DROWSINESS DETECTION FOR CAR ASSISTED DRIVER SYSTEM USING IMAGE PROCESSING ANALYSIS – INTERFACING WITH HARDWARE

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BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **DROWSINESS DETECTION FOR CAR ASSISTED DRIVER SYSTEM USING IMAGE PROCESSING ANALYSIS – INTERFACING WITH HARDWARE**

SESI PENGAJIAN: 2009/2010

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Date : 29 NOVEMBER 2010

DROWSINESS DETECTION FOR CAR ASSISTED DRIVER SYSTEM USING IMAGE PROCESSING ANALYSIS – INTERFACING WITH HARDWARE

HUONG NICE QUAN

This thesis is submitted as partial fulfillment of the requirements for the award of the degree of Bachelor of Electrical Engineering (Electronics)

Faculty of Electrical & Electronics Engineering
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NOVEMBER, 2010

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Date : 24 NOVEMBER 2010

To my beloved father, mother, brothers and sister

To my respectful supervisor Dr. Kamarul

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I would like to take this opportunity to show my gracefulness to my respectful supervisor, Dr. Kamarul Hawari bin Ghazali for his precious guides throughout this project. He spent so much time with me to discuss and help with this project. His ideas, helps, and guides keep my passion throughout these two semesters.

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ABSTRACT

The purpose of this study is to detect drowsiness in drivers to prevent accidents and to improve safety on the highways. A method for detecting drowsiness/sleepiness in drivers is developed by using a camera that point directly towards the driver's face and capture for the video. Once the video is captured, monitoring the face region and eyes in order to detect drowsy/fatigue. The system able to monitoring eyes and determines whether the eyes are in an open position or closed state. In such a case when drowsy is detected, a warning signal is issued to alert the driver. It can determine a time proportion of eye closure as the proportion of a time interval that the eye is in the closed position. If the driver's eyes are closed cumulatively more than a standard value, the system draws the conclusion that the driver is falling asleep, and then it will activate an alarm sound to alert the driver.

ABSTRAK

Tujuan pengkajian ini adalah untuk mengesan pemandu yang menghadapi masalah mengantuk semasa memandu dan menggelakkan kemalangan serta meningkatkan keselamatan di jalan raya. Kaedah yang digunakan untuk mengesan kantuk/ngantuk terhadap pemandu dengan menggunakan kamera mengarah langsung ke arah wajah pemandu untuk dan merakam untuk video. Setelah video dirakam, pematauan terhadap wajah dan mata untuk mengesan masalah mengantuk/keletihan. Sistem ini mampu memantaukan dan menentukan mata dalam keadaan terbuka atau keadaan tertutup. Dalam kes ketika mengantuk dikesan, isyarat amaran dikeluarkan untuk memberi amaran kepada pemandu. Sistem ini dapat menentukan perkadaran masa penutupan masa sebagai perkadaran selang masa yang mata dalam kedudukan tertutup. Sekiranya mata pemandu tertutup secara kumulatif lebih daripada nilai standard, sistem tersebut akan membuat kesimpulan bahawa pemandu dalam keadaan mengantuk, dan kemudian akan mengaktifkan suara penggera untuk memberi isyarat dan amaran kepada pemandu.

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LIST OF ABBREVIATIONS

PERCLOS	Percentage of Eyelid Closure Over the Pupil over time
CMOS	Complimentary Metal-Oxide Semiconductor
CCD	Charge-Coupled Device
AVI	Audio/Video Interleaved
MPEG	Moving Picture Experts Group
MP4	Moving Picture Experts Group Part 14
3GP	Third Generation Partnership Project
PDA	Personal Digital Assistant
JPEG	Joint Photographic Experts Group
TIFF	Tagged Image File Format
PNG	Portable Network Graphics
HDF	Hierarchical Data Format
FITS	Flexible Image Transport System
ASCII	American Standard Code for Information Interchange 2
BIP	Basic Imaging Profile

FAKULTI KEJURUTERAAN ELEKTRIK & ELEKTRONIK
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BORANG ABSTRAK PENUH PROJEK

Nama Pelajar: Huong Nice Quan	**Kod Projek: EE024/KHG/4A/1011I**

Tajuk projek (Terbaru): Drowsiness Detection For Car Assisted Driver System Using Image Processing Analysis – Interfacing With Hardware.

Abstrak (English version, Font: Times New Roman, 12pts, single line spacing & one paragraph):

The purpose of this study is to detect drowsiness in drivers to prevent accidents and to improve safety on the highways. A method for detecting drowsiness/sleepiness in drivers is developed by using a camera that point directly towards the driver's face and capture for the video. Once the video is captured, monitoring the face region and eyes in order to detect drowsy/fatigue. The system able to monitoring eyes and determines whether the eyes are in an open position or closed state. In such a case when drowsy is detected, a warning signal is issued to alert the driver. It can determine a time proportion of eye closure as the proportion of a time interval that the eye is in the closed position. If the driver's eyes are closed cumulatively more than a standard value, the system draws the conclusion that the driver is falling asleep, and then it will activate an alarm sound to alert the driver.

Supervisor's approval (signature & stamp):

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Table 1.1 Gantt chart PSM 1

PROJECT TITLE: Drowsiness Detection for Car Assisted Driver System using Image Processing Analysis – Interfacing with hardware																								
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• Submit Presentation Approval Form to coordinator																								
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• Forward supervisor comment to supervisor																								
Submission Report																								
• Preparation full report with correction																								
• Submit full report and log book to supervisor																								
Preparation of PSM 2																								
• Plan the hardware design and constructions																								
• Discuss with Supervisor																								

Table 1.2: Gantt chart PSM 2

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Compilation and Submission of Thesis																								
• Printing and Submit Thesis for Hard Binding																								

CHAPTER 1

INTRODUCTION

1.1 Introduction to the Project

Driving with drowsiness is one of the main causes of traffic accidents. Driver fatigue is a significant factor in a large number of vehicle accidents. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Due to the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects.

There are many technologies for drowsiness detection and can be divided into three main categories: biological indicators, vehicle behavior, and face analysis [1]. The first type measures biological indicators such as brain waves, heart rate and pulse rate. These techniques have the best detection accuracy but they require physical contact with the driver [2]. They are intrusive. Thus, they are not practical. The second type measures vehicle behaviors such as speed, lateral position and turning angle. These techniques may be implemented non-intrusively, but they have several limitations such as the vehicle type, driver experience and driving conditions. Furthermore, it requires special equipment and can be expensive. The third type is face analysis. Since the human face is dynamic and has a high degree of variability, face detection is considered to be a difficult problem in computer vision research. As one of the salient features of the human face, human eyes play an important role in face recognition and facial expression analysis. In fact, the eyes can be considered salient and relatively stable feature on the face in comparison with other facial features. Therefore, when we detect facial features, it is advantageous to detect eyes before the detection of other facial features. The position of other facial features can be estimated using the eye position [3]. In addition, the size, the location and the image-plane rotation of face in the image can be normalized by only the position of both eyes.

The aim of this project is to develop a drowsiness detection system. The vision-based systems have been widely used because of its accuracy and non-intrusiveness. Visual cues such as eye states (i.e. whether they are open or closed) can typically reflect the driver's level of fatigue. Therefore, an automatic and robust approach to extract the eye states from input images is very important. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns.

This project is focused on the localization of the eyes, which involves looking at the entire image of the face, and determining the position of the eyes. Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect fatigue.

1.2 Problem Statement

Driver drowsiness is a serious hazard in transportation systems. It has been identified as a direct or contributing cause of road accident [4]. Driver drowsiness is one of the major causes of road accident. Drowsiness can seriously slow reaction time, decrease awareness and impair a driver's judgment. It is concluded that driving while drowsy is similar to driving under the influence of alcohol or drugs [5]. In industrialized countries, drowsiness has been estimated to be involved in 2% to 23% of all crashes [6].Systems that detect when drivers are becoming drowsy and sound a warning promise to be a valuable aid in preventing accidents.

1.3 Objective

The objectives of this project are to develop a drowsiness detection system that can detect drowsy or fatigue in drivers to prevent accidents and to improve safety on the roads. This system able accurately monitors the open or closed state of the driver’s eye. When drowsy is detected toward a driver, a warning signal is issued to alert the driver.

1.4 Scope of Project

The simulation and analysis based on eyes scanning using image processing technology. This detection involves- observation of eyes that is in open or closed state and the blinking patterns for a driver. A warning signal will be generated to trigger a hardware device (alarm) to alert user.

1.5 Thesis Overview

This Drowsiness Detection for Car Assisted Driver System Using Image Processing Analysis - Interfacing with Hardware final thesis is a combination of five different chapters. Each of the chapters elaborates details regarding different aspects. The included aspects are Introduction, Literature Review, Methodology, Hardware and Software Implementation, Result and Discussion, and Conclusion. Furthermore, the Gantt charts in table 1.1 and table 1.2 show that the detailed of progress.

Chapter 1: Basic introduction of the this project

Chapter 2: Literature Review for the development of this project

Chapter 3: Method used throughout the development of the whole project

Chapter 4: Hardware & Software Implementation for the project.

Chapter 5: Results and Discussion on the performance of this project.

Chapter 6: Conclusion of this project.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews about the studies that have been done before or during the development of this project. It is the summary of all related study material and components required in this research. All ideas and concepts yield are to be implemented on the research.

2.1 Face Detection Technologies

Due to the human face is dynamic and has a high degree of variability; face detection is considered to be a complex task in computer vision. Despite its difficulties, scientists and computer researchers have developed and improved various face detection techniques.

Face detection is a necessary step in all face processing systems, and its efficiency influences the overall performance of drowsiness detection systems. Researchers classified the face detection techniques using the following approaches:

the top down model based approach (search different face model at different scales level), bottom up feature based approach (searches the image for a set of facial features), texture based approach (faces are detected by examining the spatial distribution of gray or colour information), neural network approach (detects faces by sampling different regions and passing it to neural network), colour based approach (labels each pixel according to its similarity to skin colour and face shape), motion based approaches (use image subtraction to extract the moving foreground from the static background).

Besides, another major classification categorizes the face detection algorithms into the following approaches: feature-based, image-based, and template matching. The general classification for face detection algorithms and supported tools are presented by Hjelm [7] and it can be divided into three categories: feature based, template matching, and image based.

2.2 Efficient Eye States Detection in Real-Time for Drowsy Detection

A reliable method of eye states detection in real-time for drowsy monitoring by given a restricted local block of eye regions, the Local Binary Pattern (LBP) histogram of the block is extracted and each bin of the histogram is treated as a feature of the eye and followed by an AdaBoost based cascaded classifier is trained to classify the eye states as open or closed. According to the states of the eye, the PERCLOS (the percentage of time that an eye is closed in a given period) score is measured to decide whether the driver is at drowsy state or not.

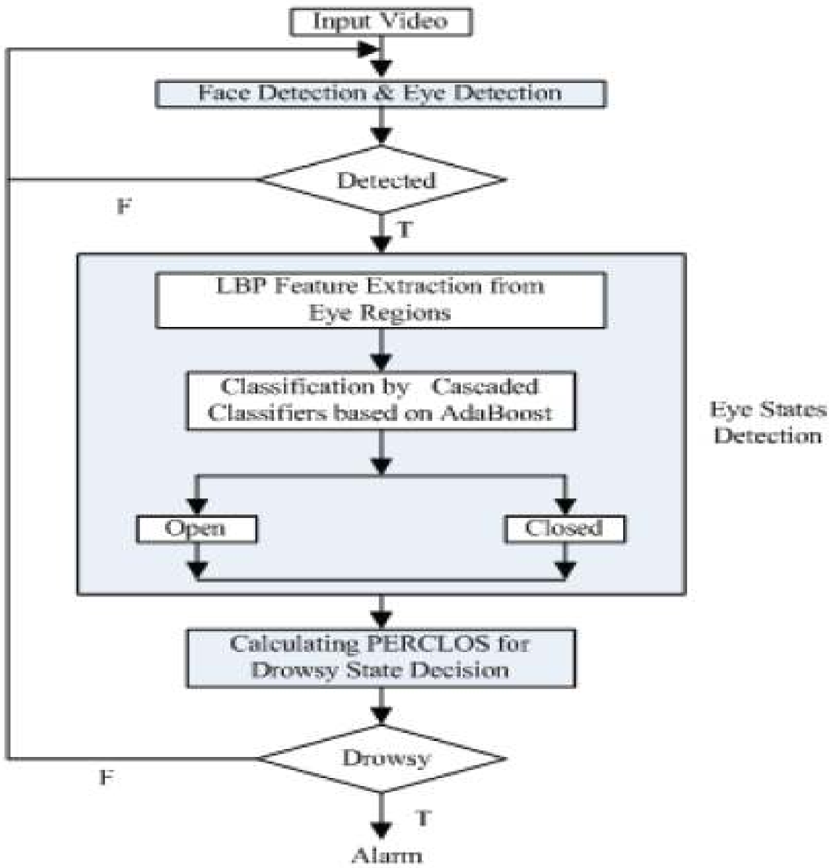


Figure 2.1: Overview of drowsy driving monitoring system

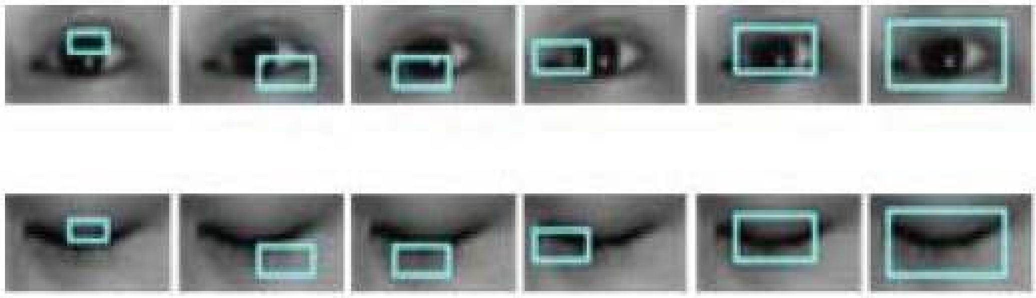


Figure 2.2: Examples of effective regions selected by AdaBoost

AdaBoost- learning is an algorithm which maximizing classification margin iteratively.

The face and eye detectors are built based on the standard AdaBoost training methods combined with Violas cascade approach using haar-like features [8]. This method of face and eye detection has been proved to be fast and effective enough for real-time eye states detection system, even under weak or strong light conditions, as long as the training data include these situations.

Next, the experimental results on eye-state detection are based on the assumption that eye regions of each frame are all corrected located. By the use of cascaded AdaBoost for learning effective features from the large feature set and discard redundant information. It show the effectiveness most of the blocks are centralized at the regions of pupil, eye corners or eyelids, which are evidently the distinctive regions for distinguishing open and closed states.

Finally, a decision about drowsiness is made by measuring the PERCLOS (Percentage of eye closure over time). PERCLOS is the most popular method of measuring eye blinking because high PERCLOS scores are strongly related to drowsiness [9]. The time that the eye is closed is continuously accumulated for the latest 30 seconds in order to acquire the PERCLOS. Fig. 1 is the plots of PERCLOS measured over 150 seconds. For the alert state, the graph is more stable and the score is much lower than the drowsy one. When the score exceeds 30%, warning message is given for the drowsy state by the system.

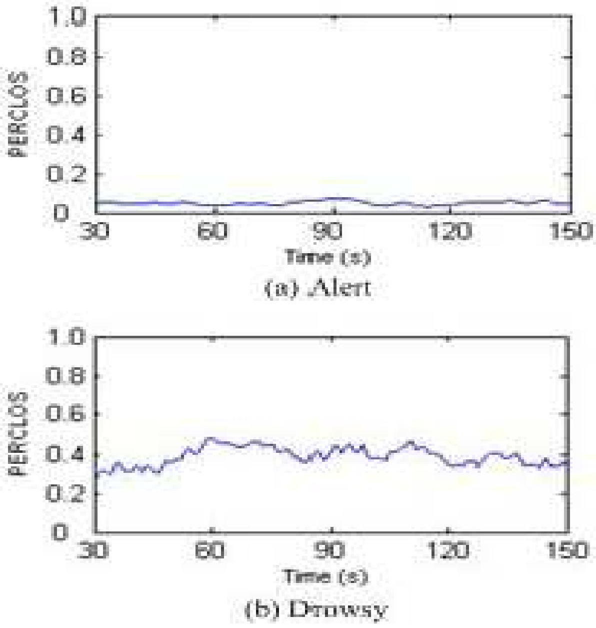


Figure 2.3: PERCLOS measurements for alert and drowsy data

2.3 Drowsiness Detection Based on Brightness and Numeral Features of Eye Image

An algorithm for eye state analysis, which incorporates into a four step system for drowsiness detection: face detection, eye detection, eye state analysis, and drowsy decision. It requires no training data at any step or special cameras. The novel eye state analysis algorithm detects open, semi-open, and closed eye during two steps which is based on brightness and numeral features of the eye image.

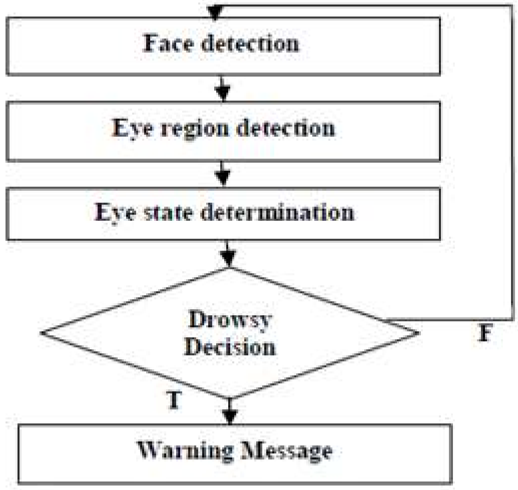
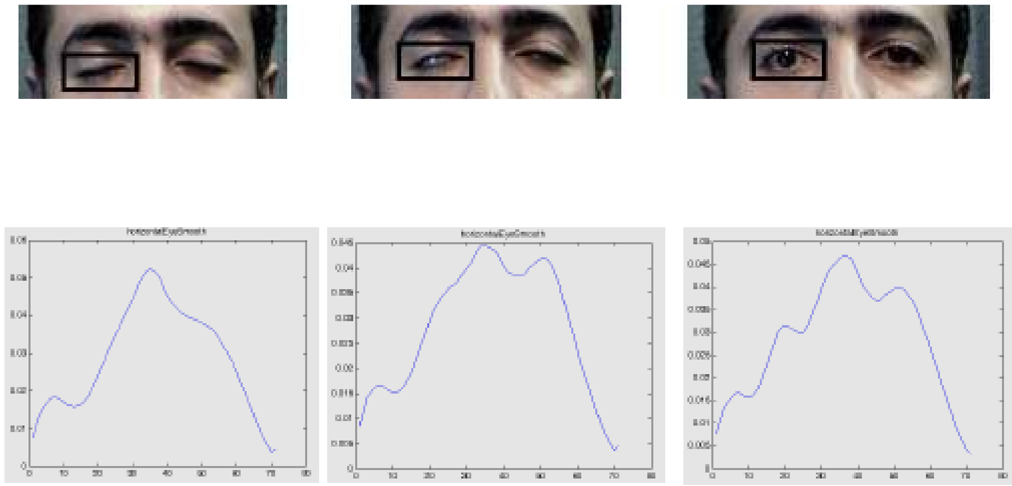


Figure 2.4: Flowchart of the system for drowsiness detection

Table 2.1: Accuracy of open, semi-open, closed eye determination on database

Eye State (eye frame in special state/ total eye frame)	Variance based algorithm	Eyelids distance – based algorithm	The proposed algorithm
	Accuracy (%)	Accuracy (%)	Accuracy (%)
Open (1125/2250)	96.4	100	96.4
Semi-Open (375/2250)	100	95.2	95.2
Closed (750/2250)	67.5	72.5	94.7



(a) (b) (c)

Figure 2.5: Variance projection curve in vertical direction of different eye states.

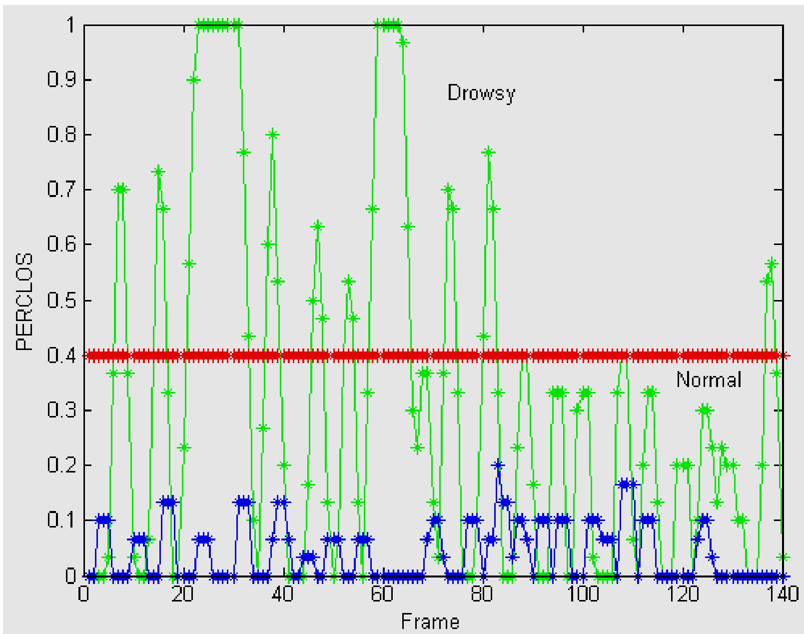


Figure 2.6: Measured PERCLOS parameter for one person in non-drowsy and drowsy states with warning message.

Firstly, it detects face using a popular approach of utilizing skin color because skin color based methods are fast and simple followed by detecting eye region by constructing Eye Map [8]. This method has very good performance for eye region detection in different light conditions and has lower computational complexity.

After eye detection, it performs eye state analysis - determination of whether the eye is open or closed based on brightness and numeral features of the eye image. This method can determine open, partially open and closed eye states with a high accuracy without using any training data sets. Finally, a decision about drowsiness is made by measuring the PERCLOS using eye blinking which is shown in Figure 2.6.

2.4 Drowsy Detection and Alarming System (DroDeASys)

The system is basically developed to detect drivers dozing at the wheel at night time driving. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. It uses a small infra-red night vision camera that points directly towards the driver's face and monitors the driver's eyes in order to detect fatigue.

Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns. The eye detection algorithm as well as the drowsy detection procedure has been implemented using a self developed algorithm. The system is developed using image processing fundamentals.

The focus of the system is on accurately determining the open or closed state of the eyes. Depending on the state of the eyes it can be said whether the driver is alert or not. The decision whether the driver is dozing or not is taken depending on whether the eyes are open for a specific number of frames. If the eyes are found to be closed for a certain number of consecutive frames then the driver is alerted with an alarm. In such a case when fatigue is detected, a warning signal is issued to alert the driver.

To achieve the result, clustering and slope detection algorithms were used. The images of the drivers face are acquired from the infra-red night vision camera. The infra red camera illuminates the drivers face at night time. The images obtained are converted to binary images first and then clusters on those images are found out. The slope detection algorithm is used to make the former algorithm more accurate in detecting the state of the eyes. It calculates the slope between each of the clusters and keeps on discarding the clusters till finally the eyes are detected. If the eyes are found with the driver is alert and there is no need of raising an alarm. But if the eyes are not found or are closed for a period of 3 seconds continuously then it is safe to assume that the alertness level has dropped down to certain level and the driver is dozing. In such a case the driver is alerted by raising an alarm. The system uses a completely software approach that including three phases:

I. Pre-processing
II. Processing
III. Post-processing

There are few tested samples shown below:

Figure 2.7: Tested Samples

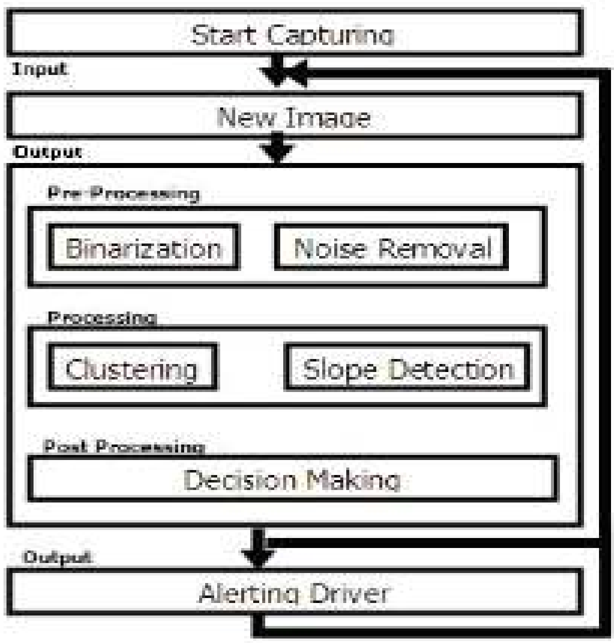


Figure 2.8: Block diagram of DroDeASys

2.4.1 Pre-processing

The images acquired from the infra red night vision camera are converted into binary images using a specific threshold. Also the image is enhanced by isolating independent pixels.

2.4.2 Processing

The binary image is then input to the clustering algorithm where in clusters are found out within the binary image. Clusters are nothing but the areas of the face which are turned on after applying a specific threshold. Once the clusters are detected the centers of each of the clusters is found out and distance is calculated. To detect the eyes the distance is checked between the clusters and if ever the clusters are found to be within that range then the eyes are detected.

To accurately detect the eyes the slope detection algorithm is used to calculate the slope between each of the clusters and it discards the clusters till finally the eyes are detected. If ever the eyes are found then the driver is alert and there is no need of raising an alarm. But if the eyes are not found or are closed for a period of 10 seconds continuously then it is safe to assume that the alertness level has dropped down to certain level and the driver is dozing. In such a case the driver is alerted by raising an alarm.

2.4.3 Post Processing

Depending on the state of the eyes found in the previous stage an appropriate decision is made and then displayed onscreen.

2.5 Drowsiness Detection System Using Electrooculography (EOG)

The use of electrooculogram (EOG) as an alternative to video-based systems in detecting eye activities caused by drowsiness is explored and evaluated. The EOG, which is the electrical signal generated by eye movements, is acquired by a mobile biosignal acquisition module and are processed offline using personal computer. Digital signal differentiation and simple information fusion techniques are used to detect signs of drowsiness in the EOG signal. Based on the tested offline processing techniques, an online fatigue monitoring system prototype based on a Personal

Digital Assistant (PDA) has been designed to detect driver dozing off through EOG signal.

EOG is electrical signal generated by polarization of the eye ball and can be measured on skin around the eyes. Its magnitude varies in accordance to the displacement of the eye ball from its resting location [10]. Rapid eye movements (REM), which occur when one is awake, and slow eye movements (SEM), which occur when one is drowsy, can be detected through EOG [11].

EOG signal is acquired by placing Ag/AgCI electrophysiology electrodes around the eyes. Two channels of bipolar EOG signal are acquired for analysis, which are the horizontal channel and vertical channel. The horizontal channel EOG reflects horizontal eyeball movements while the vertical channel EOG reflects vertical eyeball movements. Two disposable Ag/AgCI electrodes were placed above and below the right eye to measure vertical EOG while two other such electrodes were placed at the outer canthi to measure horizontal EOG. A silver plated electrode was clipped on the left earlobe, acting as the group point. The illustration of electrodes placements is shown in Figure 2.9.

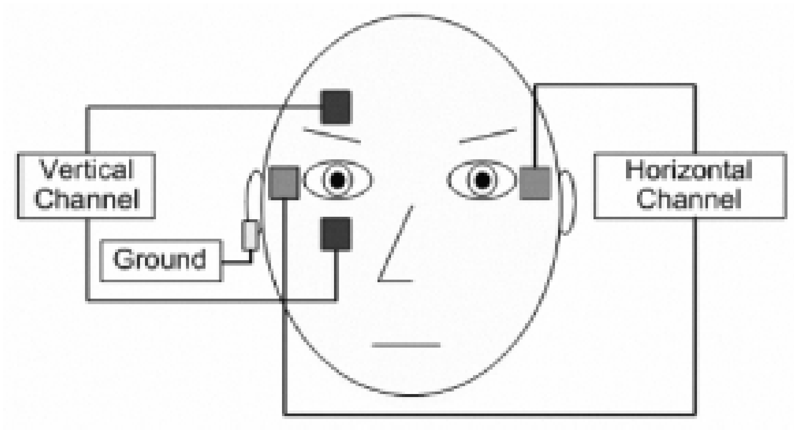


Figure 2.9: Electrode placement positions for EOG measurement

The EOG signals were acquired by using a mobile electrophysiological signal acquisition module with sampling frequency of 256 Hz and resolution of 16 bit. The acquisition module has AC coupled inputs, with frequency response from 0.01 to 30 Hz. The recorded data were stored on a Personal Digital Assistant (PDA) connected to the acquisition module. Upon completion of the recording, the stored data was transferred to a PC for off-line processing. Subjects' behaviors during signal recording were video recorded using a web camera to provide reference to the recorded data concerning the subject's alertness. The instrument setup used during data collection is shown in Figure 2.10.

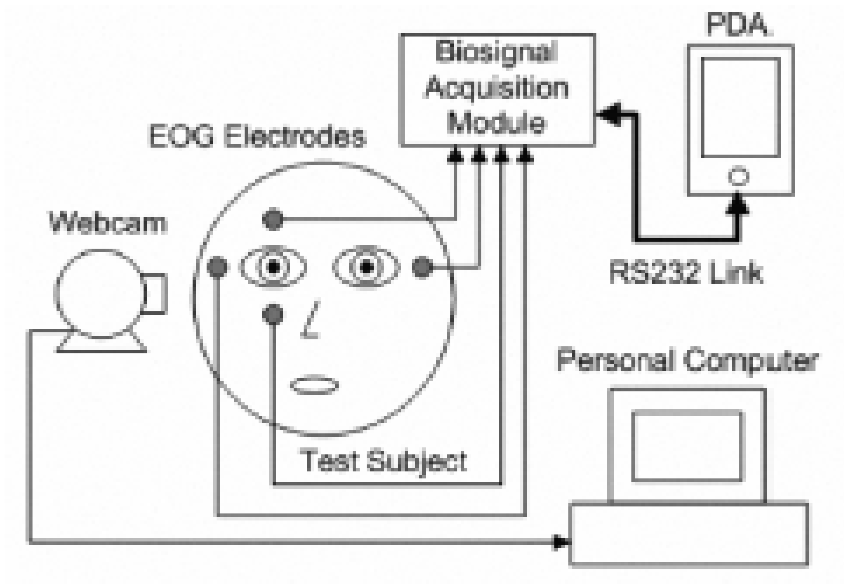


Figure 2.10: Instrument setup during data collection

The fatigue detection process through differentiation of EOG signal is summarized in Figure 2.11.

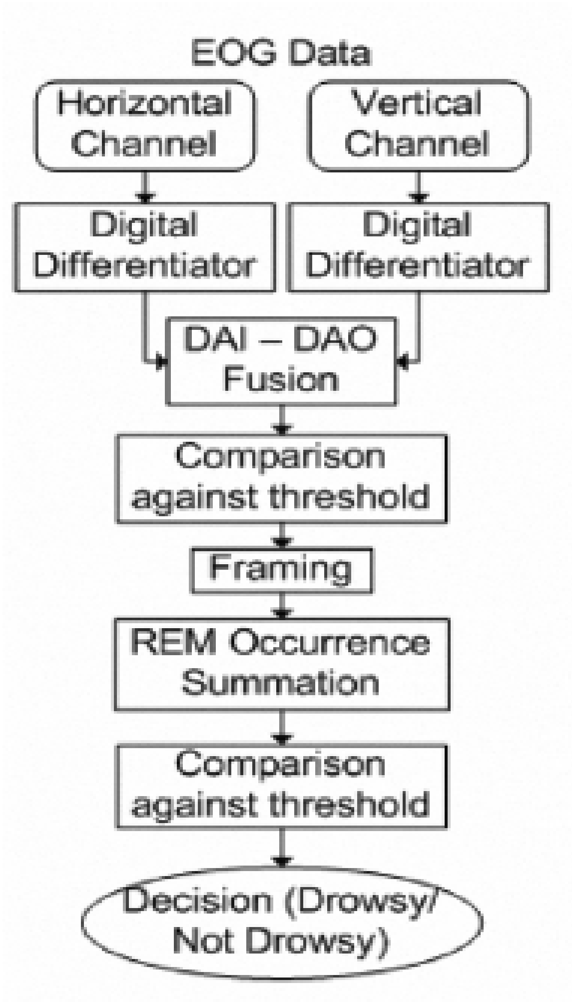


Figure 2.11: Summary of the EOG process algorithm

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes how this research has been done and the method used to achieve the research objectives and purpose. The overview of this researches shown here in methodology, one of the most important elements to be considered as it is the guideline to make sure that this research is right on track and on time.

3.2 Image Acquisition

The most important aspect of implementing a drowsiness detection system is the image acquisition. Any deficiencies in the acquired images can cause problems with image analysis and interpretation. Examples of such problems are a lack of detail due to insufficient contrast or poor positioning of the camera: this can cause the objects to be unrecognizable, so the purpose of vision cannot be fulfilled.

3.2.1 Illumination

A correct illumination scheme is a crucial part of insuring that the image has the correct amount of contrast to allow to correctly processing the image. One of the criteria of the drowsy driver detection system, the light source is placed in such a way that the maximum light being reflected back is from the face. Since the algorithm for the eye monitoring system is highly dependent on light, the following important illumination factors to consider are:

I. Different parts of objects are lit differently, because of variations in the angle of incidence, and hence have different brightness as seen by the camera.
II. Brightness values vary due to the degree of reflections of the object. Parts of the background and surrounding objects are in shadow, and can also affect the brightness values in different regions of the object.
III. Surrounding light sources (such as daylight) can diminish the effect of the light source on the object.

3.2.2 Camera

The next item to be considered in image acquisition is the video camera. The camera used in this system is a HTC HD2 and LG Arena (KM900) cell phone. Both of it have features an integrated digital camera with a resolution of 5.0 Megapixels. This enables user to capture videos clearly of driver's face. This type of drowsiness detection system is based on the use of image processing technology that will be able to accommodate individual driver differences. The camera is placed in front of the driver, approximately 30 cm away from the face. The facial image data is in 320x240 pixel format. The camera must be positioned such that the following criteria are met:

I. The driver's face takes up the majority of the image.
II. The driver's face is approximately in the centre of the image.

3.3 Face Detection and Eye Detection Function

Firstly, a video is recorded in *Audio Video Interleave* (AVI) format. Next, all frames is extracted from the video structure with MATLAB® coding. After inputting a facial image, pre-processing is first performed by binarizing the image. Binarization is converting the image to a binary image.

A binary image is an image in which each pixel assumes the value of only two discrete values. In this case the values are 0 and 1, 0 representing black and 1 representing white. With the binary image it is easy to distinguish objects from the background.

The greyscale image is converting to a binary image via thresholding. The output binary image has values of 0 (black) for all pixels in the original image with luminance less than level and 1 (white) for all other pixels. Thresholds are often determined based on surrounding lighting conditions and the complexion of the driver. All images were generating in MATLAB® using the image processing toolbox.

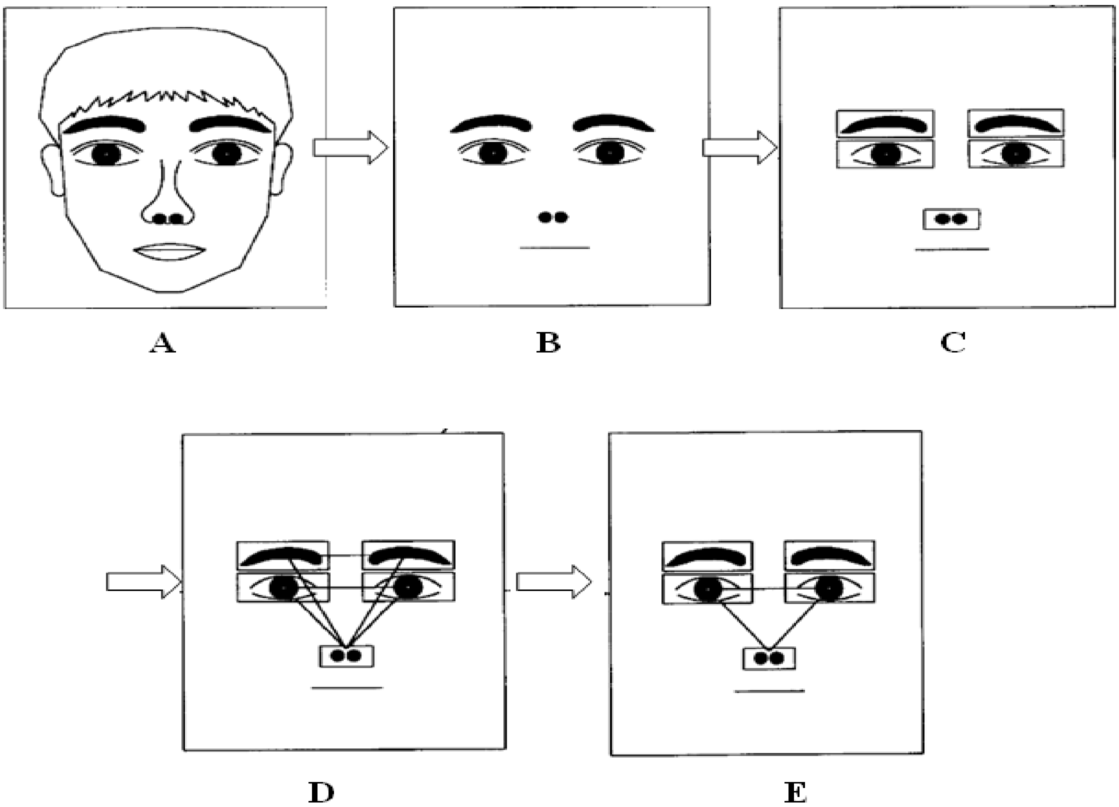


Figure 3.1: Process flow of image binarization

3.4 Determining the State of the Eyes

The state of the eyes (whether it is open or closed) is determined by the pixel values at eye regions. When the eyes are closed, the pixel values are obviously drop to low if compared to when the eyes are open.

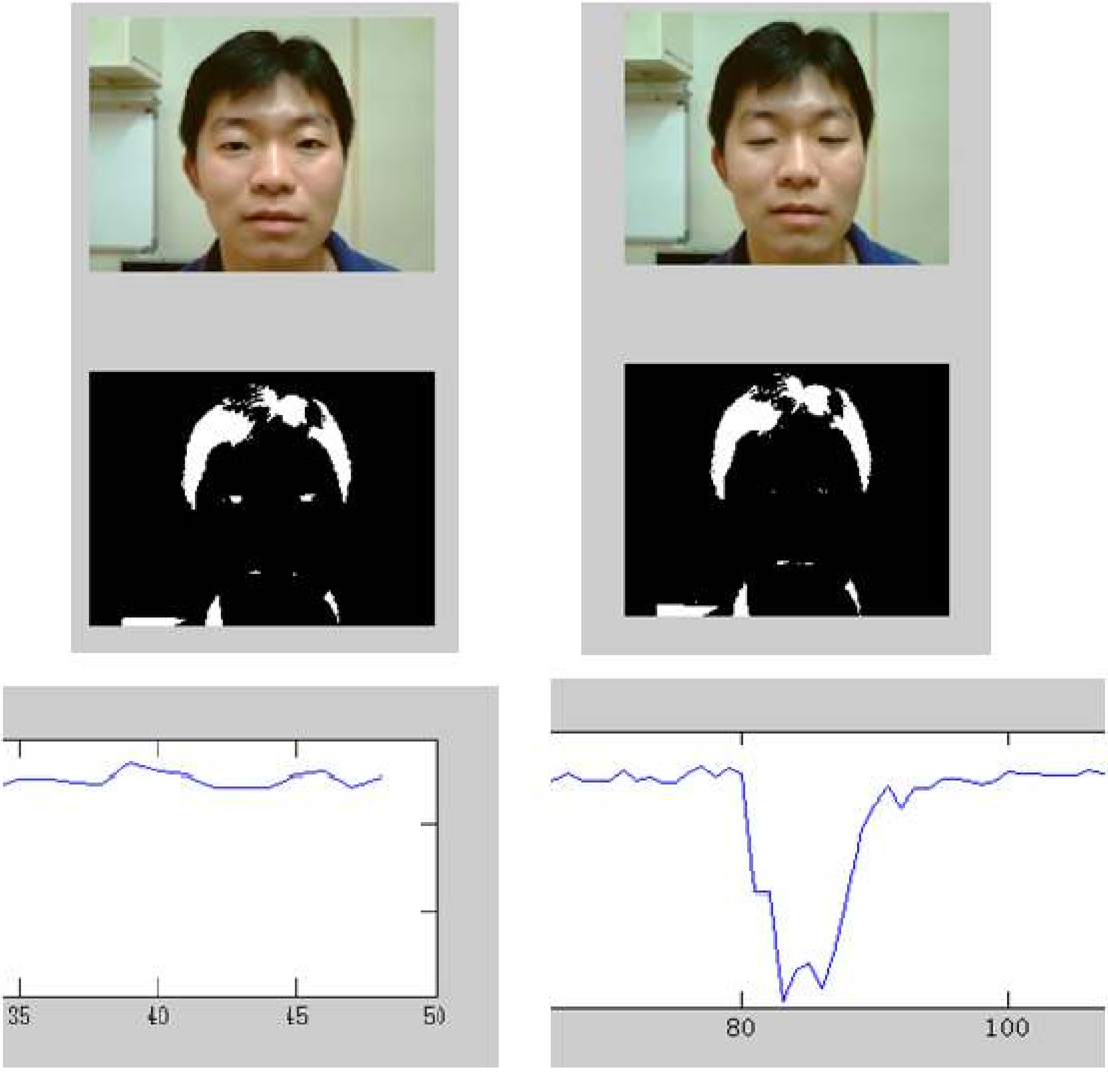


Figure 3.2: Output comparison between eyes opening state

The limitation to this is if the driver moves their face closer to or further from the camera. Because of this limitation, the system developed assumes that the driver's face stays almost the same distance from the camera at all times.

3.5 Drowsy Decision

Eyelid movement is one of the visual behaviors that reflect a person's level of drowsiness. Here, a decision about drowsiness is made by measuring the "PERCLOS" using eye blinking was found to be the most reliable and valid determination of a driver's alertness level. PERCLOS is the percentage of eyelid closure over the pupil over time and reflects slow eyelid closures ("droops") rather than blinks. A PERCLOS drowsiness metric was established in a 1994 driving simulator study as the proportion of time in a minute that the eyes are at least 80 percent closed [2]. Based on research by Wierwille and colleagues (1994) [2], the (Federal Highway Administration) FWHA and (National Highway Traffic Safety Administration) NHTSA consider PERCLOS to be among the most promising known real-time measures of alertness for in-vehicle drowsiness-detection systems.

Based on the theory, when there are 5 consecutive frames find the eye closed in a video recorded, the system draws the conclusion that the driver is falling asleep and the alarm is activated, and a driver is alerted to wake up. Consecutive number of closed frames is needed to avoid including instances of eye closure due to blinking. When the person is tired, his eyes will involuntarily extend the eyelid closure duration to protect the eyes. Criteria for judging the alertness level on the basis of eye closure count is based on the results found in a previous study [2].

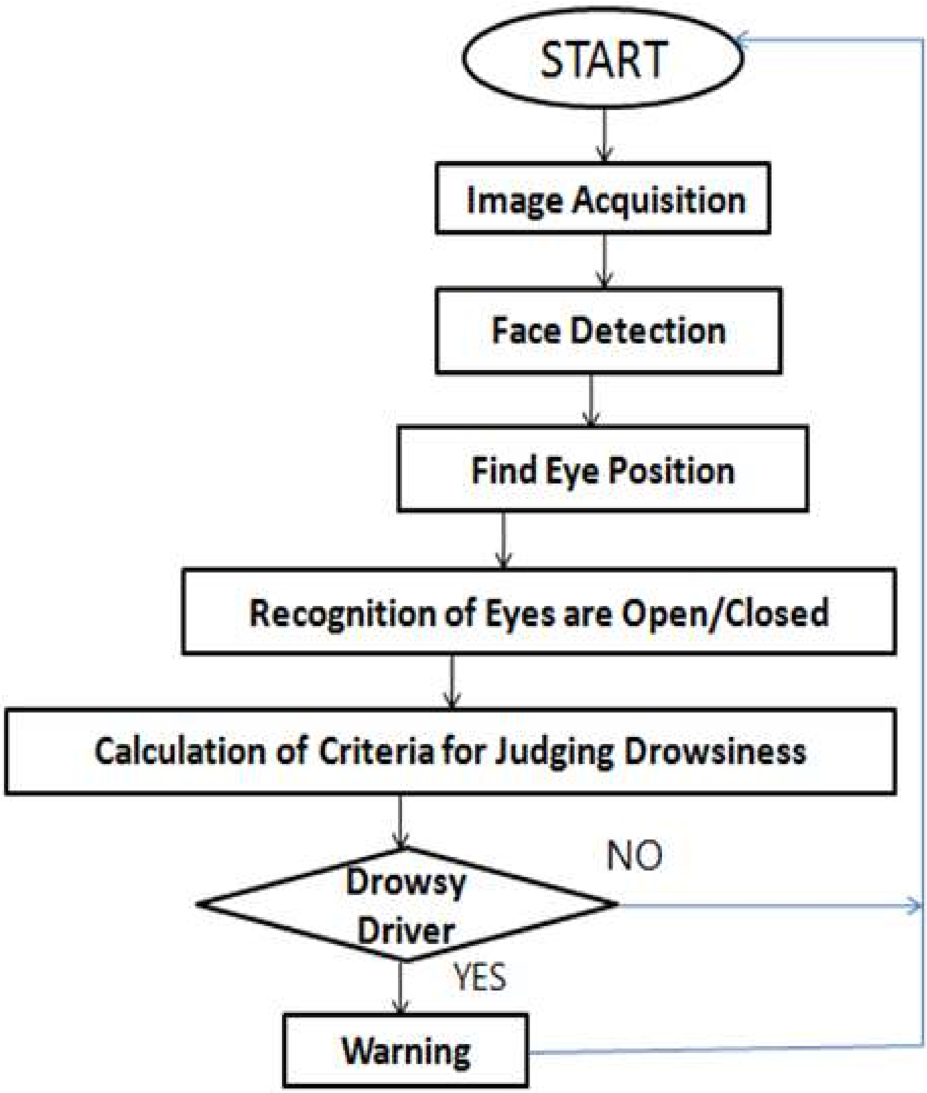


Figure 3.3: Flowchart of the proposed system for drowsiness detection.

CHAPTER 4

HARDWARE AND SOFTWARE IMPLEMENTATION

This chapter reviews about hardware and software implementation in the drowsiness detection system.

4.1 Camera Hardware

In this project, the camera used in this system is a HTC HD2 and LG Arena (KM900) PDA phone. Both of it have features an integrated digital camera with a resolution of 5.0 Megapixels.

The HTC HD2 integrated camera using CMOS sensor with autofocus. The HTC HD2 camcorder features have up to 30 frames per second in video recording and various resolutions such as 320x240, 640 x480, and 352x288.On the other hand, the LG Arena use Schneider Kreuznach camera lens with autofocus for the integrated camera. The camcorder features have up to 30 frames per second in video recording and support different resolution, which is 176x144, 320x240, 640x480, and 720x480.


Start
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10
AM
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London
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Calendar
Camera
NY Times
Marketplace
Menu
Phone
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HTC HD2


htc

LG ARENA (KM900)

4.2 Different Between CMOS and CCD Technology

Digital cameras have become extremely common as the prices have come down. One of the drivers behind the falling prices has been the introduction of CMOS image sensors. CMOS sensors are much less expensive to manufacture than CCD sensors.

Both **CCD** (**C**harge-**C**oupled **D**evice) and **CMOS** (**C**omplimentary **M**etal-**O**xide **S**emiconductor) image sensors start at the same point - they have to convert light into electrons. One simplified way to think about the sensor used in a digital camera (or camcorder) is to think of it as having a 2-D array of thousands or millions of tiny solar cells, each of which transforms the light from one small portion of the image into electrons. Both CCD and CMOS devices perform this task using a variety of technologies. Each has unique strengths and weaknesses giving advantages in different applications.

CCDs and CMOS imagers were both invented in the late 1960s and 1970s. Both types of imagers convert light into electric charge and process it into electronic signals. In a **CCD** sensor, every pixel's charge is transferred through a very limited number of output nodes (often just one) to be converted to voltage, buffered, and sent off-chip as an analogue signal. All of the pixel can be devoted to light capture, and the output's uniformity (a key factor in image quality) is high. In a **CMOS** sensor, each pixel has its own charge-to-voltage conversion, and the sensor often also includes amplifiers, noise-correction, and digitization circuits, so that the chip outputs digital bits. These other functions increase the design complexity and reduce the area available for light capture. With each pixel doing its own conversion, uniformity is lower. But the chip can be built to require less off-chip circuitry for basic operation.

CCD became dominant, primarily because they gave far superior images with the fabrication technology available. CMOS image sensors required more uniformity and smaller features than silicon wafer foundries could deliver at the time. Not until the 1990s did lithography develop to the point that designers could begin making a case for CMOS imagers again. Renewed interest in CMOS was based on expectations of lowered power consumption, camera-on-a-chip integration, and lowered fabrication costs from the reuse of mainstream logic and memory device fabrication. While all of these benefits are possible in theory, achieving them in practice while simultaneously delivering high image quality has taken far more time, money, and process adaptation than original projections suggested.

Both CCDs and CMOS imagers can offer excellent imaging performance when designed properly. CCDs have traditionally provided the performance benchmarks in the photographic, scientific, and industrial applications that demand the highest image quality (as measured in quantum efficiency and noise) at the expense of system size. CMOS imagers offer more integration (more functions on the chip), lower power dissipation (at the chip level), and the possibility of smaller system size, but they have often required tradeoffs between image quality and device cost.

Because of the manufacturing differences, there have been some noticeable differences between CCD and CMOS sensors.

4.2.1 Feature and Performance Comparison

Feature	**CCD**	**CMOS**
Signal out of pixel	Electron packet	Voltage
Signal out of chip	Voltage (analogue)	Bits (digital)
Signal out of camera	Bits (digital)	Bits (digital)
Fill factor	High	Moderate
Amplifier mismatch	N/A	Moderate
System Noise	Low	Moderate
System Complexity	High	Low
Sensor Complexity	Low	High
Camera components	Sensor + multiple support chips + lens	Sensor + lens possible, but additional support chips common
Relative R&D cost	Lower	Higher
Relative system cost	Depends on Application	Depends on Application
Performance	CCD	CMOS
Responsivity	Moderate	Slightly better

Dynamic Range	High	Moderate
Uniformity	High	Low to Moderate
Uniform Shuttering	Fast, common	Poor
Uniformity	High	Low to Moderate
Speed	Moderate to High	Higher
Windowing	Limited	Extensive
Anti blooming	High to none	High
Biasing and Clocking	Multiple, higher voltage	Single, low-voltage

4.2.2 CMOS Development's Winding Path

Initial Prediction for CMOS	Twist	Outcome
Equivalence to CCD in imaging performance	Required much greater process adaptation and deeper submicron lithography than initially thought	High performance available in CMOS, but with higher development cost than CCD
On-chip circuit integration	Longer development cycles, increased cost, tradeoffs with noise, flexibility during operation	Greater integration in CMOS, but companion chips still required for both CMOS and CCD
Reduced power consumption	Steady improvement in CCDs	Advantage for CMOS, but margin diminished
Reduced imaging subsystem size	Optics, companion chips and packaging are often the dominant factors in imaging	CCDs and CMOS comparable

	subsystem size	
Economies of scale from using mainstream logic and memory foundries	Extensive process development and optimization required	CMOS imagers use legacy production lines with highly adapted processes akin to CCD fabrication

4.3 Image Processing

In electrical engineering and computer science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Image processing usually refers to digital image processing, but optical and analogue image processing also are possible. A technique in which the data from an image are digitized and various mathematical operations are applied to the data, generally with a digital computer, in order to create an enhanced image that is more useful or pleasing to a human observer, or to perform some of the interpretation and recognition tasks usually performed by humans. It is also known as picture processing.

4.4 MATLAB - History

MATLAB® was created in the late 1970s by Cleve Moler, the chairman of the computer science department at the University of New Mexico [12]. He designed it to give his student's access to LINPACK and EISPACK without having to learn Fortran. It soon spread to other universities and found a strong audience within the applied mathematics community. An engineer named Jack Little was exposed to it during a visit Moler made to Stanford University in 1983. Recognizing its commercial potential, he joined with Moler and Steve Bangert. They rewrote MATLAB® in C and founded MathWorks in California in 1984 to continue its development.

4.5 MATLAB - Introduction

MATLAB® is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. By using the MATLAB® product, it can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran.

MATLAB® can be use in wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. It has add-on toolboxes (collections of special-purpose MATLAB functions, available separately) extend the MATLAB® environment to solve particular classes of problems in these application areas. MATLAB® provides a number of features for documenting and able integrate the coding with other languages and applications, it also distribute our MATLAB® algorithms and applications.

The MATLAB® language supports the vector and matrix operations that are fundamental to engineering and scientific problems. It enables fast development and execution. With the MATLAB® language, it can program and develop algorithms faster than traditional languages because it do not need to perform low-level administrative tasks, such as declaring variables, specifying data types, and allocating memory. In many cases, MATLAB eliminates the need for 'for' loops. As a result, one line of MATLAB® code can often replace several lines of C or C++ code. At the same time, MATLAB® provides all the features of a traditional programming language, including arithmetic operators, flow control, data structures, data types, object-oriented programming (OOP), and debugging features.

MATLAB can execute commands or groups of commands one at a time, without compiling and linking, enabling quickly iterate to the optimal solution. For fast execution of heavy matrix and vector computations, MATLAB® uses processor-optimized libraries. For general-purpose scalar computations, MATLAB® generates machine-code instructions using its JIT (Just-In-Time) compilation technology. This technology, which is available on most platforms, provides execution speeds that rival those of traditional programming languages.

4.6 MATLAB – Image Processing Toolbox

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. User can use it to perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, spatial transformations, and image registration. Many functions in the toolbox are multithreaded to take advantage of multi-core and multi-processor computers.

Image Processing Toolbox supports a diverse set of image types, including high dynamic range, gigapixel resolution, ICC-compliant colour, and tomographic images. Graphical tools able to explore an image, examine a region of pixels, adjust the contrast, create contours or histograms, and manipulate regions of interest (ROIs). With the toolbox algorithms it can restore degraded images, detect and measure features, analyze shapes and textures, and adjust the colour balance of images.

Image Processing Toolbox supports images generated by a wide range of devices, including digital cameras, satellite and airborne sensors, medical imaging devices, microscopes, telescopes, and other scientific instruments. It can visualize, analyze, and process these images in many data types, including single- and double-precision floating-point and signed and unsigned 8-, 16-, and 32-bit integers. It supports standard data and image formats, including JPEG, JPEG-2000, TIFF, PNG, HDF, FITS, Microsoft Excel, ASCII, and binary files. It also supports the multiband image formats BIP, as used by LANDSAT for example. Low-level I/O and memory mapping functions enable you to develop custom routines for working with any data format.

CHAPTER 5

RESULTS AND DISCUSSION

The overall results that obtained in this project are noted and discussed in this part. Step by step of the demonstration, for face, binarizing the image, location of eyes and drowsy detection is shown in figure below.

5.1 Simulation Results

Figure 5.1: Demonstration of first step in the process video playback

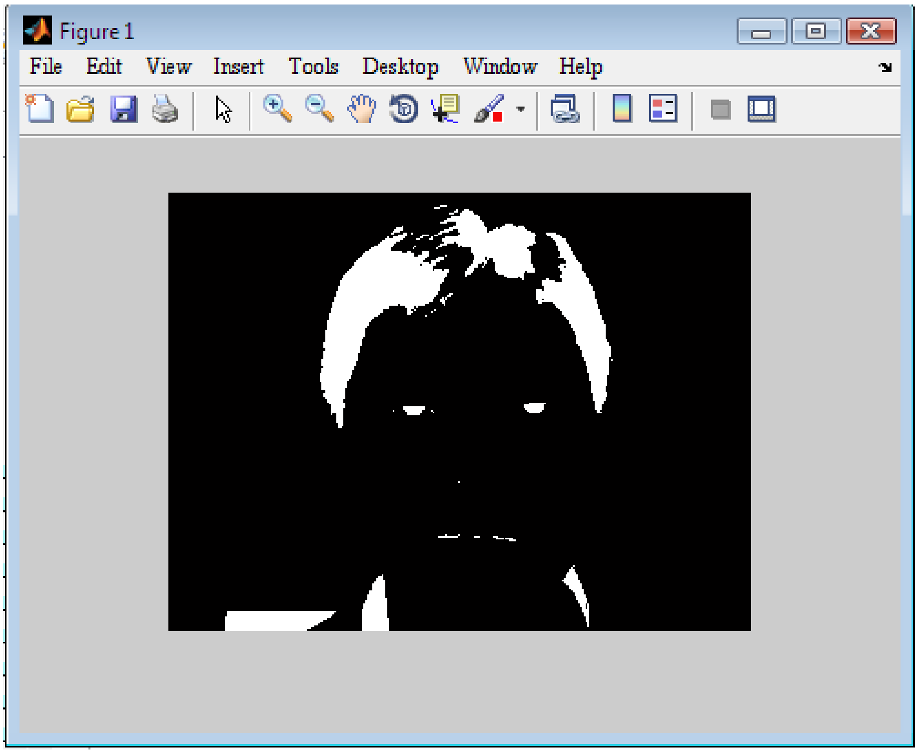


Figure 5.2: Demonstration of binarizing the image

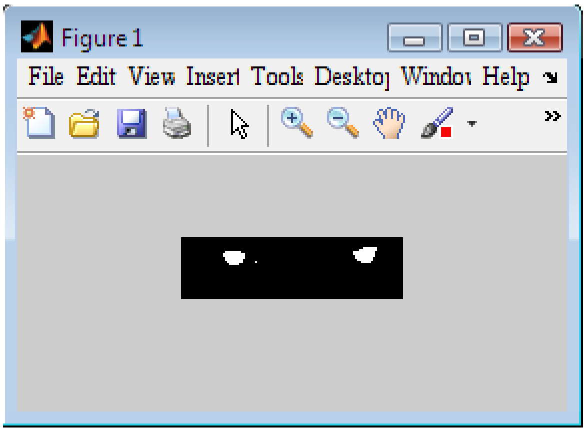


Figure 5.3: Demonstration of the location of eyes

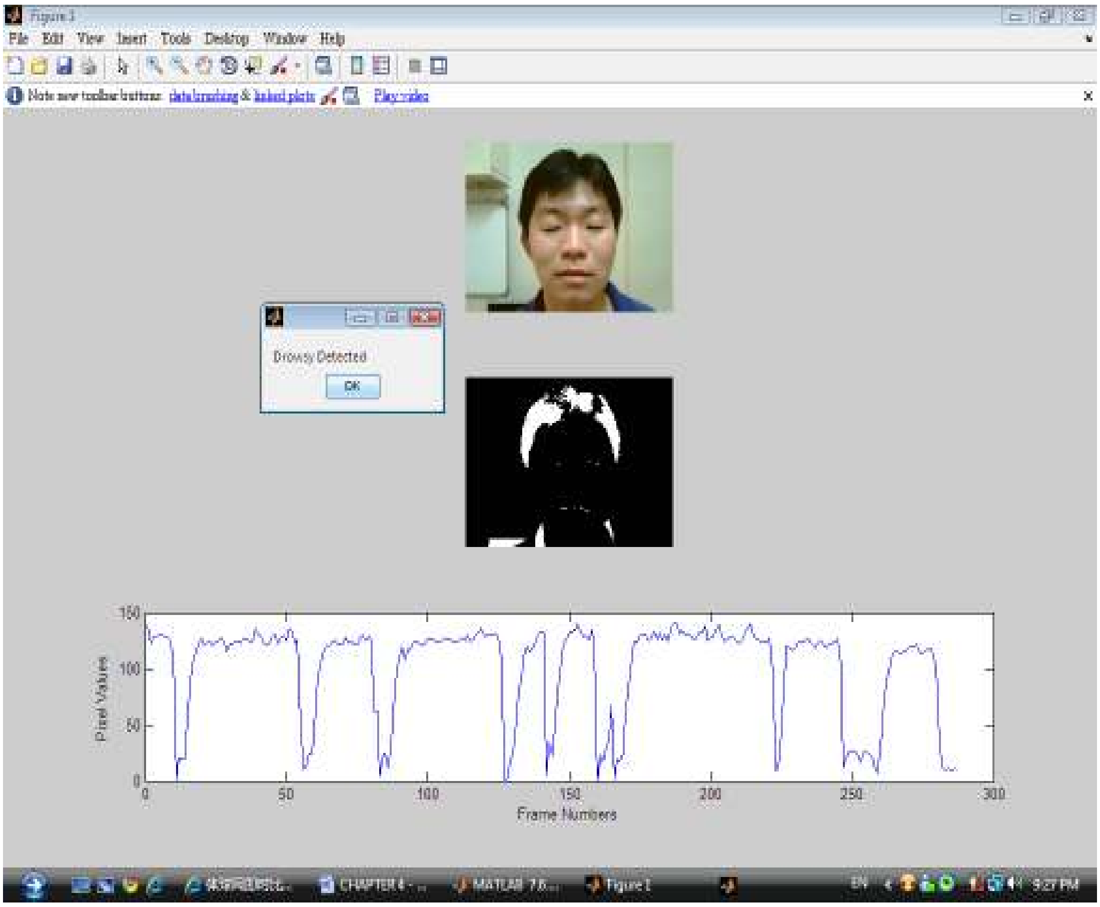


Figure 5.4: Result show of ‘drowsy detected’

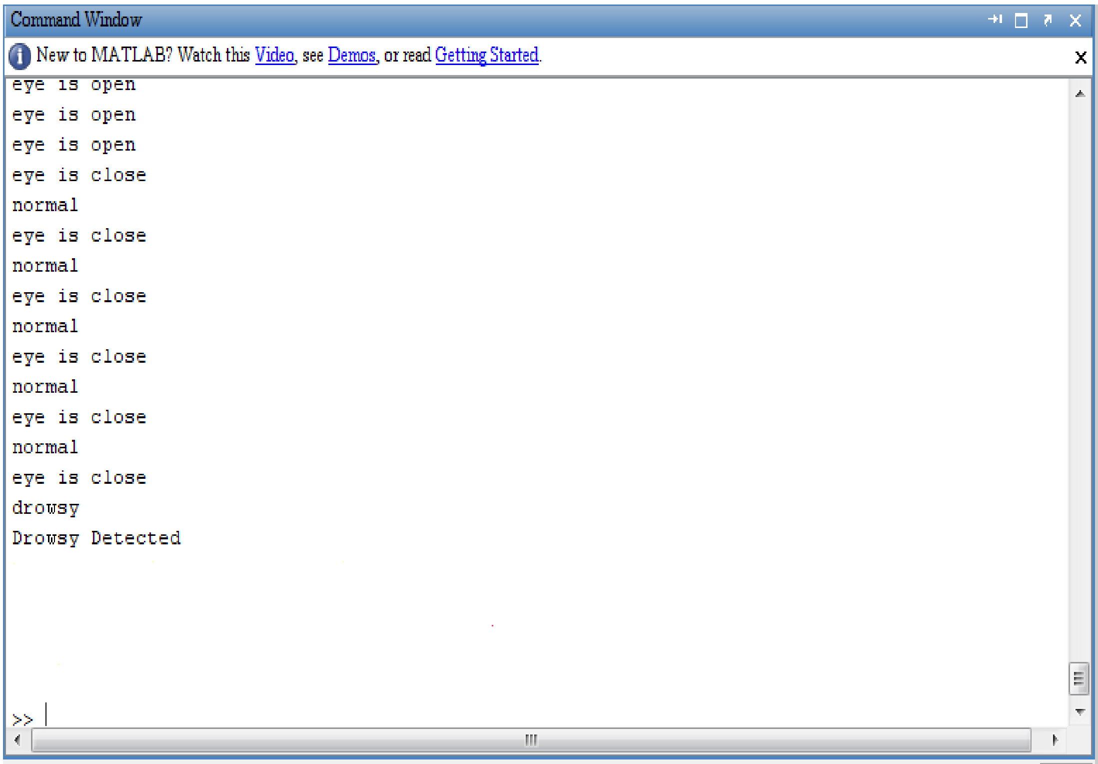


Figure 5.5: Result displays of ‘drowsy detected’ in command window

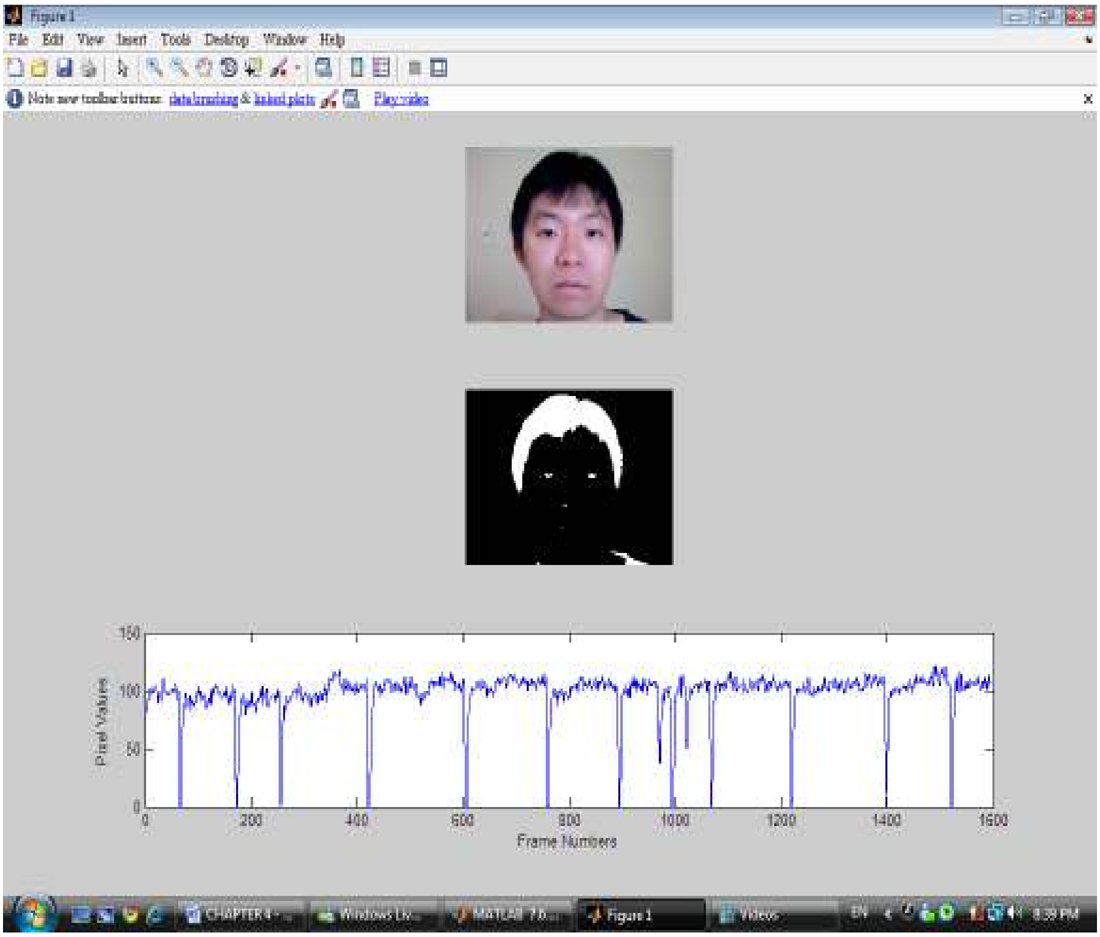


Figure 5.6: Result show of no ‘drowsy detected’

Figure 5.7: Result display of ‘normal state’ in command window

5.2 Analysis

5.2.1 Handling videos in MATLAB®

MATLAB® supports only “raw” uncompressed AVI files on Linux and only some Indeo and Cinepack compressed versions on Windows. For first step, when the video recorded in variety format such as MPEG, MP4, 3GP or others, it need convert to raw or any supported format.

5.2.1.1 Loading Video Files - Read Audio/Video Interleaved (AVI) File

Description

mov = **aviread**(‘filename.avi’) reads the AVI movie filename into the MATLAB® movie structure mov. mov has two fields, cdata and colormap. The content of these fields varies depending on the type of image. **aviread** supports 8-bit frames, for indexed and grayscale images, 16-bit grayscale images, or 24-bit truecolor images. However, the movie only accepts 8-bit image frames; it does not accept 16-bit grayscale image frames.

Syntax

mov = **aviread**(‘filename.avi’);

5.2.1.2 Editing Frames

Description

After loading a whole video sequence, single frames can be accessed by MATLAB®. It allows us to handle movie frames like single images and determines total frames in the video playback.

Syntax

size(mov, 2);

/**************************************/

Coding:

```
% Open the video.avi movie that ships with MATLAB.
        movieFullFileName = 'C:\Users\Huong\Videos\d-huong.avi';
        mov = aviread(movieFullFileName);
% Determine how many frames there are.
        numberOfFrames = size(mov, 2);
        numberOfFramesWritten = 0;
```

/*************************************/

5.2.2 Pre-Processing

Description

After read the movie structure into the MATLAB® followed by extracted all the frames from the movie structure, each single frame can be assessed with following syntax. MATLAB® provides a data struct for holding movie frames in memory. It consists of two fields. The field cdata contains the image data of the frame, whereas colormap contains information about the colormap that is used to display the frames. If the frames are truecolor images the field colormap will be empty. In this project, cdata is choosen because it more suitable and take shorter time to process all the frames in the video structure compare to colormap.

Syntax

for frame = 1: numberOfFrames

thisFrame = mov(frame).cdata;

```
/***************************************/
Coding:
        for frame = 1: numberOfFrames
 % Extract the frame from the movie structure.
         thisFrame = mov(frame).cdata;

/*************************************/
```

5.2.3 Processing

Description

After the image data of a frame is extracted, next is processing all the frames in the video structure. This is done by convert the colour picture to gray scale picture. Next, is converting the gray scale picture into binary picture with suitable threshold value.

For this project, the threshold value is try to set different value for better ressult, but the most suitable to differentiate the eye region, that is t = 0.12. This is because it is the most clear to see eye region in binary picture.

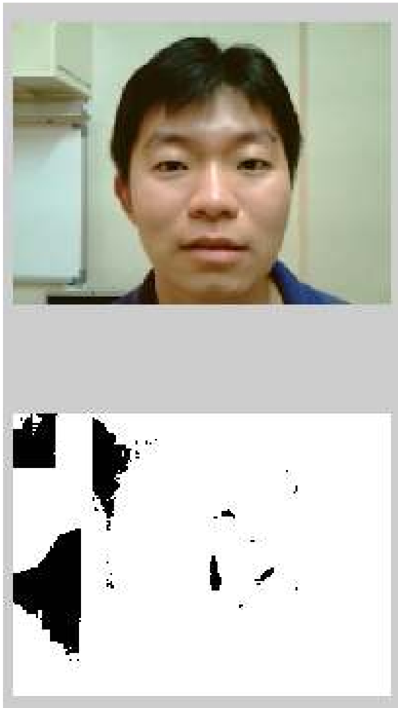
/**************************************/

Coding:

```
pic=thisFrame;
im=frame;
t=0.12;
pic_rgb=rgb2gray(pic);
ca=im2bw(pic_rgb,t);
c=~ca;
%Morphology On B&W Image to Detect Location Of Eyes
se=strel('square',1);
eye_dil=imdilate(c,se);
d=imcrop(eye_dil,[110 110 110 30]);
figure(1)
subplot(311),imshow(pic)
subplot(312),imshow(eye_dil)
```

/**************************************/

Below is a few try of setting different value of threshold value:



When t = 0.80

When t = 0.50

When t = 0.30

When t = 0.12

Figure 5.8: Different threshold values for binary image

It is clear that setting threshold value is a very important step to differentiate eye region. As example, when the t is set to 0.80, the binary picture cannot see the face, however when the t is set to 0.50, the binary picture able to see the blur face portion. Next, trying another threshold value, that is set the t to 0.30, now is able to see the face more clearly in black and white picture. Finally, value of t is set to 0.12 and it can show very clear for the eye region of a face in the binary picture.

After set the threshold value, now have to use the function imcrop in MATLAB to crop out the eye portion for further processing. IMCROP creates an interactive image cropping tool, associated with the image displayed in the current figure, called the target image. The tool is a moveable, resizable rectangle that is interactively placed and manipulated using the mouse. After positioning the tool, user crops the target image by either double clicking on the tool or choosing 'Crop Image' from the tool's context menu.

Description

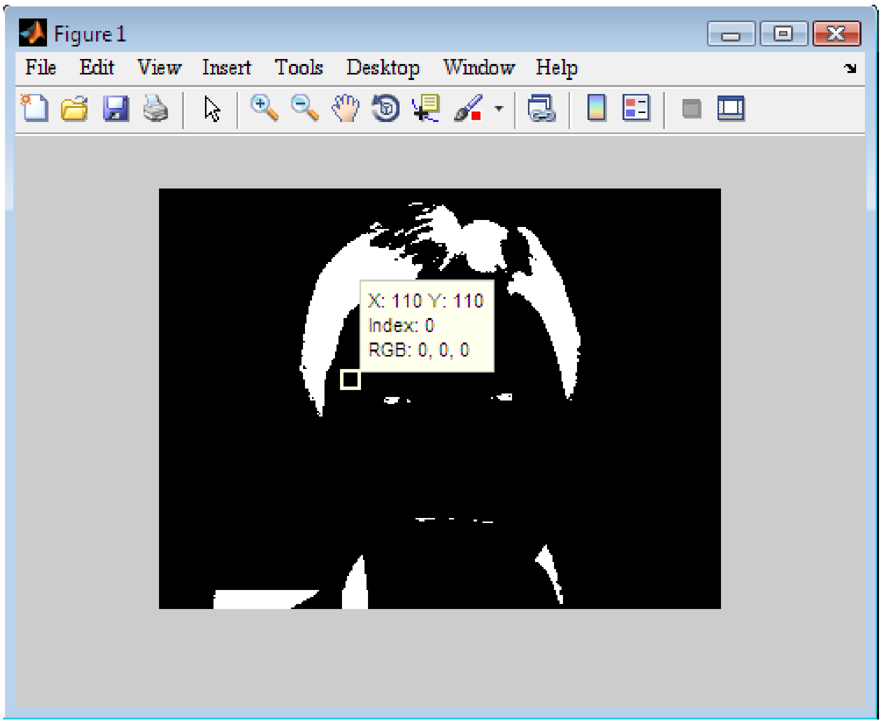
I2 = IMCROP(I) displays the image I in a figure window and creates a cropping tool associated with that image. I can be a grayscale image, an RGB image, or a logical array. The cropped image returned, I2, is of the same type as I. It can also specify to crop picture rectangle non-interactively, using these syntaxes:

I2 = IMCROP(I,RECT)

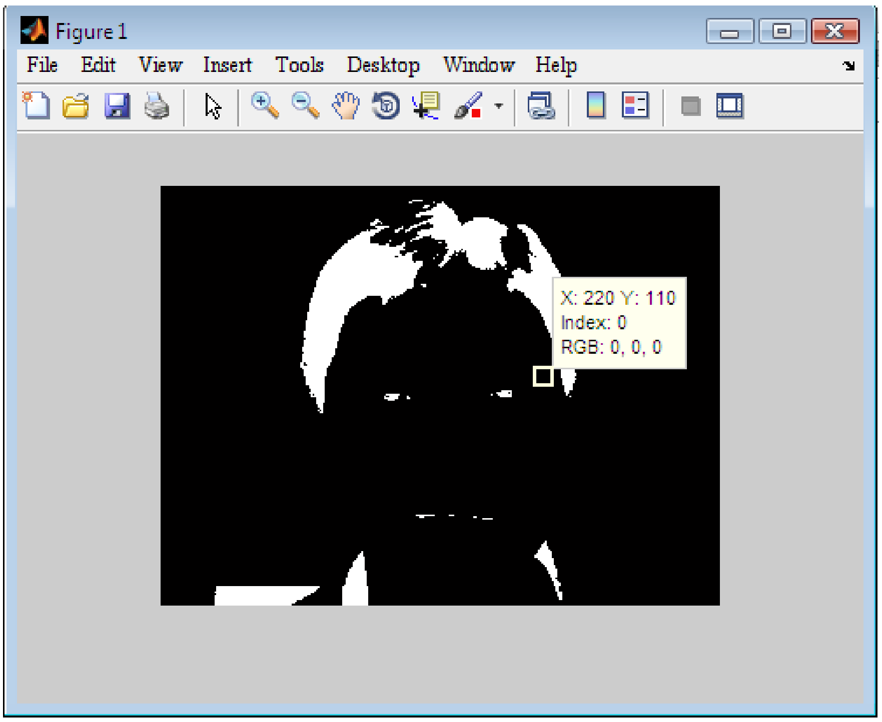
RECT is a 4-element vector with the form [XMIN YMIN WIDTH HEIGHT]; these values are specified in spatial coordinates.

Syntax

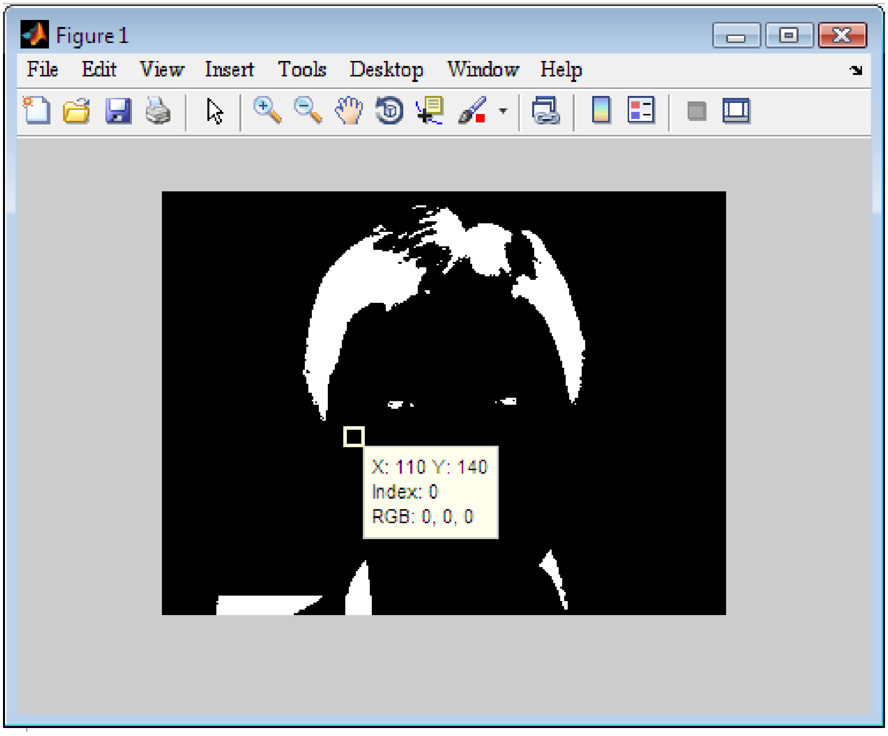
d=**imcrop**(eye_dil,[110 110 110 30]);



Spatial Coordinates [XMIN =110, YMIN =110]



Spatial Coordinates [WIDTH =110]



Spatial Coordinates [HEIGHT = 30]

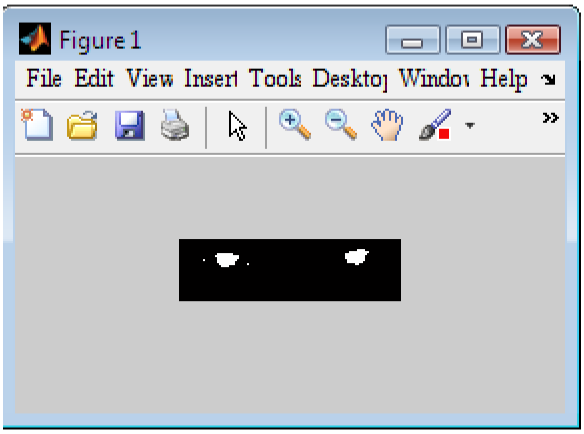


Image from IMCROP

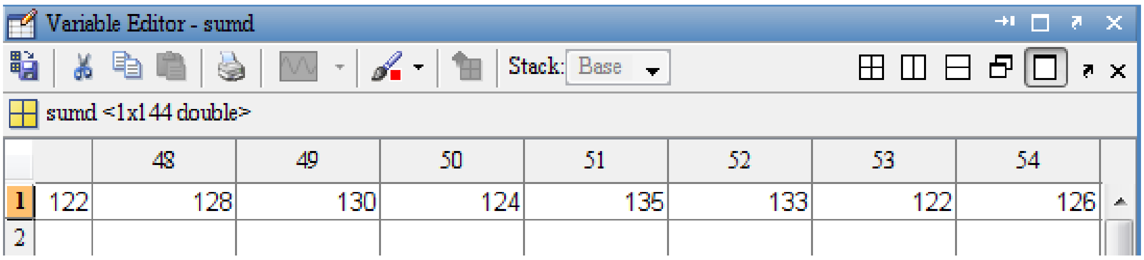
Figure 5.9: Eye region cropped

After the eye region is crop from the face portion, the following step is calculating the pixel values of the eye region. A binary image is an image in which each pixel assumes the value of only two discrete values. In this case the values are 0 and 1, 0 representing black and 1 representing white. With the binary image it is easy to determine the state of the eyes whether it is open or closed. When the eyes are closed, the pixel values are obviously drop to low if compared to when the eyes are open.

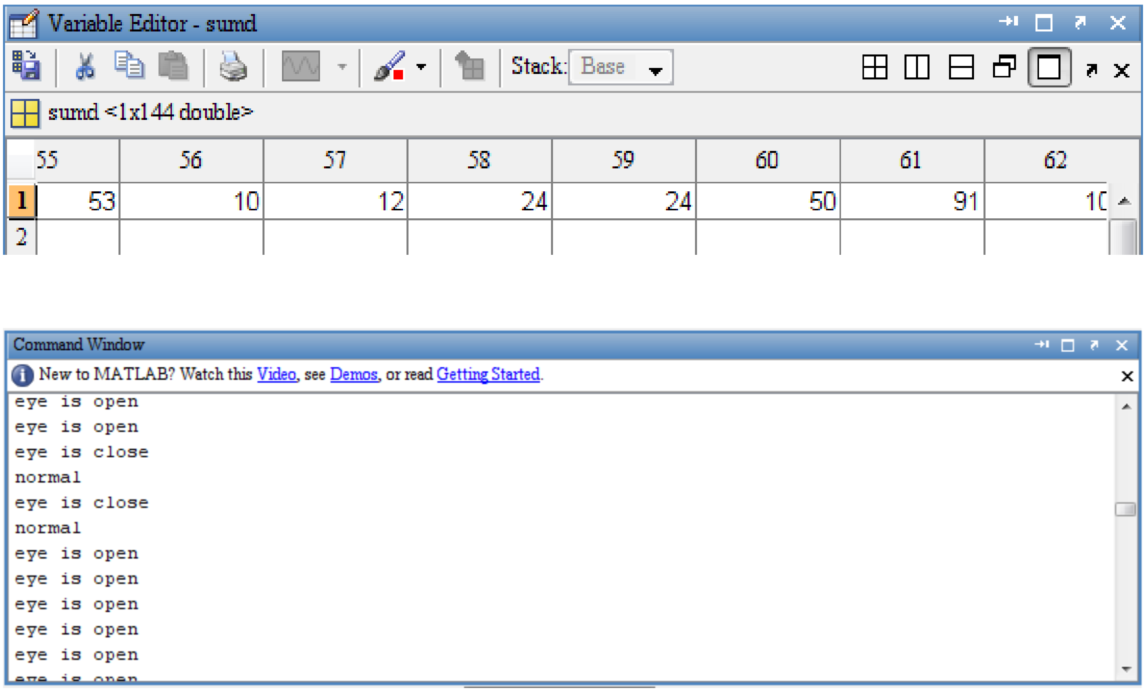
```
/***************************************/
Coding:
% For subplot
        sumd(1,im)=sum(sum(d));
        subplot(313), plot(sumd);
        xLabel('Frame Numbers');
        yLabel('Pixel Values');
 %For store and decision
         sumc1=sum(sum(d));

% Decision close or open
        if sumc1<(20)
          disp('eye is close')
        else
         disp('eye is open')
        end
/***************************************/
```

Description

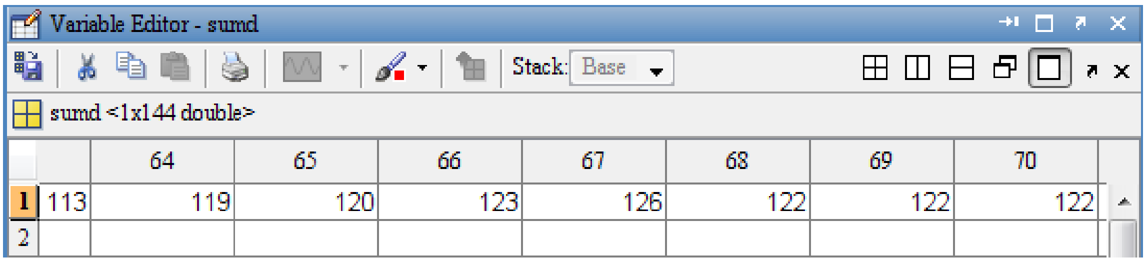
For the eye region, if the pixel values is less than 20, it means the eyes is close state, whereas if the pixel values is greater than 20, it means the eyes is open state. By calculating the pixel values at the eye region, it can differentiate clearly between open and closed eyes state.



(a)



(b)



(c)

Figure 5.10: Pixel values of eye region

From figure 4.3(a, c) it shows the pixel values of eye region from frame 48-54 and from frame 63-70. The pixel values ranging are around 122-135, from this it is clearly that the eyes is in open state. However from figure 4.3(b) it shows the pixel values of eye region from frame 55 to frame 62. The pixel values for frame 56 and 57 are below 20, that is 10 and 12 only. From here, it shows clearly at command window that the eye is at close state, whereas others frame is consider as open state. It is an action of blinking eyes.

5.2.4 Post-Processing

A decision about drowsiness is made by measuring the "PERCLOS" using eye blinking was found to be the most reliable and valid determination of a driver's alertness level. When there are 5 consecutive frames find the eye closed in a video recorded, the system draws the conclusion that the driver is falling asleep and the alarm is activated, and a driver is alerted to wake up.

Description

Firstly, it has to initialize a drowsy frame for close eye state before it can make decision for drowsy state. Then, when it detects a close eye state, it will make an increment to the number of drowsy frame. Once the closed eye states are more than 5 frames, it will activate the alarm to alert the user. It will reset the counter again when the eyes is open state. Once detect drowsy a pop up message will be given and alarm is activated.

/***************************************/

Coding:

```
%Initialize
            drowsyFrames = 0
% Decision close or open
           if sumc1<(20)
           disp('eye is close')
% Increment the number of frames where the eye is closed.
           drowsyFrames = drowsyFrames+1;
 % Check to see if it's been closed for the past 5 frames.
           if drowsyFrames >= 6
           disp('drowsy')
           else

 % It's been closed less than 5 frames, so this is a normal eye blink.
           disp('normal')
           end
           else
           disp('eye is open')
% Reset counter when the eye is open.
           drowsyFrames = 0;
           end

if drowsyFrames >= 6
    promptMessage = sprintf('Drowsy Detected');
    open('C:\Program Files\TTPlayer\TTPlayer.exe'); %ActivateAlarm.
    disp(promptMessage); % Write to command window.
    uiwait(msgbox(promptMessage)); % Also pop up a message box.
    if strcmp(button, 'OK')
    end
end
```

/***************************************/

5.3 Discussion

Firstly acquiring the video file of the driver's image, followed by converted into consecutive frames of images. Then, pre-processing is first performed by binarizing the image. Binarization is converting the image to a binary image. The next step is locating the eyes by finding the pixel values changes on the eye region. This is done using the binary image and not the color image.

The state of the eyes whether it is open or closed is determined by the pixel values at eye regions. When the eyes are closed, the pixel values are obviously drop to low if compared to when the eyes are open. When the eyes are found closed for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep and issues a warning signal. The algorithm is proposed, implemented, tested, and found working satisfactorily.

CHAPTER 6

CONCLUSION

There are two different parts in this chapter which are achievement of this project and future recommendation that can be done for this project.

6.1 Achievement

This project is considered as successfully done since the objectives for this project are achieved. The objectives for this project are to develop a drowsiness detection system that can detect drowsy or fatigue in drivers to prevent accidents and to improve safety on the roads. This system able accurately monitors the open or closed state of the driver’s eye. When drowsy is detected toward a driver, a warning signal is issued to alert the driver.

6.2 Limitations

It is obvious that there are limitations to the system. The most significant limitation is that it will not work with people who have very dark skin. This is apparent, since the core of the algorithm behind the system is based on binarization. For dark skinned people, binarization doesn't work.

Another limitation is rapid head movement was not allowed. For small head movements, the system rarely loses track of the eyes. When the head is turned too much sideways, it will activate the alarms as a result of no eyes found in the video.

6.3 Future Recommendation

This project is recommended with suggestions in order to improve the efficiency of the system. One of the suggestions is to detect drowsiness in real time instead of offline. Real time drowsy detection is more advance compare to the offline drowsy detection.

Currently there is not adjustment in zoom or direction of the camera during operation. Future work may be to automatically zoom in on the eyes once they are localized. This would avoid the trade-off between having a wide field of view in order to locate the eyes, and a narrow view in order to detect fatigue.

This system only count at the number of consecutive frames where the eyes are closed. At that point it may be too late to issue the warning. By studying eye movement patterns, it is possible to find a method to generate the warning sooner.

Using 3D images is another possibility in finding the eyes. The eyes are the deepest part of a 3D image, and this maybe a more robust way of localizing the eyes.

Adaptive binarization is an addition that can help make the system more robust. This may also eliminate the need for the noise removal function, cutting down the computations needed to find the eyes. This will also allow adaptability to changes in ambient light. The system does not work for dark skinned individuals.

DROWSINESS DETECTION FOR CAR ASSISTED DRIVER SYSTEM USING IMAGE PROCESSING ANALYSIS – INTERFACING WITH HARDWARE

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Abstract **– The purpose of this study is to detect drowsiness in drivers to prevent accidents and to improve safety on the highways. A method for detecting drowsiness/sleepiness in drivers is developed by using a camera that point directly towards the driver's face and capture for the video. Once the video is captured, monitoring the face region and eyes in order to detect drowsy/fatigue. The system able to monitoring eyes states and determines whether the eyes are in an open position or closed state. In such a case when drowsy is detected, a warning signal is issued to alert the driver. It can determine a time proportion of eye closure as the proportion of a time interval that the eye is in the closed position. If the driver's eyes are closed cumulatively more than a standard value, the system draws the conclusion that the driver is falling asleep, and then it will activate an alarm sound to alert the driver.**

Key-words: **safety; drowsiness detection; face region; eyes states**

I. INTRODUCTION

Driving with drowsiness is one of the main causes of traffic accidents [1]. Driver fatigue is a significant factor in a large number of vehicle accidents. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Due to the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects.

There are many technologies for drowsiness detection and can be divided into three main categories: biological indicators, vehicle behavior, and face analysis [2]. The first type measures biological indicators such as brain waves, heart rate and pulse rate. These techniques have the best detection accuracy but they require physical contact with the driver [3]. They are intrusive. Thus, they are not practical. The second type measures vehicle behaviors such as speed, lateral position and turning angle. These techniques may be implemented non-intrusively, but they have several limitations such as the vehicle type, driver experience and driving conditions. Furthermore, it requires special equipment and can be expensive. The third type is face analysis. Since the human face is dynamic and has a high degree of variability, face detection is considered to be a difficult problem in computer vision research. As one of the salient features of the human face, human eyes play an important role in face recognition and facial expression analysis. In fact, the eyes can be considered salient and relatively stable feature on the face in comparison with other facial features. Therefore, when we detect facial features, it is advantageous to detect eyes before the detection of other facial features. The position of other facial features can be estimated using the eye position [4]. In addition, the size, the location and the image-plane rotation of face in the image can be normalized by only the position of both eyes.

The aim of this project is to develop a drowsiness detection system. The vision-based systems have been widely used because of its accuracy and non-intrusiveness. Visual cues such as eye states (i.e. whether they are open or closed) can typically reflect the driver's level of fatigue. Therefore, an automatic and robust approach to extract the eye states from input images is very important. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns.

This project is focused on the localization of the eyes, which involves looking at the entire image of the face, and determining the position of the eyes. Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect fatigue.

Related Work

The existing work in drowsy detection is studies before or during the development of this project. All ideas and concepts yield are to be implemented on the research. Human face is dynamic and has a high degree of variability; face detection is considered to be a complex task in computer vision. Face detection is a necessary step in all face processing systems, and its efficiency influences the overall performance of drowsiness detection systems. Researchers classified the face detection techniques using the following approaches: the top down model based approach - search different face model at different scales level, bottom up feature based approach - searches the image for a set of facial features, texture based approach - faces are detected by examining the spatial distribution of gray or colour information, neural network approach - detects faces by sampling different regions and passing it to neural network, colour based approach - labels each pixel according to its similarity to skin colour and face shape, motion based approaches - use image subtraction to extract the moving foreground from the static background. The general classification for face detection algorithms and supported tools are presented by Hjelm [5] and it can be divided into three categories: feature based, template matching, and image based.

A reliable method of eye states detection in real-time for drowsy monitoring by given a restricted local block of eye regions, the Local Binary Pattern (LBP) histogram of the block is extracted and each bin of the histogram is treated as a feature of the eye and followed by an AdaBoost based cascaded classifier is trained to classify the eye states as open or closed. The face and eye detectors are built based on the standard AdaBoost training methods combined with Violas cascade approach using haar-like features [6]. According to the states of the eye, the PERCLOS (the percentage of time that an eye is closed in a given period) score is measured to decide whether the driver is at drowsy state or not.

Another method of drowsiness detection is based on brightness and numeral features of eye image, which incorporates into a four step: face detection, eye detection, eye state analysis, and drowsy decision. It detects face using a popular approach of utilizing skin color because skin color based methods are fast and simple followed by detecting eye region by constructing Eye Map [7]. After eye detection, it performs eye state analysis - determine open, partially open and closed eye states with a high accuracy without using any training data sets. Finally, a decision about drowsiness is made by measuring the PERCLOS score

Besides, drowsiness detection system using Electrooculography (EOG) is another method to detect drowsy. The EOG, which is the electrical signal generated by eye movements, is acquired by a mobile biosignal acquisition module and are processed offline using personal computer. Digital signal differentiation and simple information fusion techniques are used to detect signs of drowsiness in the EOG signal.

II. METHODLOGY

It describes how this research has been done and the method used to achieve the research objectives and purpose. The most important aspect of implementing a drowsiness detection system is the image acquisition. Any deficiencies in the acquired images can cause problems with image analysis and interpretation.

A correct illumination scheme is a crucial part of insuring that the image has the correct amount of contrast to allow to correctly processing the image. One of the criteria of the drowsy driver detection system, the light source is placed in such a way that the maximum light being reflected back is from the face. Since the algorithm for the eye monitoring system is highly dependent on light, the following important illumination factors to consider are:

I. Different parts of objects are lit differently, because of variations in the angle of incidence, and hence have different brightness as seen by the camera.
II. Brightness values vary due to the degree of reflections of the object. Parts of the background and surrounding objects are in shadow, and can also affect the brightness values in different regions of the object.
III. Surrounding light sources (such as daylight) can diminish the effect of the light source on the object.

The video camera used in this system is a HTC HD2 and LG Arena (KM900) cell phone. Both of it have features an integrated digital camera with a resolution of 5.0 Megapixels. This enables user to capture videos clearly of driver's face. The camera is placed in front of the driver, approximately 30 cm away from the face. The facial image data is in 320x240 pixel format. The camera must be positioned such that the following criteria are met:

I. The driver's face takes up the majority of the image.
II. The driver's face is approximately in the centre of the image.

Firstly, a video is recorded in Audio Video Interleave (AVI) format. Next, all frames is extracted from the video structure with MATLAB coding. After inputting a facial image, pre-processing is first performed by binarizing the image. Binarization is converting the image to a binary image. A binary image is an image in which each pixel assumes the value of only two discrete values. In this case the values are 0 and 1, 0 representing black and 1 representing white. With the binary image it is easy to distinguish objects from the background. The grayscale image is converting to a binary image via thresholding. The output binary image has values of 0 (black) for all pixels in the original image with luminance less than level and 1 (white) for all other pixels. Thresholds are often determined based on surrounding lighting conditions and the complexion of the driver. All images were generating in MATLAB using the image processing toolbox.

The state of the eyes (whether it is open or closed) is determined by the pixel values at eye regions. When the eyes are closed, the pixel values are obviously drop to low if compared to when the eyes are open.

Eyelid movement is one of the visual behaviors that reflect a person's level of drowsiness. Here, a decision about drowsiness is made by measuring the "PERCLOS" using eye blinking was found to be the most reliable and valid determination of a driver's alertness level. PERCLOS is the percentage of eyelid closure over the pupil over time and reflects slow eyelid closures ("droops") rather than blinks. Based on the theory, when there are 5 consecutive frames find the eye closed in a video recorded, the system draws the conclusion that the driver is falling asleep and the alarm is activated, and a driver is alerted to wake up. Consecutive number of closed frames is needed to avoid including instances of eye closure due to blinking. When the person is tired, his eyes will involuntarily extend the eyelid closure duration to protect the eyes. Criteria for judging the alertness level on the basis of eye closure count is based on the results found in a previous study [2].

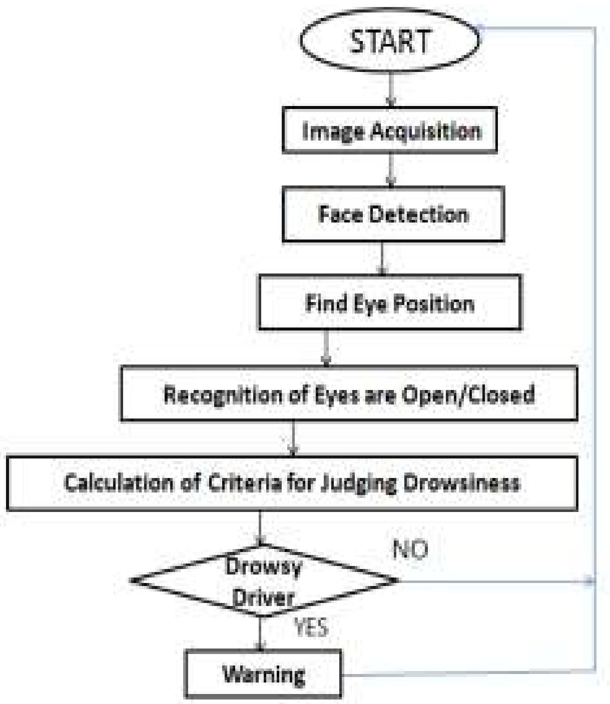


Fig. 1: Flowchart of the proposed system for drowsiness detection.

III. RESULT & DISCUSSION

The overall results that obtained in this project are noted and discussed in this part.

Fig. 2: Demonstration of the process video playback

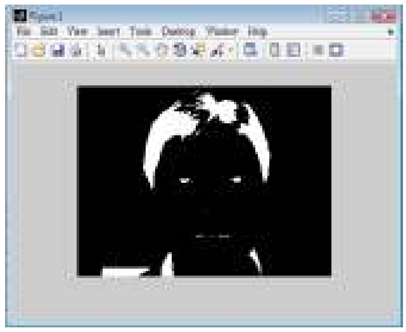


Fig. 3: Demonstration of binarizing the image

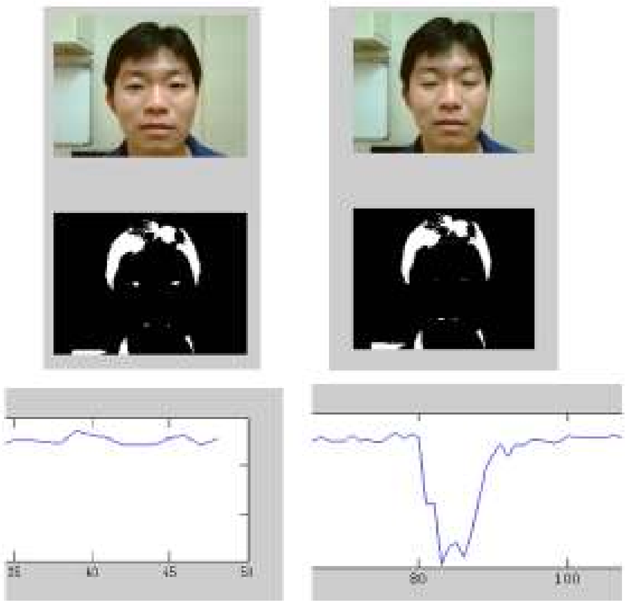


Fig. 4: Pixel values comparison between eyes opening state

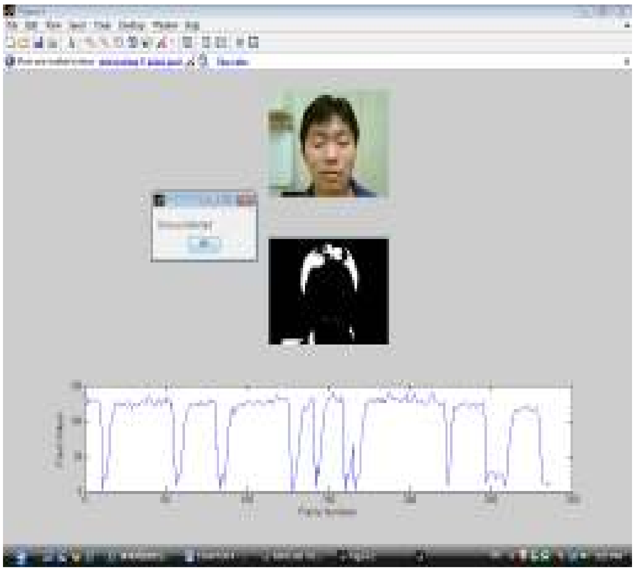


Fig. 5: Result show of ‘drowsy detected’

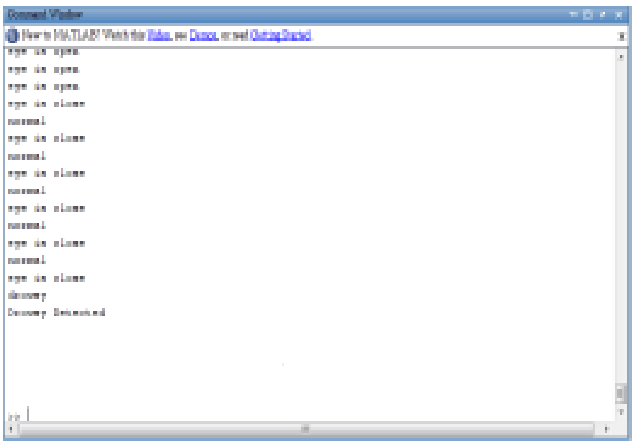


Fig. 6: Result displays of ‘drowsy detected’ in command window

Analysis of the Project

MATLAB supports only “raw” uncompressed AVI files on Linux and only some Indeo and Cinepack compressed versions on Windows. For the video recorded in variety format such as MPEG, MP4, 3GP or others, it have to convert it to raw or any supported format. After loading a whole video sequence, single frames can be accessed by MATLAB. It allows us to handle movie frames like single images and determines total frames in the video playback.

MATLAB provides a data struct for holding movie frames in memory. It consists of two fields. The field cdata contains the image data of the frame, whereas colormap contains information about the colormap that is used to display the frames. If the frames are truecolor images the field colormap will be empty. In this project, cdata is choosen because it more suitable and take shorter time to process all the frames in the video structure compare to colormap.

For this project, the threshold value is try to set different value for better result, but the most suitable to differentiate the eye region, that is t = 0.12. This is because it is the most clear to see eye region in binary picture. Below is a few try of setting different value of threshold value:

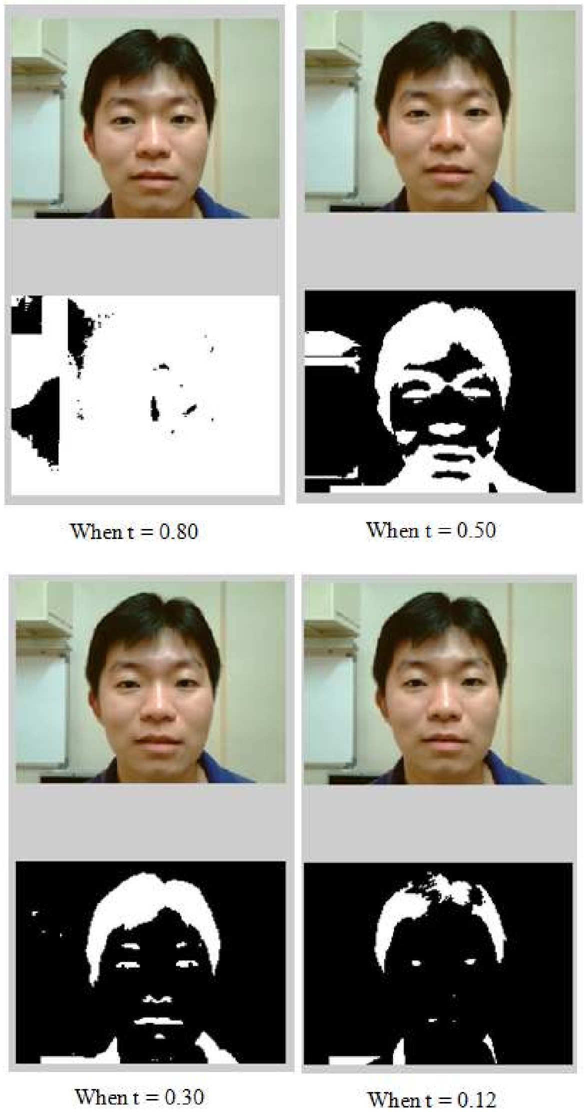


Fig. 7: Different threshold values for binary image

From the above figure, it is clear that setting threshold value is a very important step to differentiate eye region. After setting the threshold value, the function

IMCROP in MATLAB allow to crop out the eye portion for further processing.

Image2 = IMCROP (Image, RECT)

RECT is a 4-element vector with the form [XMIN YMIN WIDTH HEIGHT]; these values are specified in spatial coordinates.

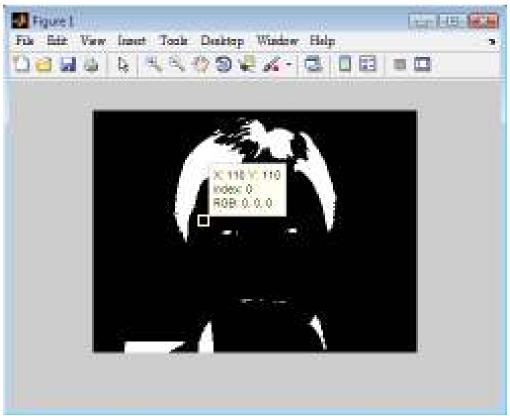


Fig. 8: Original image from video recorded (Image)

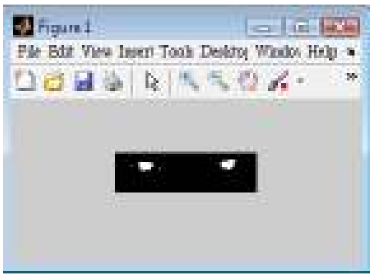
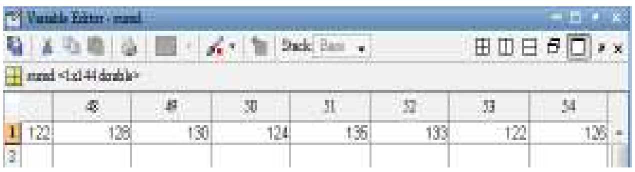
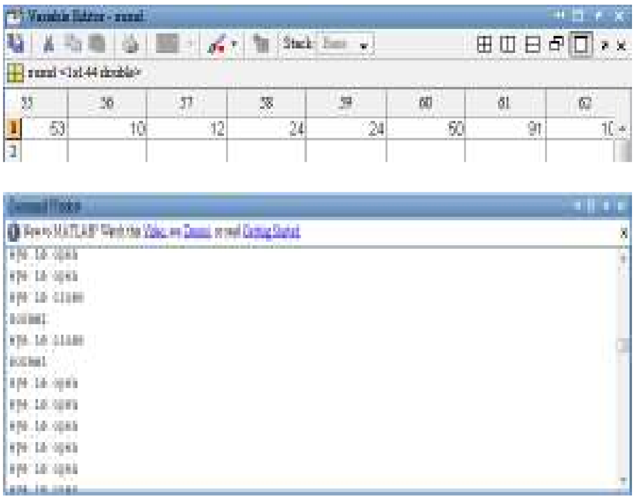


Fig. 9: Eye portion is crop out (Image2)

After the eye region is crop from the face portion, the following step is calculating the pixel values of the eye region. From the calculation of pixel values at eye portion, if the pixel values is less than 20, it means the eyes is close state, whereas if the pixel values is greater than 20, it means the eyes is open state. By calculating the pixel values at the eye region, it can differentiate clearly between open and closed eyes state.



(a)



(b)

Fig. 10(a & b) Pixel values of eye region

From fig. 10(a) it shows the pixel values of eye region from frame 48-54, the pixel values ranging are around 122-135, from this it is clearly that the eyes is in open state. However from fig. 10(b) it shows the pixel values of eye region from frame 55 to frame 62. The pixel values for frame 56 and 57 are below 20, that is 10 and 12 only. From here, it shows clearly at command window that the eye is at close state, whereas others frame is consider as open state. It is an action of blinking eyes.

Next, a decision about drowsiness is made by measuring the “PERCLOS” using eye blinking was found to be the most reliable and valid determination of a driver’s alertness level. For the decision, it has to initialize a drowsy frame for close eye state before it can make decision for drowsy state. Then, when it detects a close eye state, it will make an increment to the number of drowsy frame. When there are 5 consecutive frames find the eye closed in a video recorded, the system draws the conclusion that the driver is falling asleep and the alarm is activated, and a driver is alerted to wake up. It will reset the counter again when the eyes is open state. Once detect drowsy a pop up message will be given and alarm is activated.

IV. COCLUSION

This project is considered as successfully done since the objectives for this project are achieved. The objectives for this project are to develop a drowsiness detection system that can detect drowsy or fatigue in drivers to prevent accidents and to improve safety on the roads. This system able accurately monitors the open or closed state of the driver’s eye. When drowsy is detected toward a driver, a warning signal is issued to alert the driver.

Limitations

It is obvious that there are limitations to the system. The most significant limitation is that it will not work with people who have very dark skin. This is apparent, since the core of the algorithm behind the system is based on binarization. For dark skinned people, binarization doesn't work.

Another limitation is rapid head movement was not allowed. For small head movements, the system rarely loses track of the eyes. When the head is turned too much sideways, it will activate the alarms as a result of no eyes found in the video.

Future Recommendation

This project is recommended with suggestions in order to improve the efficiency of the system. One of the suggestions is to detect drowsiness in real time instead of offline. Real time drowsy detection is more advance compare to the offline drowsy detection.

Currently there is not adjustment in zoom or direction of the camera during operation. Future work may be to automatically zoom in on the eyes once they are localized. This would avoid the trade-off between having a wide field of view in order to locate the eyes, and a narrow view in order to detect fatigue.

This system only count at the number of consecutive frames where the eyes are closed. At that point it may be too late to issue the warning. By studying eye movement patterns, it is possible to find a method to generate the warning sooner.

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