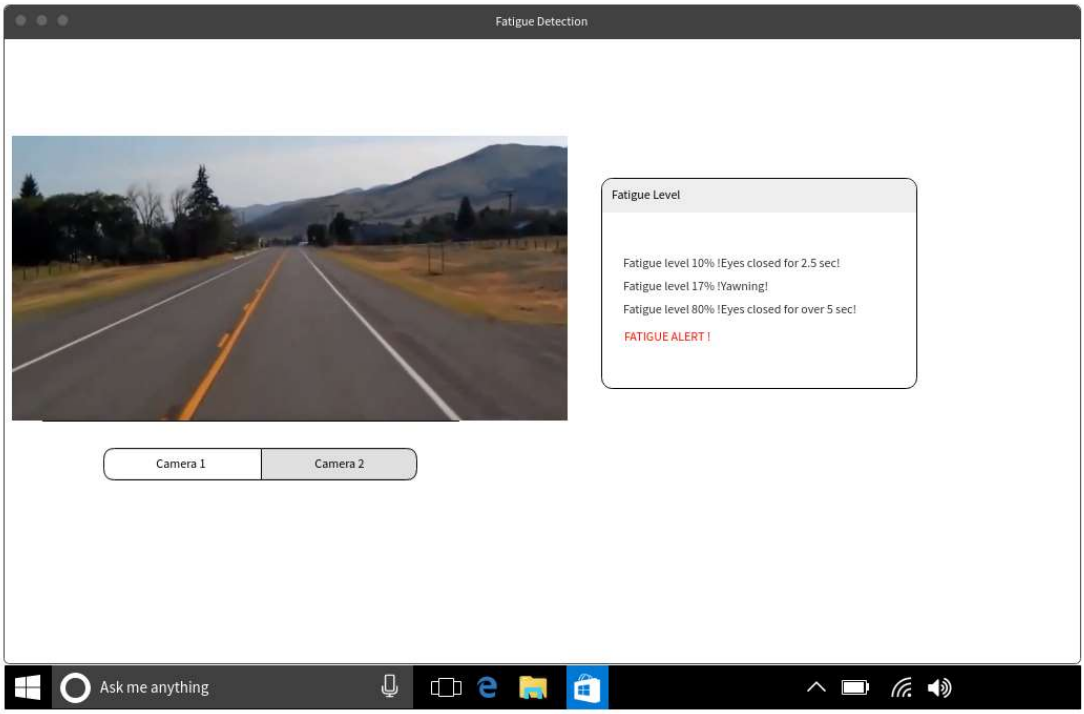


Figure 5 Testing UI 2

The user interface will consist of 2 parts. The first one is for cameras. The user will be able to switch between these cameras. The second part will be the output box. This box will print the output of each frame that was received from both cameras. If the fatigue level starts increasing, the output box will give alert both as in text and in sound.

5.3 System Architecture

5.3.1 Data Management

This fatigue detection system will work on a computer. Due to this, the data that we obtained from users' driving session will be stored in the computer.

5.3.2 Hardware/software mapping

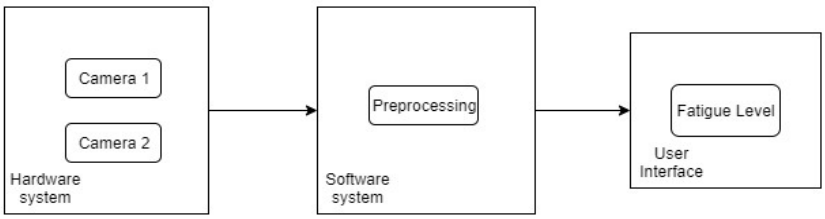


Figure 6 Hardware/Software Mapping

In Figure 6:

- Camera 1: This camera will be used for monitoring drivers' behavior.
- Camera 2: This camera will be used for lane tracking.

5.3.3 Preprocessing

Preprocessing can be referred to as the preparation process of giving the data that was obtained from camera 1 and camera 2. We will be using the OpenCV library for this process.

5.3.3.1 Access control and security

In this system, when the driver starts to drive, and the system starts to receive input. We store the data and only the computer uses the data we obtain while the driver is driving. Therefore, no security problems will be encountered.

6 Test Plan

6.1 Introduction

6.1.2 Version Control

Table 3 Version Control

Version No	Description of Changes	Date
1.0	First Version	Apr 24, 2020
2.0	Second Version	May 28, 2020

6.1.3 Overview

Designed system does not require any GUI but for testing the system a user interface needed which we will call it the testing interface. Detecting the user's facial movements is fatal our system which means we will need the individuate the mouth, eyes and the entire face.

6.1.4 Scope

This document will include the test cases that we will consider in Fatigue Detection system.

6.1.5 Terminology

Table 4 Terminology

Acronym	Definition
GUI	Graphical User Interface
UI	User Interface

6.2. Features to be tested

6.2.1 Face Detection (FD)

Face detection has a major impact in this system. According to detection of users' face, the system will be able to detect other symptoms.

6.2.2 Eye Detection (ED)

Frequently eye blinking is an important symptom for this system. Detecting the eyes will provide serious data to the system.

6.2.3 Mouth Detection (MD)

Yawning is one of the most important symptoms to be able to detect yawning, firstly the system should detect mouth of the user.

6.2.4 Road Lane Detection (RLD)

To understand the behavior of user, we will also consider lane tracking. This will provide more information to the system aside with other symptoms.

6.2.5 Test Interface (TI)

This interface will contain different parameters, buttons and it will show the current images of both cameras in the car. We will also test this interface.

6.3 Item pass / fail criteria

With the dataset that we have, we will test specific images, videos for the detection of the features that we mentioned above. We will test our code and if the accuracy is higher than 85%, we will accept it.

6.3.1 Exit Criteria

- 100% of the test cases are executed as planned.
- 85% of the test cases passed the criteria.
- All High and Medium Priority test cases passed.

6.4 References

https://github.com/CankayaUniversity/ceng-407-408-2019-2020-Fatigue-Detection/wiki/SoftwareDesign-Document

https://github.com/CankayaUniversity/ceng-407-408-2019-2020-Fatigue-Detection/wiki/SoftwareRequirements-Specification

7 Test design specifications

7.1 Test Interface (TI)

7.1.1 Sub-features to be tested

7.1.1.1 Camera Switch Button (TI.Cam.Swc.But)

Tester can switch between the two cameras (one for users' facial movements control, other one is for road lanes) by selecting the camera button.

7.1.1.2 Fatigue Result (TI.Fat.Res)

This system measures fatigue level of the user. To measure the fatigue level, the system needs above features to work. According to these measures, the system will calculate the fatigue level and alert the user if it is too high.

7.1.1.3 Exit Button (TI.Exit)

7.1.2 Test Cases

Table 5 Test Cases

TC ID	Requirements	Priority	Scenario Description
TI.Cam.Swc.But	*6.3.1*	*M*	*For accessing to the cameras.s*
TI.Fat.Res	*6.3.1*	H	Detect signs of fatigue and then warn if the result is positive(which means user is fatigued).
TI.Exit	*6.3.1*	L	Exit testing interface.

8 Detailed Test Cases

8.1 TI.Cam.Swc.But

TC_ID	TI.Cam.Swc.But
Purpose	Switch between user and road lane cameras.
Requirements	6.3.1
Priority	Medium
Estimated Time Needed	20 Secs.
Dependency	For both cameras there has to be an input.
Setup	No installation required.
Procedure	System is running
	Open testing Interface
	Select between cam1 and cam2
Cleanup	Exit

8.2 TI.Fat.But

TC_ID	TI.Fat.Res
Purpose	Fatigue Detection
Requirements	6.3.1
Priority	High
Estimated Time Needed	10 Minustes
Dependency	Symptom detection and comparasion.
Setup	No installation required.
Procedure	System is running
	Open testing Interface
	Both cameras are running.
	System is looking for symptoms and analyzing
Cleanup	Exit

8.3 TI.Exit

TC_ID	TI.Exit
Purpose	Exit from the system
Requirements	6.3.1
Priority	Low
Estimated Time Needed	10 Secs
Dependency	-
Setup	-
Cleanup	-

9 Test Results

9.1 Individual Test Results

Table 6 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
TI.Cam.Swc.But	M	15.04.2020	Berkay Ekebaş	Fail	Input error.
TI.Cam.Swc.But	M	16.04.2020	Berkay Ekebaş	Pass	
TI.Fat.Res	H	25.04.2020	Damla Ebru Parlak	Fail	The system failed to start.
TI.Fat.Res	H	1.05.2020	Damla Ebru Parlak	Fail	Algorithm errors.
TI.Fat.Res	H	6.05.2020	İrem Kaymakçılar	Fail	Algorithm errors.
TI.Fat.Res	H	7.05.2020	Damla Ebru Parlak	Fail	Algorithm errors.
TI.Fat.Res	H	11.05.2020	İrem Kaymakçılar	Fail	Algorithm errors.
TI.Fat.Res	H	12.05.2020	Damla Ebru Parlak	Fail	Symptom detection error.
TI.Fat.Res	H	14.05.2020	Berkay Ekebaş	Fail	Symptom detection error.

TC ID	Priority	Date Run	Run By	Result	Explanation
TI.Fat.Res	H	15.05.2020	İrem Kaymakçılar	Fail	Symptom detection error.
TI.Fat.Res	H	17.05.2020	Damla Ebru Parlak	Fail	Accuracy lower than expected (85%)
TI.Fat.Res	H	19.05.2020	Berkay Ekebaş	Fail	Accuracy lower than expected (85%)
TI.Fat.Res	H	20.05.2020	Damla Ebru Parlak	Fail	Accuracy lower than expected (85%)
TI.Fat.Res	H	20.05.2020	Irem Kaymakçılar	Fail	Accuracy lower than expected (85%)
TI.Exit	L	18.04.2020	Berkay Ekebaş	Pass	

9.2 Summary of Test Results

Table 7 Test Results

Priority	Number of TCs	Executed	Passed
H	1	25	0
M	1	10	6
L	1	10	10
Total	**3**	**45**	**16**

9.3 Exit Criteria

Table 8 Exit Criteria

Criteria	Met or Not
100% of the test cases are executed	Y
85% of the test cases passed	N
All High and Medium Priority test cases passed	N

9.4 Known Problems

Fatigue definition can change from person to person and it is a very versatile issue. Therefore, there is no specific definition of “Fatigue”. Also, we can say that there are many anti thesis about this topic according to our researches.

9.5 Conclusion

It can be seen from the results that the expectations did not meet with reality. According to these test results, the product is not ready for use. On the other hand, this system is open to any kind of improvements.

10 Conclusions

While developing our project, we have aimed to detect fatigue symptoms and combine the results of these symptoms to get a value called “Fatigue Level”. After our researches, our plan was to focus on the main symptoms of fatigue such as yawning, blinking etc. We were able to create a system that recognizes the driver’s face, road lanes and symptoms to a certain level. In the end, system is still unfinished in some aspects and can be improved further in the future.

Acknowledgement

We are grateful for the support and the guidance we received from our advisor Dr. Abdül Kadir Görür during these hard times.

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