Driver's Drowsiness Detection Using OpenCV and Raspberry Pi 3B

A Capstone Project Documentation
Presented to
The College of Information Technology
The National Teachers College

In Partial Fulfillment
of the Requirements for the Degree
BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

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February, 2023

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ACKNOWLEDGMENTS

The researchers would like to express our deepest gratitude to the following who lend them a hand on finishing this study:

First is to our Almighty God, who gives the researchers endless strength on finishing this study as well as guidance through their difficult times even in their everyday lives.

To the researcher's adviser, panelists and especially to the program head for guiding the researchers that keeps them determined since the day one of this research. The people who gave the researchers advise, recommendations, patience and for the endless assistance for improving this study.

To the researchers' parents and loved ones for the endless support and understanding despite of the researchers' busy schedule, financial expenses and sleepless nights. The people who keeps on supporting us in difficult times that keeps the researchers motivated on finishing this study.

Lastly, the researchers would like to offer this research to these people. The researchers once again would like to thank each and every one of them for the assistance that they give in fulfilling this study. This study would never be possible without their full presence and support.

ABSTRACT

Drowsy Driving is a phenomena wherein the driver begins to feel heaviness in their eyes due to exhaustion. People who are working 24/7 or in night shifts can experience feeling drowsy while driving which can result to road accidents or even death. As numerous cases of road accidents regarding drowsy driving are being reported, the researchers decided to make a drowsiness detection system using OpenCV and Raspberry Pi 3B.

The objective of this study is to create a drowsiness detection system that can be use by drivers to detect their drowsiness based on their eye movements or eye blinks. This can help drivers to prevent them from being drowsy while driving as well as reducing road accidents regarding drowsy driving. The system equipped with a night vision camera module and wired speakers will detect the driver's eye movements and will alarm the driver once they begin to feel drowsiness or if their eyes are closed for as longer as 3 seconds.

The researchers utiliized an experimental type of research wherein the researchers randomly selected ten private car owners to test the system. With the data and feedback provided by the respondents, the study found that the Drowsiness Detection System is effective for drivers as the system can easily detects their drowsiness. The system is not hard to understand as the respondents can easily use the system during their testing. Overall, the system received positive feedback from the respondents in terms of the system’s reliability, usability, efficiency, maintainability and portability as the system can be move to other places.

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Chapter 1

THE PROBLEM AND IT'S SETTING

1.1 Introduction

Drowsiness is the state where an individual has trouble maintaining their eyes open for a long time. This is one of the driver's greatest enemy while they are driving in the middle of the road (Reyes 2019). In addition, drowsiness commonly occurs when the driver has a short sleeping time. According to a study from Oxford University Press, USA, people who have slept fewer than seven hours a day have a higher possibility of car crashes. Furthermore, this risk is greater when the driver has slept fewer than four hours.

It is advisable that adults need at least 7-9 hours of sleep per night (Suni 2022). However, most people are not achieving this, especially those who are working the whole day or in a night shift. Most of them go home right after their work hours which result in them falling asleep while driving. Some people are not working at all and decide to drive for a long period of time without taking a rest to the point where their eyes get heavy, losing their focus in the process.

Drowsy driving can be dangerous as it can lead to road accidents that can injure or kill not just the driver but also the pedestrians and other drivers as well. Because of this, the researchers created a system that can detect the driver's drowsiness using OpenCV and Raspberry Pi 3B. A mini device with a night vision camera and mini wired speakers that can be installed to the driver's front windshield in order to detect the driver's eye during the road. Once the driver falls asleep and their eyes close within 3 seconds, the device automatically alarms the driver that they are drowsy. The drowsiness detection system using OpenCV and

Raspberry Pi 3B can help drivers to prevent being drowsy on the road as well as reducing future road accidents that may occur regarding drowsy driving.

1.2 Theoretical Framework

The design of the system revolves around facial recognition wherein it identifies the facial features of the driver. Furthermore, the system is going to focus on the eyes of the driver, specifically the blinking of the eyes. This all can be done by using Python which has the needed tool namely OpenCV.

OpenCV is a library of algorithms that is needed for machine learning and computer vision. The algorithm contained in this library is used to recognize human faces; this in turn will guide the system to recognize and track the driver's eyes.

A portable device will be used to compile the system so that it can be installed to the driver's vehicle wherein the Raspberry Pi 3B comes in. This device is a credit-card sized computer that has enough power to run complicated algorithms at a fast enough rate so the input to the output will have less delay. Moreover, the device will also have a night vision camera as the input to capture the driver's face in real-time and a speaker for output.

1.3 Conceptual Framework

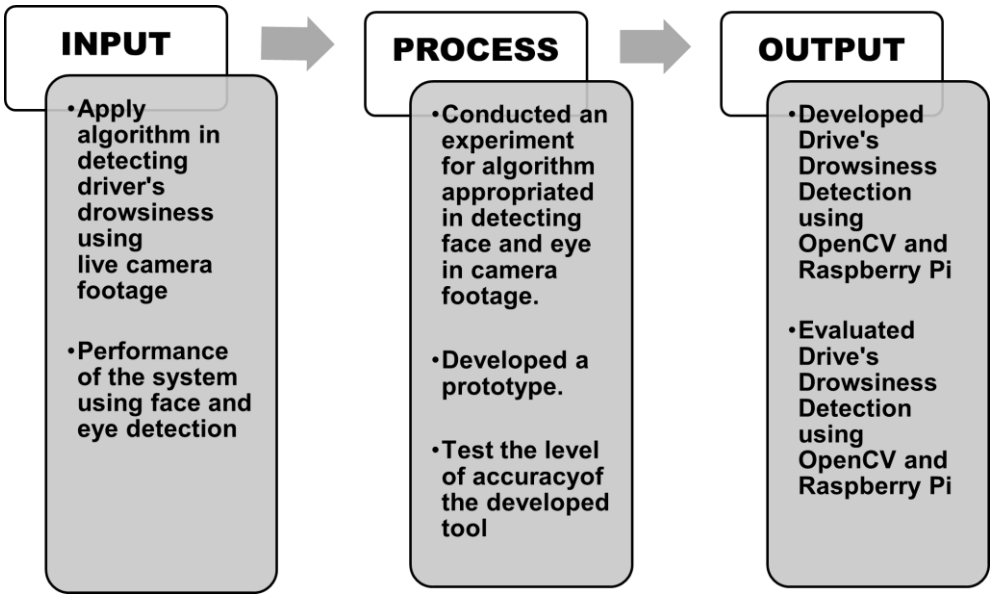


Figure 1: Conceptual Framework of the Study

The figure above indicates the input, process and output of this study. A night vision camera connected to the Raspberry Pi 3B will serve as input. For the process, the detection for the driver's face and eyes will be initiated while the researchers will conduct a test in order to identify the accuracy of the system. Lastly, a developed driver's drowsiness detection system using OpenCV and Raspberry Pi 3B will be the output of this study.

1.4 Objectives of the Study

The main objective of this study is to develop a driver drowsiness system using OpenCV and Raspberry Pi 3B for both day and drivers. Furthermore, other objectives on this study are the following:

- Develop a module that will use night vision camera that detect the driver's drowsiness based on eyelid movement or eye blinks.
- Insert an alarm loud enough for the driver to awake from their driver.
- Develop a module that automatically stops the alarm once the driver is awakened so that they can instantly focus on driving.

1.5 Significance of the Study

The researchers expect this study will be useful and can give contribution to some parties:

- **Car Manufacturers.** They can use this system as one of the safety features in their car.
- **Drivers.** It helps them to stay awake while driving so that they can avoid road accidents in the future and make them aware of their surroundings.
- **Future Researchers.** They can use the following technologies and data gathered, collected and presented in this study as their reference so that they can improve their research.

1.6 Scope and Limitations

The scope of this study is to develop a driver's drowsiness detection that will detect whether or not the driver is drowsy using OpenCV and Raspberry Pi 3B. One of the things that the system can do is that it can detect the driver's eye movement even at night by the use of a night vision camera. Furthermore, the system will alarm when the driver closes their eyes for more than 3 seconds.

The limitation of this study is that the system can be used by car drivers who don't have any genetic eye disorder that involves numerous blinking (e.g. Blepharospasm) as well as moderate to severe hearing issues (A hearing aid is allowed if the driver has a mild hearing problem). In addition, the driver must not wear any facial or headgear as it can affect the performance of the system. Clear eyeglasses on the other hand is permitted as long as the eyeglasses don't have dark shades. Moreover, drivers who are driving under alcohol or drug influence are also not included in this study.

1.7 Definition of Terms

The following below are the technical terms used in this research:

- **Algorithm** is a sequence of steps or procedures performed on a set of input data to produce a set of output data in order to solve a certain problem.

- **Blepharospasm** is an involuntary movement of eyelids causing the person to blink more often than normal.

- **Drowsy** is an inability to keep your eyes open for a long period of time.

- **Facial Recognition** is a biometric technology to identify or verify the identity of a person using their face. It takes, examines, and compares patterns based on the person's facial details.

- **Gauss Mixture Model** is a function that assumes all the data points are generated from a mixture of a finite number of Gaussian distributions with unknown parameters.

- **Graphic User Interface (GUI)** is a display wherein it conveys information and represent actions that can be taken by the user.

- **Haar Cascade Classifier** is an object detection approach wherein a cascade function is trained from a lot of both positive and negative images.

- **Library** refers to a collection of files, programs, routines, scripts or functions that can be referenced or called in the programming code.

- **Local Binary Pattern Histogram (LBPH)** is a face-recognition algorithm used to recognize a person's face. It is known for its performance and how this algorithm is able to recognize a person's face from both the front and side face.

- **Machine Learning** is a data analytics technique that teaches computers to do what comes naturally to humans and animals. Its algorithms use computational methods to learn information directly from data without relying on a predetermined equation as a reference.

- **Module** is an extension to the main program dedicated to a specific function. This term is also used in programming wherein it is a section of code that is added in as a whole or is designed for easy reusability.

- **OpenCV** enables machines and devices to process digital visual data, which can include images taken with traditional cameras, a graphical representation of a location, a video, a heat intensity map of any data, etc.

- **Powerbank** is a portable and compact battery used to recharge electronic gadgets such as cellphones if a person doesn't have access to a power outlet or charging station.

- **Python** is a computer programming language that is frequently used to create websites and applications, automate operations, and do data analysis. It is a general-purpose programming language that can be used to develop a wide range of applications and is not specialized for any particular problem.

- **Raspberry Pi** is a credit card size and low-cost hardware platform that allows developers to create IoT solutions. It is designed as a cheap educational tool to use coding skills on a board and build tech projects.

Chapter 2

REVIEW OF RELATED LITERATURES AND STUDIES

This chapter discusses the factors and risk of drowsy driving, techniques, models and methods using OpenCV and Raspberry Pi as well as other applications of Raspberry Pi and OpenCV in terms of facial recognition.

2.1 Factors and Risk of Drowsy Driving

Drowsiness or also referred to as "excess sleepiness" or "somnolence" is a feeling of sleepy or tired or inability to keep your eyes open for a long period of time. It can be accompanied by lethargy, weakness as well as mental agility (Blake 2022). It is different from blinking since blinking is the act of shutting and opening the eyes quickly while drowsy is the inability to keep your eyes open. Furthermore, drowsiness affects someone's concentration, reaction time, productivity and their safety in doing their normal day-to-day activities. Drivers who are driving long distances without taking a break are prone to get drowsy (Ramos et al 2019).

Certain lifestyle factors such as working long hours or switching to a night shift may lead to increased drowsiness (Luo 2019). Most industries nowadays such as manufacturing, logistics, transport, and more run their operations 24/7 leading their workers to work in shifts. Someone who is working shifts can cause misalignment with their internal biological circadian rhythm that can lead to sleeping disorders, drowsiness, fatigue, mood disturbances and long term health problems (Stancin et al 2021). Furthermore, drowsy driving can lead to car accidents. Some of them are caused by drowsy driving wherein a person is driving for a long period of time. This can lead to excessive fatigue and tiredness which will make the driver feel sleepy or lose their awareness (Bhagwat 2022).

2.2 Techniques, Models, and Methods Using OpenCV

OpenCV is an open source library that is useful for computer vision applications such as video analysis, CCTV footage analysis and image analysis. Well known companies such as Google, Amazon, Microsoft and Toyota are using this library because of its abilities that OpenCV can offer (Venkatesh 2020). The concept of OpenCV was initialized by Gary Bradski wherein it has the ability to perform in a multi-level framework. In addition, OpenCV helps recognize the person's frontal face as well as creating an xml document for several areas such as the parts of the body. (Dhawle et al 2020).

Yu et al (2018) developed a system that can detect moving objects using OpenCV and Frequency-tuned (FT) algorithm that make innovative improvements from distance metrics and feature graphs. Furthermore, Haar-Cascade Classifier is also added with low computational complexity. As the end result of their experimental tests, their system has a higher accuracy compared with other traditional detection methods. With the help of Gauss Mixture Model (GMM) that has a good static detection effect as well as adding the Haar Cascade Classifier, it achieved a good real-time recognition effect as well as detecting and recognizing moving objects.

Agbemenu et al (2018) created an automatic number plate recognition system using OpenCV and Tesseract OCR Engine to identify vehicles by capturing its number plate. As the result of their study, their system successfully recognized 60% among the 500 Ghanaian vehicle number plates that were processed with 0.2 seconds processing time. However, there are other factors that affect the character recognition such as faded characters, certain plate decorations and noise on the plates due to dirt.

In the study of Ismail et al (2021) developed a hand gesture recognition using Python, OpenCV and Haar-Cascade classifier wherein their system can detect, recognize and interpret hand gestures from the

user. However there are limitations to their program that can hinder its performance. The position of the user's hand and the webcam must be in the fixed position in order for the system to identify the hand gesture.

2.3 Techniques, Models, and Methods Using Raspberry Pi

Raspberry Pi is a single board computer developed by the Raspberry Pi Foundation, a charity in the UK that "works to put the power of computing and digital making into the hands of people all over the world". It is an affordable device to use in a huge variety of projects and a good option to explore in terms of electronics, hardware and computer programming (Stork 2021).

Kurniawan (2019) created a smart monitoring temperature and humidity of the room server using Raspberry Pi and Whatsapp Notifications wherein they were successfully able to send temperature and relative humidity information in real time to a database. Furthermore, their system can also perform a command to check the host server as well as the command to turn off the server directly through the Whatsapp application.

Korra and Sudarshan (2019) developed a smart healthcare monitoring system using Raspberry Pi in an IoT platform. Their system is a good communicator since the doctor can monitor the patient's health status by using their android device. In case there are abnormalities in the patient's health, it will directly be reported to the authorized person or guardian.

Sharik et al (2020) developed a real time smart traffic managing and control system using OpenCV and Raspberry Pi 3 wherein their system can reduce the traffic congestion as well as prioritize which lane has to turn green based on vehicle density. Furthermore, emergency vehicles such as ambulances or fire trucks will be directed to a particular lane that they can pass through.

2.4 Application of Raspberry Pi and OpenCV on Facial Recognition

Facial recognition refers to a subset of computer technology that has an ability to identify human faces in a digital image. Its algorithm focuses on detecting human faces in an image that may contain other subjects such as other human parts and landscapes. Over the past decades, the advancements in technology allowed computer systems to perform face recognition. OpenCV is commonly used for the implementation of facial recognition algorithms (Nagpal et al 2018).

Prathaban et al (2019) developed a vision-based home security system wherein they used OpenCV and Raspberry Pi 3B. With the help of the Haar Cascade algorithm, their system is more effective and accurate than the developed PIR motion detection system.

Dattatray et al (2021) developed a car access control system using Raspberry Pi and OpenCV wherein it uses facial recognition to authorize the registered people who were allowed to operate the car. Their system's effectiveness on face detection in real time has a high performance productivity and it can even recognize faces even in low-quality photos. Furthermore, the system can also be used in different locations such as banks, hospitals and other establishments in order to reduce the risk of illegal entrance. In addition the system can also be used if there is a robbery as the evidence can be presented to the security department.

In the study of Malve and Morade (2021) developed a smart doorbell system based on face recognition using Python, Raspberry Pi with ARMv8 Cortex-A53 core and Local Binary Pattern Histogram (LBPH). Their system's capability is to detect someone's face and announce the person's name if the system identifies the user. If an unknown person or visitor enters the house, the system will detect their face and store it to the system's database. Furthermore, the complete system has real time response and better recognition rate for home automation door security.

2.5 Synthesis of Reviewed Literature and Studies

Based on the related literature above, the researchers found out that drowsy driving is indeed a serious problem. The excessive fatigue and tiredness which will make the driver feel sleepy or lose a driver's awareness on the road. Furthermore, employees who are working in a 24/7 industries such as transportation and manufacturing as well as lifestyle factors like working long hours and switching into night shifts can contribute to someone's drowsiness.

Raspberry Pi is a great option to use for its performance based on different researchers who tried this device. It may be small in size but it can perform decently as it can be a good tool to use in a huge variety of projects. Different researchers had already tried applying OpenCV in their study and it showed a decent performance in processing images and videos to identify certain objects such as moving objects, vehicle's number plates and human face.

Creating a face recognition detection application using Raspberry Pi and OpenCV has good and accurate results on detecting human faces. However, there are other factors that can affect the accuracy such as lighting, distance between the person and the camera, if the person is wearing headgear, camera's shutter speed and the number of people within the picture or video.

Chapter 3

METHODOLOGY

This chapter will cover the details and explanation of research methodology, data gathering approaches and processes, the statistical treatment of data, software development methodology and the technologies proposed to be used for the development of the system.

3.1 Research Design

The researchers utilized an experimental type of research in this study. Experimental research responsibly adheres to a scientific approach. It includes a hypothesis and an aspect that can be manipulated, measured, calculated and compared. Moreover, experimental research is complete in a controlled environment.

The researcher gathers data and the result was supported and/or rejected hypothesis. The method is referred to as the hypothesis testing and also considered as a deductive research method. According to Babbie (2021), this type of research is used to develop new processes, techniques and tools based on the analysis of the present cases. Furthermore, this type of research does not focus only on design and development but also on evaluation.

The researcher's aim is to design and develop a Driver's Drowsiness System using OpenCV and Raspberry Pi 3B and evaluate how accurate the system is in detecting the driver's drowsiness.

3.2 Research Instrument

The data is collected using experimentation or testing. The researchers used an online survey via Google Forms to determine the system's effectiveness and face detection accuracy.

3.3 Sources of Data

The researchers gathered the data using experiments or testing the system's face and eye detection and using survey data collection method to test the system's accuracy. The system will be tested on ten random private car owners selected by the researchers of the study. Every respondent will perform different actions and change different settings to calibrate the system in each test in order to examine the tracking accuracy and drowsiness detection.

3.4 Data Gathering Procedure

Ten random private car owners will be selected to test the system. After the testing, the ten respondents will answer an online survey via Google Forms to rate the system's performance. The researchers will then collect and present the data provided by the ten respondents using tables.

3.5 Development Tools

For the development of the system, the tools that are used are the Python programming language with the OpenCV library. The hardware involved is the Raspberry Pi 3B equipped with a night vision camera module as input and a wired speaker as output.

Dimensions:	85.60 mm × 53.98 mm × 17 mm
Clock frequency:	1.2 GHz
Chipset (SoC):	Broadcom BCM2837
Processor:	64-bit quad-core ARM Cortex-A53
Graphics Processor:	Broadcom Dual Core VideoCore IV (OpenGL ES 2.0, H.264 Full HD @ 30 fps)
Memory (SDRAM):	1 GB LPDDR2
USB Ports:	4
Port Extension:	40-pin GPIO
Video Outputs:	HDMI and RCA, plus 1 CSI camera connector
Audio Outputs:	3.5 mm stereo jack or HDMI
Data Storage:	MicroSD card
Network Connection:	10/100 Ethernet, 802.11n WiFi and Bluetooth 4.1 (BLE - Low Energy)
Peripherals:	17 x GPIO
Power Supply Needed:	5V 2.5A via micro USB

Figure 2: Raspberry Pi 3B Specifications

Dimensions:	31mm x 32mm
Material:	PCB + ABS
CCD size:	1/4 inch
Aperture(F):	1.8
Focal Length:	3.6 mm (adjustable)
Field of View:	75.7 degrees
Preferred Sensor Resolution:	1080p

Figure 3: Night Vision Camera Module Specifications

Dimensions:	73 × 72 × 72mm
Product Weight:	260 ± 2g
Cable Length:	130cm
Cable Length Between Speakers:	93cm
Rated Power:	2.5W * 2
Pickup:	USB + AUX
Speaker Size Diameter:	5Ω + 0.03mm
Interface Type:	USB
Rated Impedance:	40
Load Current:	600mA
Input Voltage:	USB, 5V
Speaker Specification:	4Ω 3W

Figure 4: Wired Speakers Specifications

3.6 System Architecture

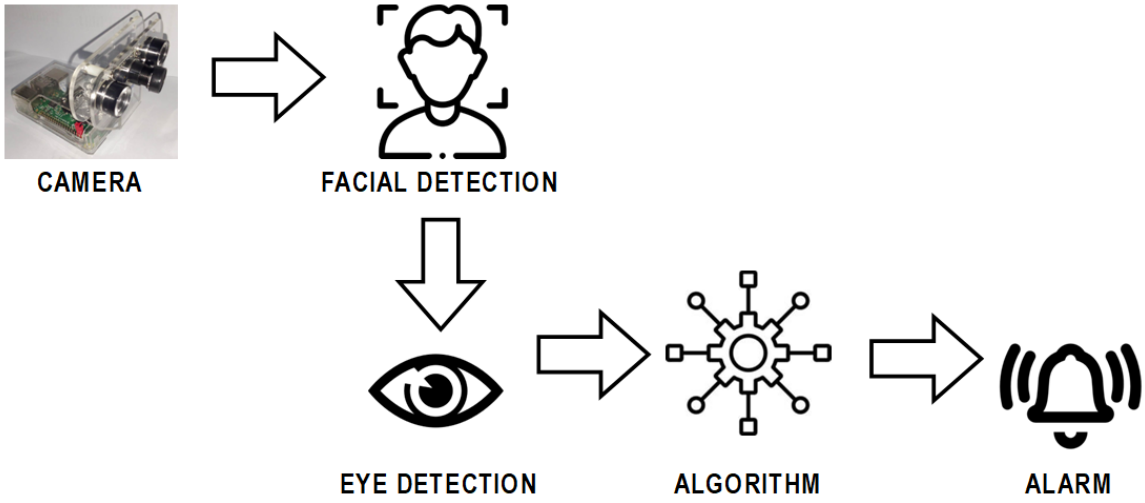


Figure 5: Proposed System Architecture

In figure 5, the camera will detect the facial structure of the driver. Once their face is detected, the camera will check the driver's eye movement to calculate if the eye movement of the driver is drowsy or not. Once it detected drowsy or closed their eyes, the alarm will be activated to wake up the driver.

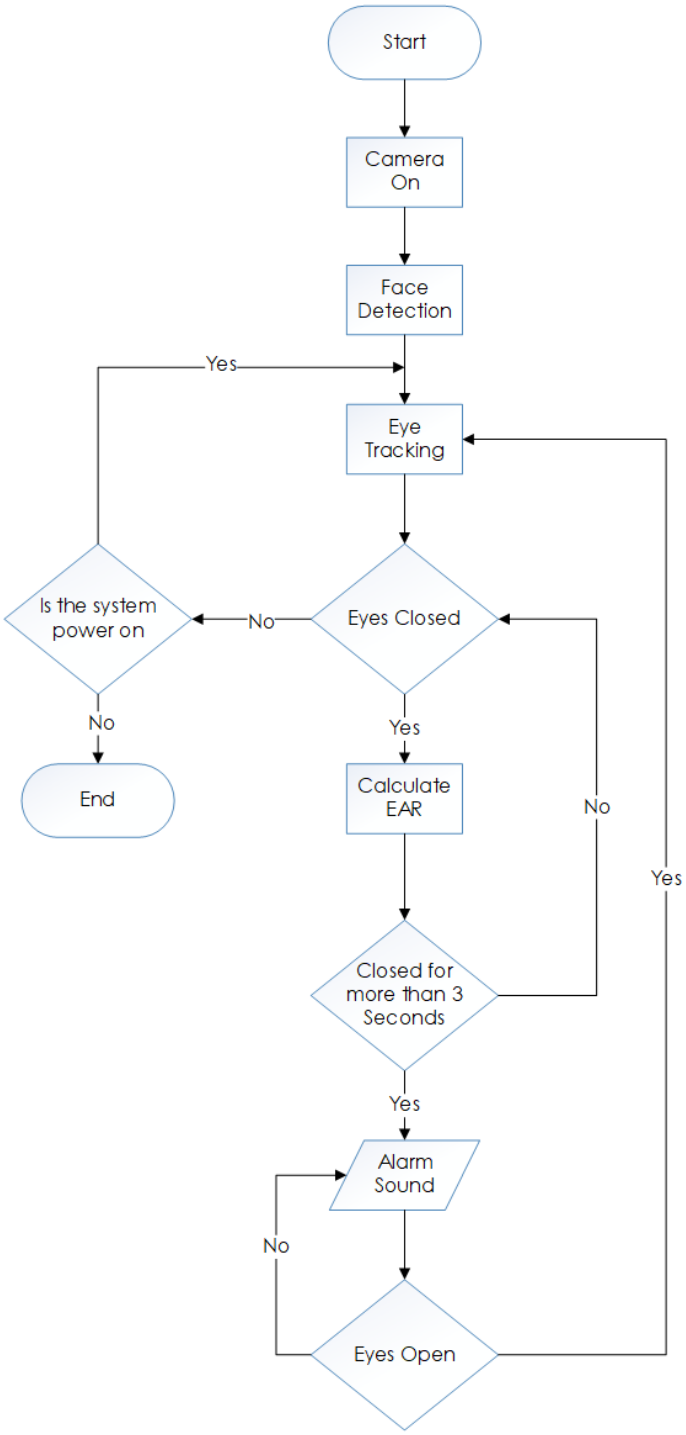


Figure 6: Flowchart of Driver's Drowsiness Detection System Using OpenCV and Raspberry Pi 3B

In figure 6, the driver must turn on the system for the camera to automatically on and detect the driver's face. Once the face was detected, the system will proceed to track the driver's eye. If the eyes are

closed, the system will calculate the Eye Track Ratio (EAR). When the driver's eyes are closed for longer as 3 seconds, an alarm will start to wake up the driver.

Once the driver wakes up, the system will stop the alarm and once again resumes tracking the driver's eyes. In addition, if the driver's eyes is still open and if the system is still on, the system will resume on eye tracking. The system will end once the driver decides to turn off the system or if the system does not receive any power supply.

3.6.1 Data Source and Preprocessing

For the system's training and test data, the researchers used the Real-Life Drowsiness Dataset created by a research team from the University of Texas at Arlington for detecting multi-stage drowsiness. The researchers used OpenCV to extract frames in the video. There were 68 total landmarks per frame but we decided to keep the landmarks for the eyes (points 37-42 for the left eye and 43-48 for the right eye). These were the important data points that will be use to extract the features for each eye of the driver.

Based on the facial landmarks extracted from the frames of the videos, the researchers ventured into developing suitable features for the system's classification model. While the researchers hypothesized and tested several features, the most important feature used to detect the driver's eyes is the Eye Aspect Ratio (EAR).

3.6.2 Facial Landmarks

The system uses facial landmarks to predict the shape of the human face. It estimates coordinates of the face and marks specific spots to create an outline shape of the face as well as the other facial features eyes, mouth, eyebrows, and nose. The system use landmarks created for the eyes. There are six landmarks each eye to determine its shape. As for how the system differentiates whether the eyes are close or open, it takes the distance of the landmarks of the top and bottom eyelids from each other.

In detecting drowsiness, the system sets a threshold for the Eye Aspect Ratio (EAR). Once the eye aspect ratio falls below the threshold for the set amount of time, it will trigger the subsequent actions in the program which is the alarm installed in the system.

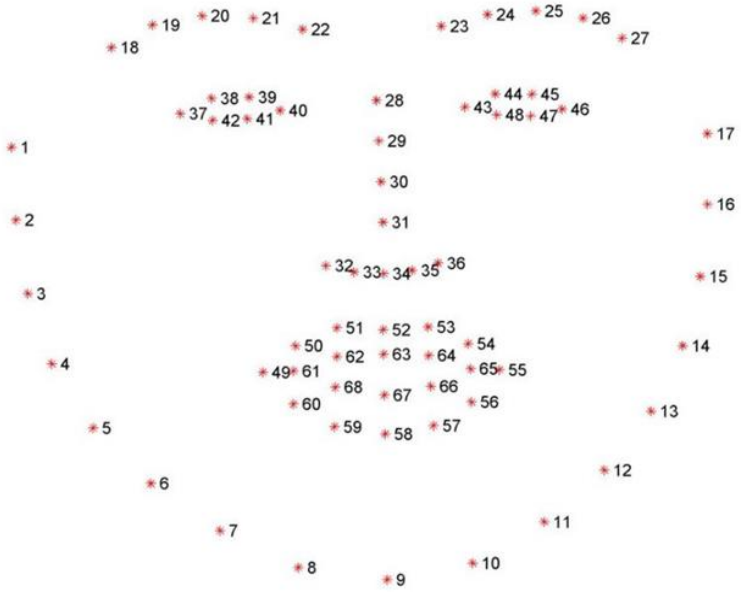


Figure 7: Trained points that the system uses to predict landmarks

3.6.3 Haar Cascade Classifier Algorithm

Haar Cascade Classifier is one of the few object detection methods with the ability to detect faces. It offers high-speed computation depending on the number of pixels inside the rectangle feature and not depending on each pixel value of the image. This method has four steps for detecting an object namely a Haar-like feature, integral image, AdaBoost learning and Cascade Classifier. For the detection of the face, Haar features are the main part of the Haar Cascade Classifier.

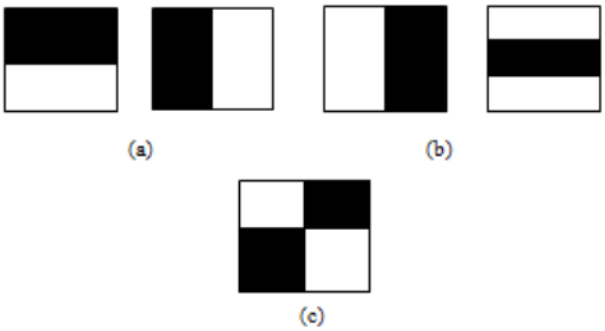


Figure 8: (a) Edge feature, (b) Line feature and (c) Four-Triangle feature

The figure 8 shows the examples of common varieties of Haar-like features. It is a rectangular feature providing specific indication to an image for rapid face detection. Furthermore, it is used to detect the presence of feature in a given image. Each feature results in a single value, which is calculated by the sum of pixels under black rectangle.

3.6.4 Eye Aspect Ratio (EAR)

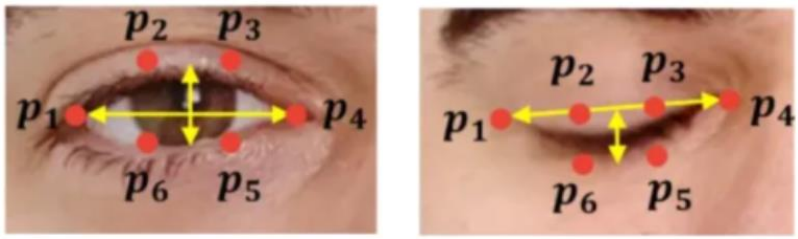
As the name suggests, it is the ratio of the length to the width of the eyes. The length of the eyes is calculated by averaging over two distinct vertical lines across the eyes.

The Eye Aspect Ratio (EAR) formula is to detect the eye blink using the scalar value. For instance, if a driver closed its eyes for about 3 seconds with an Eye Aspect Ratio (EAR) threshold of lower than 0.3, it means that the driver is in a state of drowsiness. Thus, it is necessary to detect the eye's shape accurately in order to calculate the eye blink frequency. From the landmarks detected in the image with face, the Eye Aspect Ratio (EAR) is used as an estimate of the eye openness state. For every video frame, the eye landmarks are detected between height and width of the eye that had been computed. The Eye Aspect Ratio (EAR) can be defined by the equation below:

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Figure 9: Formula for Eye Aspect Ratio (EAR)

The formula for the Eye Aspect Ratio (EAR) as shown in Figure 9 is where p1 until p6 are the 2D landmark locations. The p2, p3, p5 and p6 are used to measure the eye's height while p1 and p4 are used to measure eye's width in meters (m) as shown in Figure 10(a). The Eye Aspect Ratio (EAR) is a constant value when the eye is opened, but rapidly falls approximately to 0 when the eye is closed as shown in the Figure 10(b).



(a) x > 0; eyes open (b) 0; eyes close

Figure 10: Eye Aspect Ratio (EAR) Landmarks in the Eye (a) Open and (b) Close Eye with Landmark

Figure 10 shows the Eye Aspect Ratio (EAR)'s output range during eyes open and eyes close. During eyes closed, the Eye Aspect Ratio (EAR) result will be approximately to 0 whereas during eyes open the Eye Aspect Ratio (EAR) can be any integer number which is x greater than 0.

Chapter 4

RESULTS AND DISCUSSION

This chapter represents the comprehensive discussion on the developed system. This chapter also presented, analyzed, and interpreted the data gathered by the researchers of this study. The data were analyzed and significant findings were interpreted as well as presented according to the results obtained by the researchers.

4.1 Results by Phase of Study

A survey was conducted via Google Forms regarding the proposed system "Driver's Drowsiness Detection System using OpenCV and Raspberry Pi 3B". The respondents consist of ten randomly selected private car owners. Their answers will be gathered and will serve as a verification of the survey. Furthermore, the researchers compute and validate the survey results as it will determine if the system meet the requirements of the drivers as well as proves that the system is efficient and effective by the means of ISO-9126.

The weighted mean is relatively easy to find. But in some cases, the weights might not add up to 1. In those cases, the researchers need to use the weighted mean formula as shown in Formula 1.

Formula 1:

$$X = \frac{(\mathrm{NV})(\mathrm{S})}{\mathrm{R}}$$

Figure 11: Formula 1

Where:

X = Item

S = Scale

NV = Numerical Value

R = Respondents

To use the formula;

1. Multiply the numbers in your data set by the weights.
2. Add the numbers in Step 1 up. Set this number aside for a moment.
3. Add up all of the weights.
4. Divide the numbers you found in Step 2 by the number you found in Step 3.

The researchers conduct a survey questionnaire with ten respondents composed by ten random private car owners. The researchers analyzed and interpreted the survey questionnaire for this study by using the mean that will be gathered. The mean is the reliable way of measuring that will be coming from the survey questionnaire.

Formula 2:

$$X = \frac{\text{Total Number of Weighted Mean}}{\text{Total Number of Items}}$$

Figure 12: Formula 2

Table 4.1: Likert Scale and Interpretation

Scale	Interpretation
4.50 - 5.0	Strongly Agree
3.50 - 4.49	Agree
2.50 - 3.49	Neither Agree
1.50 - 2.49	Disagree
1.0 - 1.49	Strongly Disagree

Table 4.1 shows the Likert Scale Interpretation wherein it is a series of questions for the respondents to select a rating on a scale that ranges from one extreme to another, "Strongly Agree" to "Strongly Disagree".

Table 4.1.1 Evaluation on the Functionality

Questions	Weighted Mean	Interpretation
Does the system works each functions?	4.4	Agree
Does the system respond with the right information?	4.3	Agree
General Weighted Mean:	4.35	Agree

Table 4.1.1 shows the evaluation of the system based on functionality. With a general weighted mean of 4.35, most respondents agreed that the system works each function and responds with the right information.

Table 4.1.2 Evaluation on the Reliability

Questions	Weighted Mean	Interpretation
Does the system experienced errors during the use?	3.7	Agree
Can the system resume working after not being closed properly?	4.4	Agree
General Weighted Mean:	4.05	Agree

Table 4.1.2 shows the evaluation of the system based on reliability. With a general weighted mean of 4.05, most respondents neither agree regarding the system's reliability. The respondents agreed that they experienced errors when they used the system. In addition, they also agreed that the system resumes working after not being closed properly.

Table 4.1.3 Evaluation on the Usability

Questions	Weighted Mean	Interpretation
Does the user understand the system easily?	4.9	Strongly Agree
General Weighted Mean:	4.9	Strongly Agree

Table 4.1.3 shows the evaluation of the system based on usability. With a general weighted mean of 4.9, most respondents strongly agreed that they understand the system easily.

Table 4.1.4 Evaluation on the Efficiency

Questions	Weighted Mean	Interpretation
Does the system respond quickly?	4.3	Agree
General Weighted Mean:	4.3	Agree

Table 4.1.4 shows the evaluation of the system based on efficiency. With a general weighted mean of 4.3, most respondents agreed that the system responds quickly.

Table 4.1.5 Evaluation on the Maintainability

Questions	Weighted Mean	Interpretation
Can the system easily detects drowsiness?	4.7	Strongly Agree
Does changing information affects the system?	3.7	Agree
Does the system continue functioning if changes are made?	4.5	Strongly Agree
General Weighted Mean:	4.3	Agree

Table 4.1.5 shows the evaluation of the system based on maintainability. With a general weighted mean of 3.5, most respondents strongly agreed that the system can easily detect their drowsiness as well as the system can continue functioning even if there are changes made. In addition, most respondents agreed that changing information affects the system.

Table 4.1.6 Evaluation on the Portability

Questions	Weighted Mean	Interpretation
Can the system be moved to other environments?	4.4	Agree
Can the system be easily use?	4.8	Strongly Agree
General Weighted Mean:	4.6	Strongly Agree

Table 4.1.6 shows the evaluation of the system based on portability. With a general weighted mean of 4.6, most respondents strongly agreed that the system is easy to use as well as it can be moved to other environments.

4.8 Project Description

The developed Driver's Drowsiness Detection System Using OpenCV and Raspberry Pi 3B is a face-detection prototype that can be installed in vehicles. This helps drivers to prevent getting drowsy while driving as the system can detect the driver's drowsiness. Once the system is open, the camera will automatically turn on to detect the driver's face and eyes. Once the driver closes their eyes for as long as 3 seconds, an alarm will be triggered to alert the driver. Once the driver wakes up and the camera detects their eyes once again, the alarm will automatically turn off. The Driver's Drowsiness Detection System was developed using Raspberry Pi 3B. OpenCV was used by the developers in order to detect the driver's face and eyes.

4.9 Project Structure

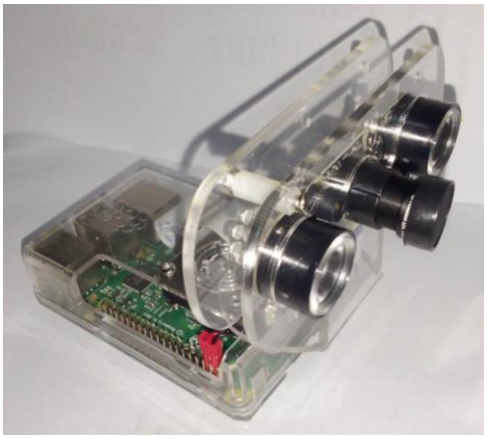


Figure 13: Prototype System Drowsiness Detection System Using OpenCV and Raspberry Pi 3B

Figure 13 shows the actual picture of the prototype of the system. For the prototype to be use, the driver must first install the prototype to their vehicle's windshield in order for the camera to record their face and eyes. The driver must also have a power source to turn on the Raspberry Pi 3B and install the wired speakers in the prototype for the alarm.

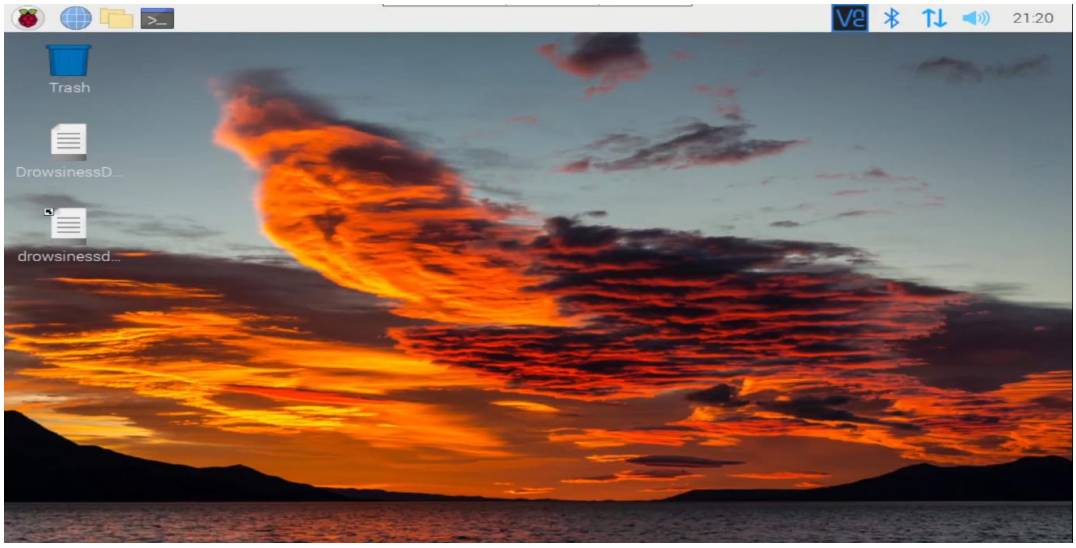


Figure 14: Prototype User Interface

Figure 14 shows the user interface of the Prototype/Raspberry Pi 3B. The desktop design is almost as similar as Windows and Linux with a difference of the taskbar which is located at the top of the screen. Drivers can install Graphic User Interface (GUI) to see the whole system. They can still use the system without the help of Graphic User Interface (GUI) as the system works independently.

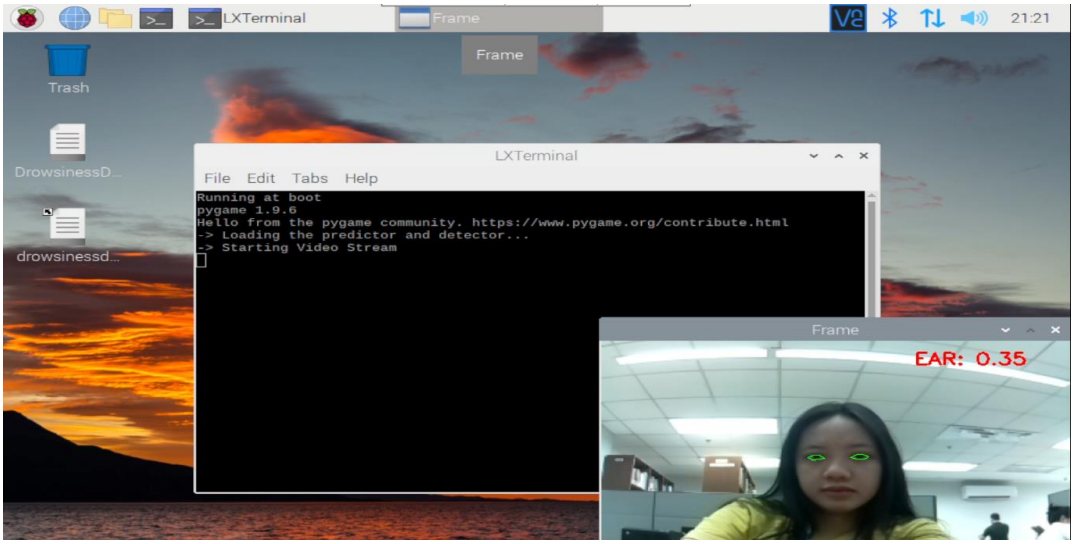


Figure 15: Video Stream

Figure 15 shows the video stream wherein the system's night vision camera is streaming the user in real time. Once the driver's face is found, the system will automatically apply facial landmark detection and extract the eye regions as well as computing the Eye Aspect Ratio (EAR) that is displayed on the top right of the video stream.

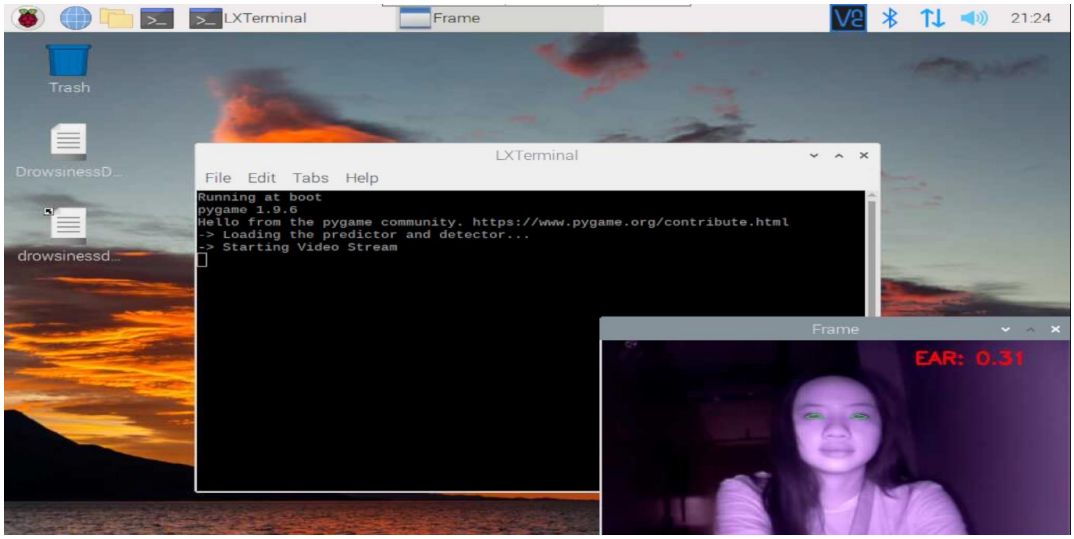


Figure 16: Video Stream in Night Vision Feature

Figure 16 shows the video stream if the user is in a dark environment. The night vision feature will automatically turn on if the driver is driving at night. Similar to Figure 15, the system will detect the user's face and apply facial landmarks as well as extracting the eye regions. In addition, the Eye Aspect Ratio (EAR) will also be displayed on the top right of the video stream.

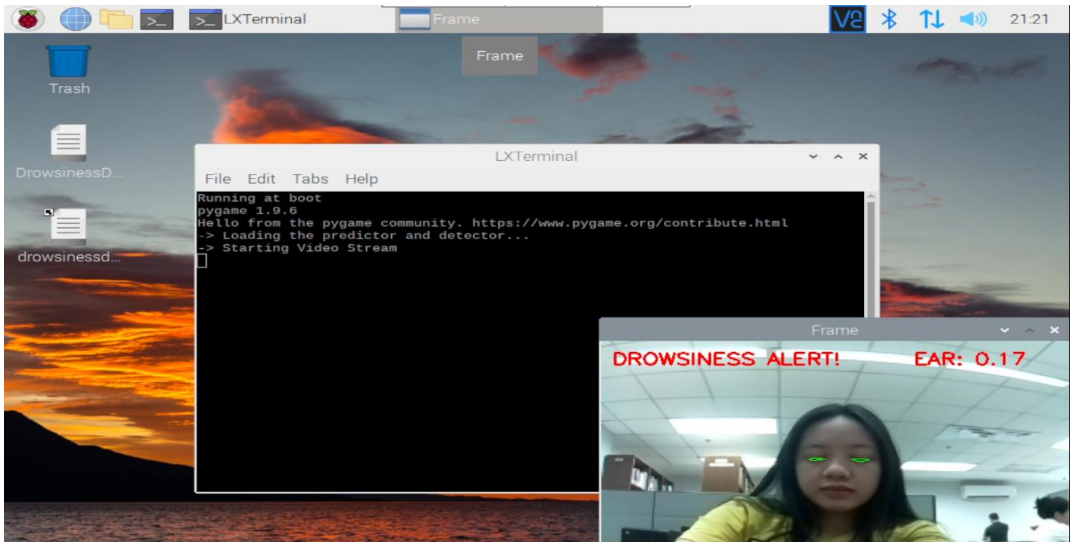


Figure 17: Alarm Message

Figure 17 shows the alarm once the driver is in a drowsiness state. If the eye aspect ratio (EAR) is below 0.30 for 3-5 seconds, the system will initiate the alarm to wake up the driver. In addition, an alarm message will be shown in which is located at the top left side of the video stream.

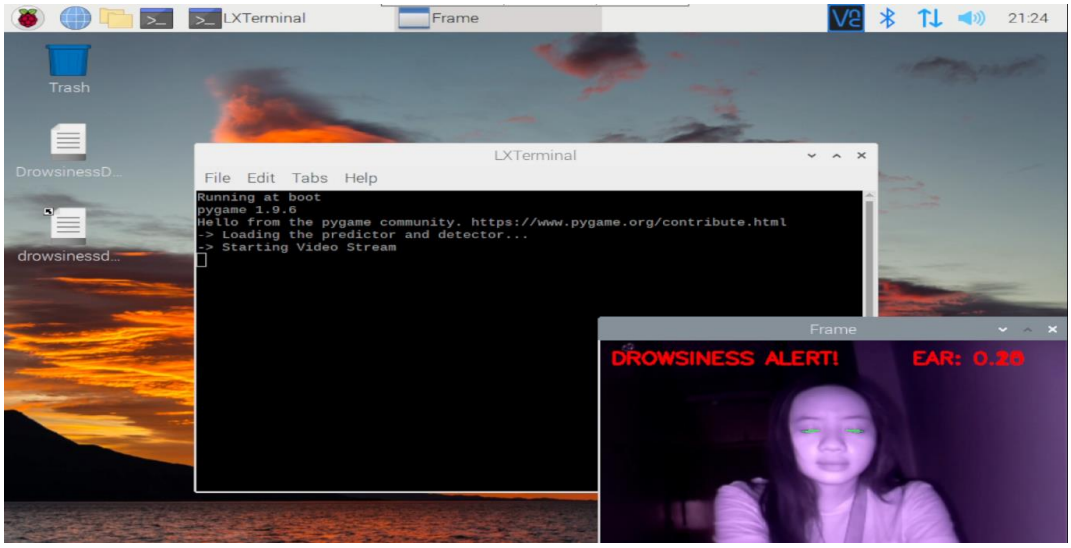


Figure 18: Alarm Message in Night Vision Feature

Figure 18 shows the alarm once the driver is in a drowsiness state. In similar to Figure 17, if the eye aspect ratio (EAR) is below 0.30 for 3-5 seconds, the system will initiate the alarm to wake up the driver. In addition, an alarm message will also be shown in which is located at the top left side of the video stream.

Chapter 5

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The focus of this study is to develop a drowsiness detection system for drivers using OpenCV and Raspberry Pi 3B. The finished system detects the driver's drowsiness. A night vision camera module was installed in the prototype for the system to detect the driver's drowsiness even at night. In addition, an alarm was installed to the system to alert the driver once they became drowsy on the road or if their Eye Aspect Ratio (EAR) drops down below 0.30. The alarm will automatically turn off once the driver wakes up and if their Eye Aspect Ratio (EAR) comes back to 0.30 or greater. The proposed system can help drivers prevent being drowsy while driving as well as reducing road accidents regarding drowsy driving.

5.2 Conclusion

In conclusion, the researchers accomplished the following based on all the gathered data and the discussion from the previous chapter:

Develop a module that will use night vision camera that detect the driver's drowsiness based on eyelid movement or eye blinks.

The Drowsiness Detection System is a prototype that detects the driver's drowsiness using OpenCV and Raspberry Pi 3B. A night vision camera module installed can detect the driver's drowsiness based on eyelid movement or eye blinks even in a dark environment.

Insert an alarm loud enough for the driver to awake from their driver.

The Driver's Drowsiness Detection System has an alarm installed to the system that will alert the driver once the system detects their drowsiness. The alarm is loud enough for the driver to wake up from their drowsiness.

Develop a module that automatically stops the alarm once the driver is awakened so that they can instantly focus on driving.

The Driver's Drowsiness Detection System has a module that can automatically stop the alarm. Once the system detects that the driver has woken up from their drowsiness, the system then automatically stops the alarm so that it will not be a distraction when the driver goes back to driving.

5.3 Recommendation

The researchers would like to propose the following recommendations for the driver's drowsiness system using OpenCV Raspberry Pi 3 B:

Drivers

They can use the Driver's Drowsiness Detection System using OpenCV and Raspberry Pi 3B and install it to their vehicles. However, despite the researcher's recommendation to use this study for detecting drowsy driving, it is still the best for the drivers to choose not to drive when they feel tired and instead take a rest before they hit the road for their own safety. But if the driver still insists on driving even if they are physically exhausted, they can also use this system to increase their safety on the road as well as preventing them from getting drowsy while driving.

Customization and Upgrade

Drivers may apply customizations to the system for their own preference such as replacing the alarm, installing Graphic User Interface (GUI) for visual output and upgrading the night vision camera module with a higher quality to improve the system's performance. In addition, drivers can also use a powerbank as an alternative if they don't have a power supply available. However, the researchers will not be responsible for the driver's safety if the driver chooses to customize the system for their own preference.

Future Researchers

For those who would like to resume this study, the researchers would like to recommend improving the data as well as adding other features such as adding yawning detection to improve the system's performance. Future researchers can use other sources available aside from this study.

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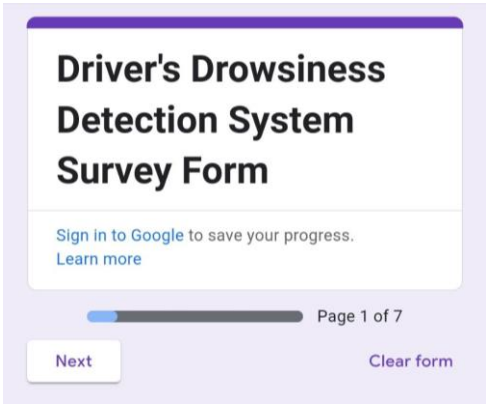
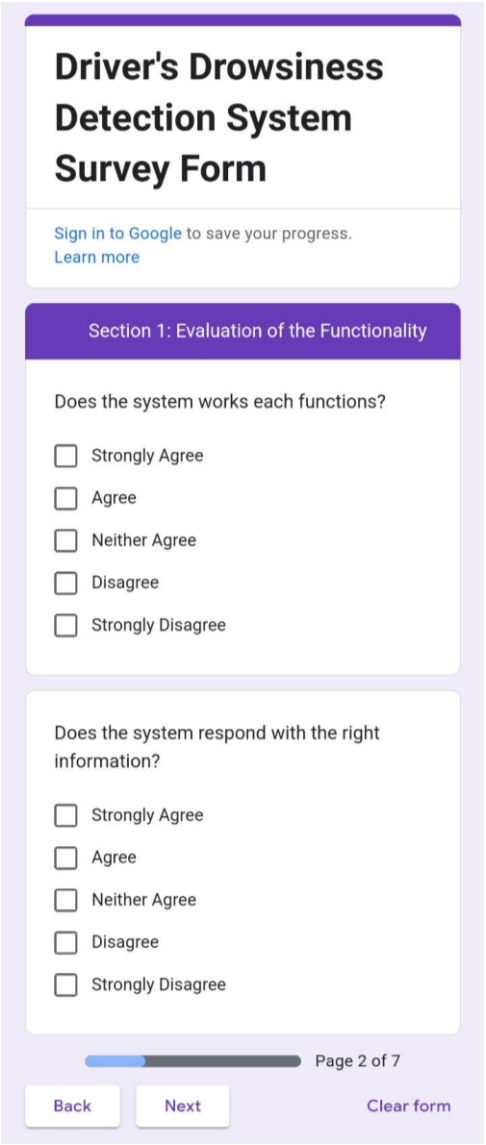
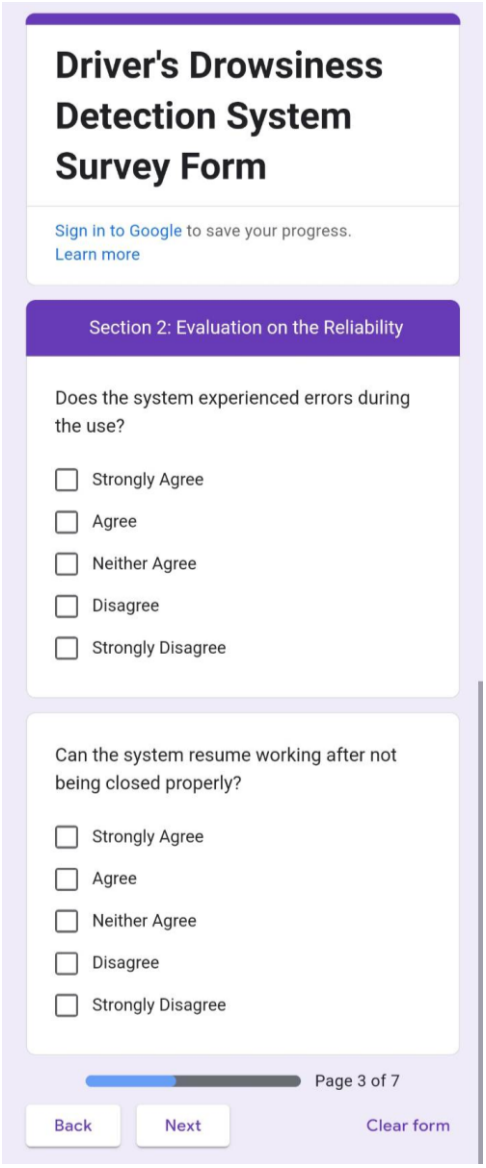
APPENDICES

Appendix A: Screenshot of Survey Questionnaires






Driver's Drowsiness Detection System Survey Form
Sign in to Google to save your progress.
Learn more
Section 2: Evaluation on the Reliability
Does the system experienced errors during the use?
Strongly Agree
Agree
Neither Agree
Disagree
Strongly Disagree
Can the system resume working after not being closed properly?
Strongly Agree
Agree
Neither Agree
Disagree
Strongly Disagree
Page 3 of 7
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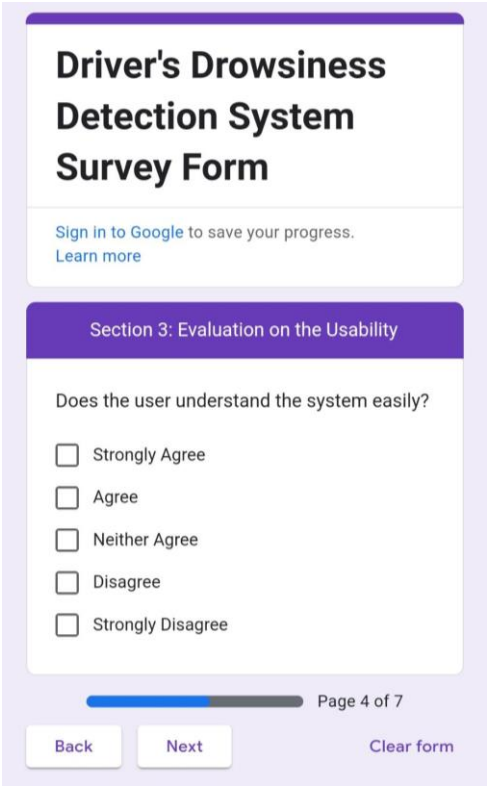
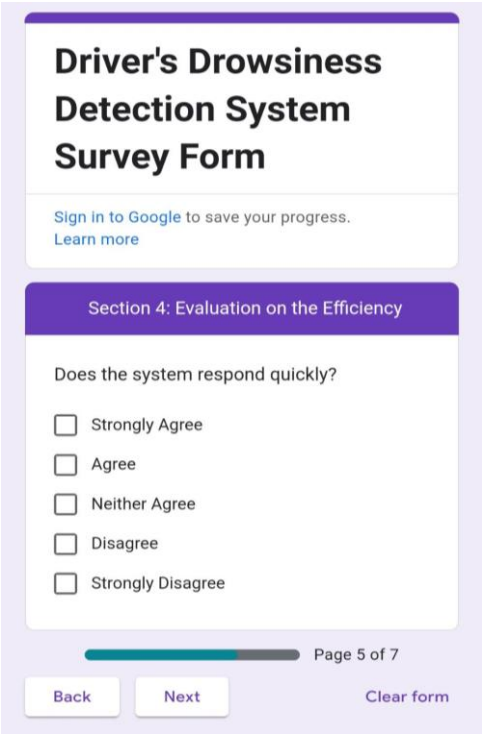
Next
Clear form


Driver's Drowsiness Detection System Survey Form
Sign in to Google to save your progress.
Learn more
Section 3: Evaluation on the Usability
Does the user understand the system easily?
Strongly Agree
Agree
Neither Agree
Disagree
Strongly Disagree
Page 4 of 7
Back
Next
Clear form


Driver's Drowsiness Detection System Survey Form
Sign in to Google to save your progress.
Learn more
Section 4: Evaluation on the Efficiency
Does the system respond quickly?
Strongly Agree
Agree
Neither Agree
Disagree
Strongly Disagree
Page 5 of 7
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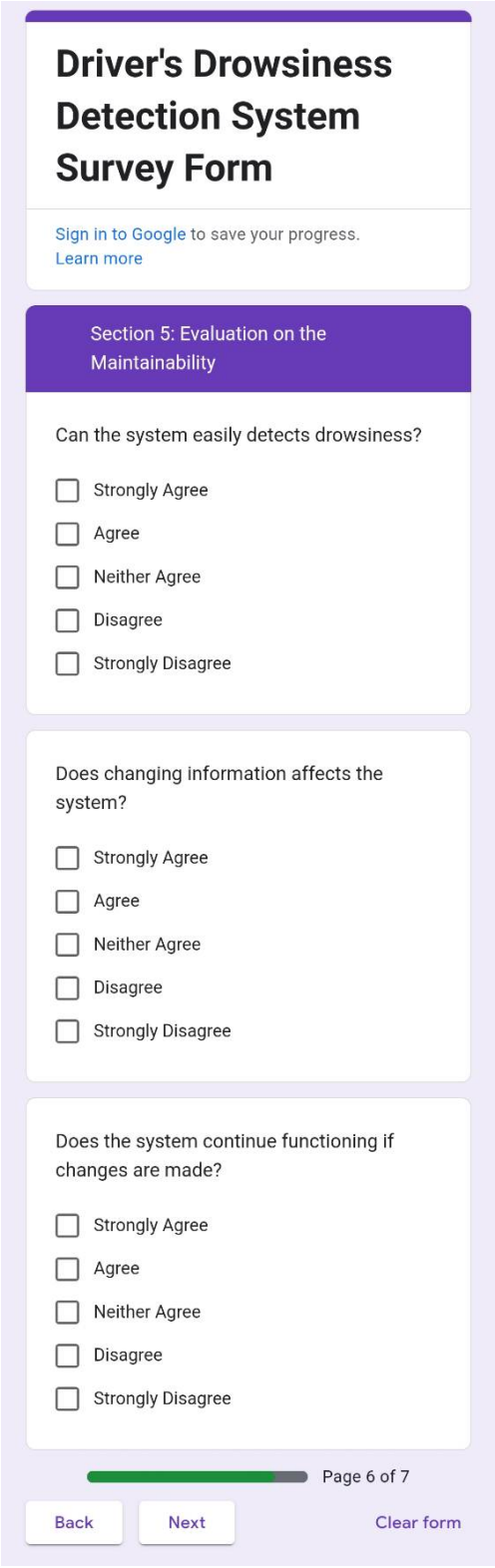
Clear form



Driver's Drowsiness Detection System Survey Form

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Learn more

Section 5: Evaluation on the Maintainability

Can the system easily detects drowsiness?

- [ ] Strongly Agree
- [ ] Agree
- [ ] Neither Agree
- [ ] Disagree
- [ ] Strongly Disagree

Does changing information affects the system?

- [ ] Strongly Agree
- [ ] Agree
- [ ] Neither Agree
- [ ] Disagree
- [ ] Strongly Disagree

Does the system continue functioning if changes are made?

- [ ] Strongly Agree
- [ ] Agree
- [ ] Neither Agree
- [ ] Disagree
- [ ] Strongly Disagree

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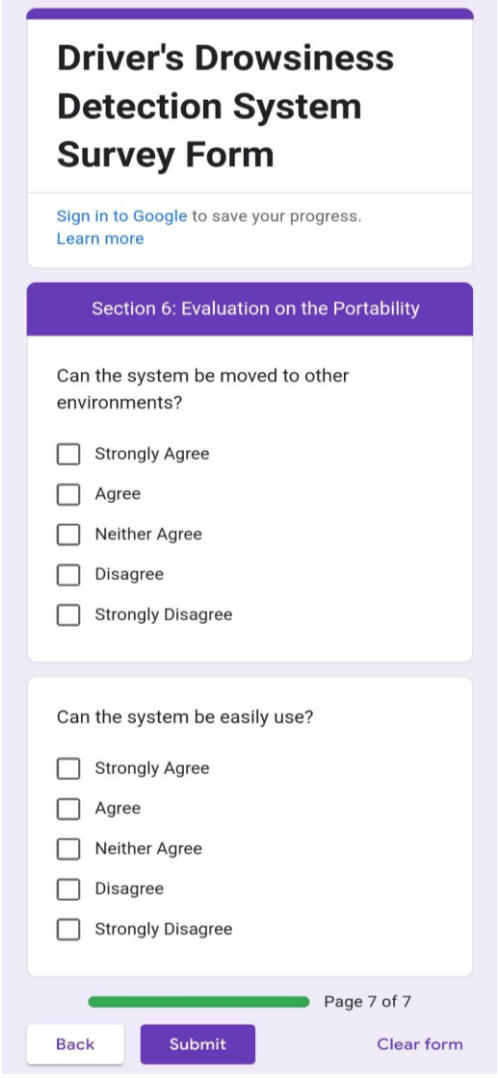

Driver's Drowsiness Detection System Survey Form

Sign in to Google to save your progress.
Learn more

Section 6: Evaluation on the Portability

Can the system be moved to other environments?

- [ ] Strongly Agree
- [ ] Agree
- [ ] Neither Agree
- [ ] Disagree
- [ ] Strongly Disagree

Can the system be easily use?

- [ ] Strongly Agree
- [ ] Agree
- [ ] Neither Agree
- [ ] Disagree
- [ ] Strongly Disagree

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Back Submit Clear form

Appendix B: Survey Results

Questions	Weighted Mean	Interpretation
Does the system works each functions?	4.4	Agree
Does the system respond with the right information?	4.3	Agree
General Weighted Mean:	4.35	Agree

Evaluation of the Functionality

Questions	Weighted Mean	Interpretation
Does the system experienced errors during the use?	3.7	Agree
Can the system resume working after not being closed properly?	4.4	Agree
General Weighted Mean:	4.05	Agree

Evaluation of the Reliability

Questions	Weighted Mean	Interpretation
Does the user understand the system easily?	4.9	Strongly Agree
General Weighted Mean:	4.9	Strongly Agree

Evaluation of the Usability

Questions	Weighted Mean	Interpretation
Does the system respond quickly?	4.3	Agree
General Weighted Mean:	4.3	Agree

Evaluation of the Efficiency

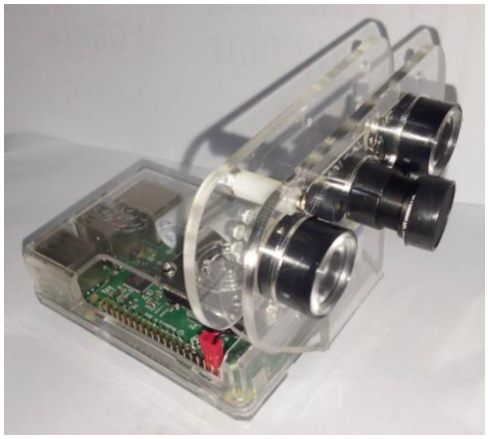
Questions	Weighted Mean	Interpretation
Can the system easily detects drowsiness?	4.7	Strongly Agree
Does changing information affects the system?	3.7	Agree
Does the system continue functioning if changes are made?	4.5	Strongly Agree
General Weighted Mean:	4.3	Agree

Evaluation of the Maintainability

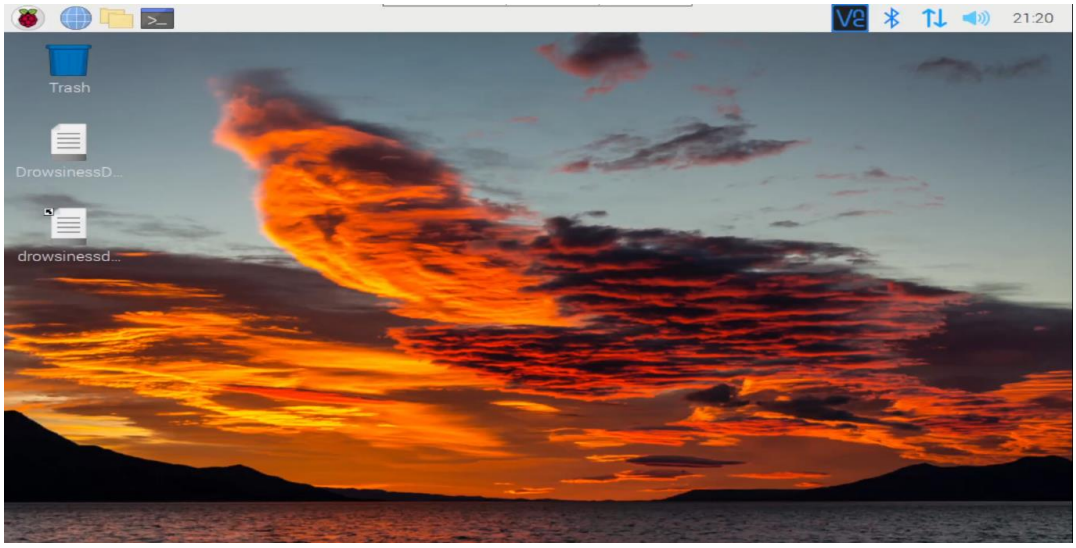
Questions	Weighted Mean	Interpretation
Can the system be moved to other environments?	4.4	Agree
Can the system be easily use?	4.8	Strongly Agree
General Weighted Mean:	4.6	Strongly Agree

Evaluation of the Portability

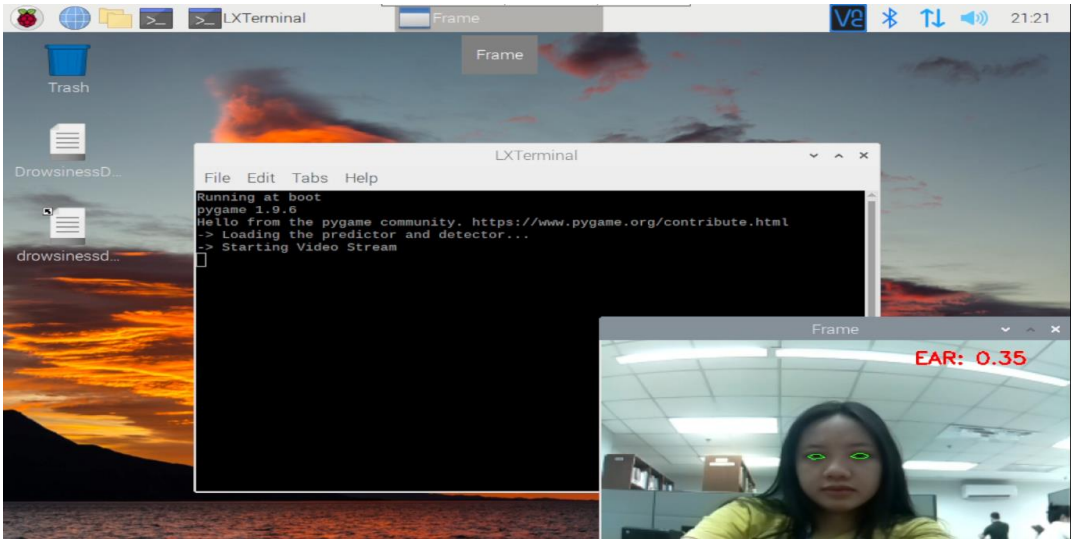
Appendix C: System Screenshots and Prototype



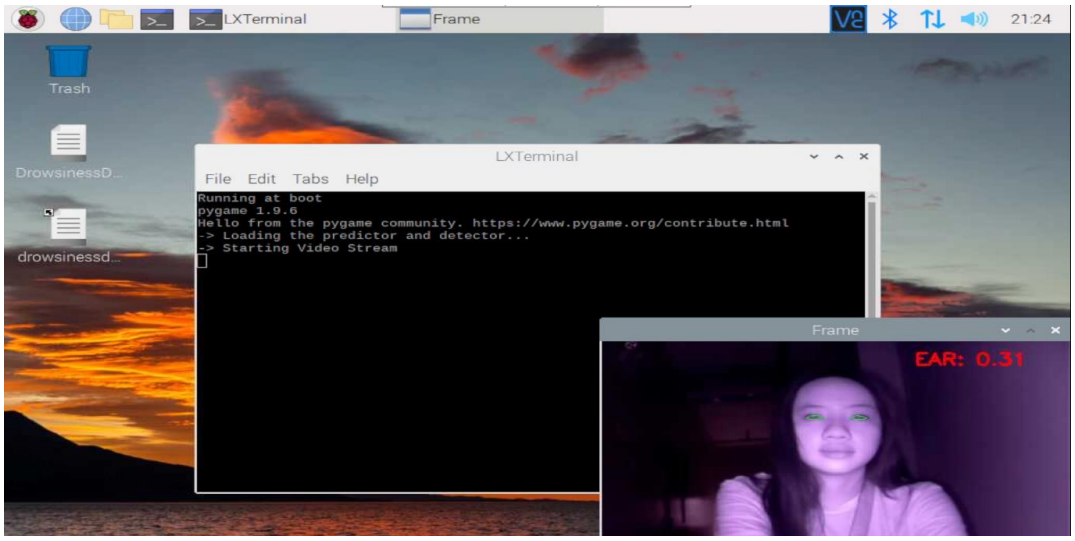
Prototype System Drowsiness Detection System Using OpenCV and Raspberry Pi 3B



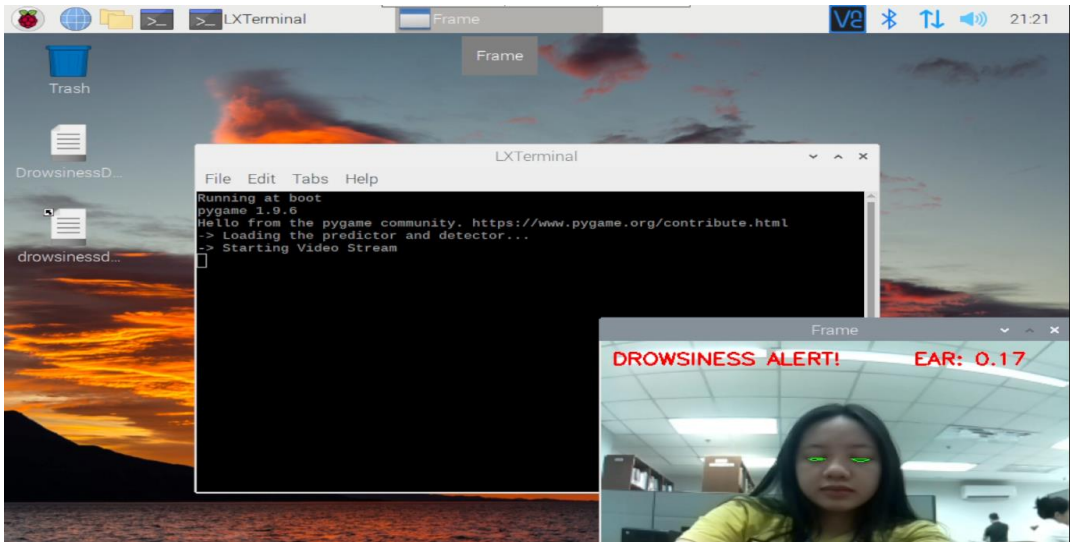
Prototype User Interface



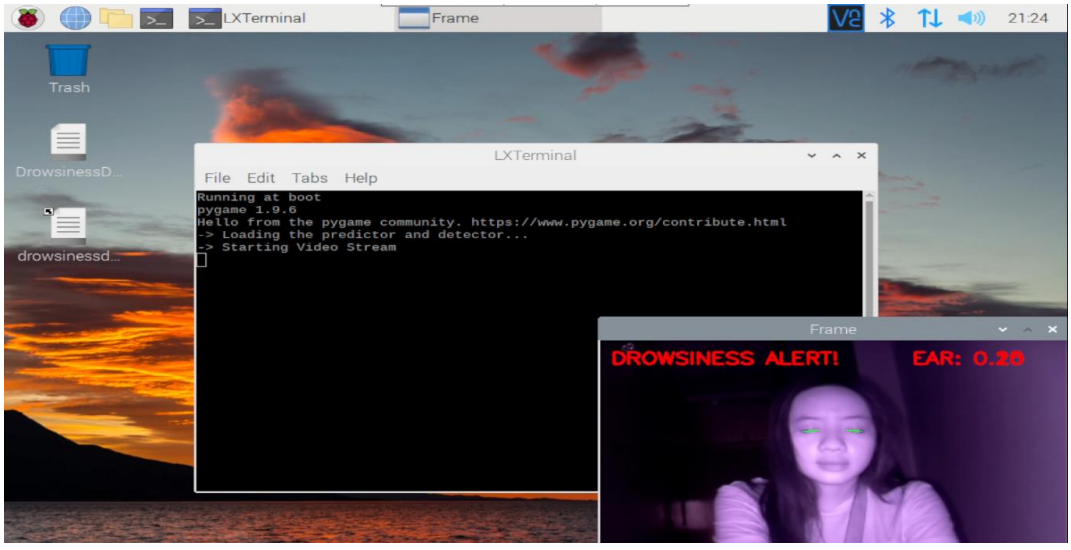
Video Stream



Video Stream in Night Vision Feature



Alarm Message



Alarm Message in Night Vision Feature

CURRICULUM VITAE

MA. ANGELINE I. DUERME

PROFILE

Reserved yet approachable. Observant and adaptable. Always the one who always lend a hand to those in need and always willing to take the first step on doing every tasks. An encourager and a great follower that sticks to the team's plan for achieving success. An outstanding individual that always finish every task on hand without being on the spotlight.

CONTACT

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+639065974187

Manila, Philippines

SKILLS & CHARACTERISTICS

- Great memorization, organization, and communication skills
- Willing to learn and adapt skills
- Ability to use past experiences at work
- Ability to work independently
- Self-disciplined, approachable and friendly
- Basic to Intermediate knowledge on using Microsoft Office Applications (Word, PowerPoint, Excel and Publisher), Cyberlink Power Director and Adobe Photoshop CS3
- Basic to Intermediate knowledge on programming (Java, C#, JavaScript, HTML, Python, R, SQL)

EDUCATION

NATIONAL TEACHERS COLLEGE
Bachelor of Science in Information Technology
2019-2023

Highest GWA: 98.58

Relevant_Coursework:

Database Management System
Computer Programming
Software Engineering
Mobile Development
Web Development
Data Mining
System Administration and Maintenance

CERTIFICATIONS & SEMINARS

- Dean's Lister at The National Teacher College, 2021 – 2022

- *"StackLeague x PWA Pilipinas Tech Session: Learning Web Development, Top-Down"*
StackLeague - PWA Pilipinas

- *" Firebase Study Jams"*
Google Developer Student Club - UP Manila

- *"Programming for Everybody (Getting Started with Python)"*
Coursera - University of Michigan

ACTIVITY & INTERESTS

Browsing the Internet
Watching
Playing Mobile Games
Reading Online Forums/Articles
Listening to Music

JORIZH T. INGRESO

PROFILE

Always a pleasant and friendly student! Expert in conflict resolution. A student who is acutely aware of professors' and the surrounding needs or activity. Punctual problem solver and avid multitasker. Track record of being an essential part of group projects and instrumental in providing effective solutions that have an immediate impact and contribute to the establishment's long-term success.

CONTACT

oris.ingreso@gmail.com

+6309954886919

Manila, Philippines

SKILLS & CHARACTERISTICS

- Can work under pressure and extreme work condition in any assigned responsibility.
- Good in written and verbal communication skills.
- Familiar with Internet Application and MS Office such as MS Word, Excel and PowerPoint.
- Can use an Adobe Photoshop and Canva.
- Open to learn new things and can adapt to any culture.
- Can multi-task in any given responsibility.

EDUCATION

NATIONAL TEACHERS COLLEGE
Bachelor in Information Technology
2019-2023

Highest GWA: 97.8

Relevant Coursework:

- Database Management System
- System Analysis and Designs
- Software Engineering
- Advanced Mobile Development
- Advanced Web Development
- Advanced Data Mining
- System Administration and Maintenance

CERTIFICATIONS & SEMINARS

- Dean's Lister at The National Teacher College 2021 – 2022
- *"How To Be You Po: Careers in Cybersecurity"* Cybersecurity Bureau - DICT - Region IV
- *"Firebase Study Jams"* Google Developer Student Club - UP Manila
- *"Basic Video Editing using Premiere Pro and Graphic Design"* DICT Region IV-A

ACTIVITY & INTERESTS

- Photography
- Singing
- Cooking
- Travel
- Watching
- Playing mobile games

Joemar G. Langas

Address:
Manila, Philippines

Contact:
09999308564

Email:
joemarlangas@gmail.com

Profile

A student with a passion for academics and work related activities determine to make a positive results. Dedicated to learn to able to provide a valued contribution.

Education

National Teachers College
Bachelor of Science in Information Technology
2019-2023

- GPA: 98.1

Skills

Familiar with a basic IT infrastructure
Able to edit Photo and Video
Familiar with office applications
Troubleshooting some devices

Interest

Self-repair electronic devices
Computer Building
Computer Games

LUZ VERGARA

PROFILE

Highly motivated student major in information technology looking for career opportunities to expand my coding and editing skills. Responsible and driven team player with an eye for detail.

CONTACT ME

09085270056

luzvergara0512@gmail.com

1278 Ducepec St
Paco Manila
Philippines

EDUCATION

NATIONAL TEACHERS COLLEGE
BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY
2019-2023
- **GPA: 96**

CHARACTERISTICS

Attention to Detail
Problem solving skills
A keen desire to learn new things

COMPUTER SKILLS

Familiar with Java and HTML
Familiar with MS Office such as MS Word, Excel and Powerpoint

INTEREST

Playing board games
Playing Instruments
Learning Music
Manga and Anime
Drawing