Drowsiness Detection of Driver while Driving using Matlab

A Dissertation

Submitted in partial fulfilment of the requirements for the award of degree of

Master of Engineering

in

Electronic Instrumentation and Control

Submitted By

Dave Ruchita Shyamprasad

Roll No: 801251006

Under the Guidance of

Dr. Gagandeep Kaur

Assistant Professor, EIED

Thapar University, Patiala

Electrical and Instrumentation Engineering Department

Thapar University

(Established under the section 3 of UGC act, 1956)

Patiala, 147004, Punjab, India

July 2014

DECLARATION

I hereby certify that the work being presented in this thesis work entitled "**Drowsiness Detection of Driver while Driving using Matlab**" in partial fulfilment of award of degree of Master of Engineering in Electronics Instrumentation & Control submitted in EIED, Thapar University, Patiala is an authentic record of my own work carried under the supervision of Dr. Gagandeep Kaur, Assistant Professor, EIED, Thapar University, Patiala, Punjab.

Date: 17/7/'14

Dave Ruchita Shyamprasad
801251006

I certify that the above statement made by the student is correct to the best of my knowledge and belief.

Date: 17.7.14

Dr. Gagandeep Kaur
Assistant Professor, EIED
Thapar University, Patiala
Punjab

Countersigned by

Dr. Ravinder Agarwal
Head of Department,
Electrical & Instrumentation Engineering Department
Thapar University, Patiala
Punjab

Dr. S.K. Mohapatra
Dean of Academic Affair
Thapar University, Patiala
Punjab

2

ACKNOWLEDGEMENT

A journey of a thousand miles begins with a single step. I would have never succeeded in completing my task without the cooperation, encouragement and help provided to me by various personalities.

I am very thankful to **Dr. Prakash Gopalan**, Director of Thapar University, Patiala for providing the facilities for the completion of M.E. I express my deep sense of gratitude towards **Dr. Ravinder Agarwal**, Head of the Electrical & Instrumentation Engineering Department, Thapar University, Patiala who has been a constant source of inspiration for me throughout this work.

With deep sense of gratitude I express my sincere thanks to my esteemed and worthy supervisor **Dr. Gagandeep Kaur**, Electrical & Instrumentation Engineering Department, Thapar University, Patiala for her valuable guidance in carrying out this work under her effective supervision, encouragement, enlightenment and cooperation. Most of the novel ideas and solutions found in this thesis are the result of our numerous stimulating discussions. Her feedback and editorial comments were also invaluable for writing of this thesis.

I am also thankful to all the staff members of the Department for their full cooperation and help. This acknowledgement would be incomplete if I do not mention the emotional support and blessings provided by my friends. I had a pleasant enjoyable and fruitful company with them.

Thapar University, Patiala
Date 17/07/14

Dave Ruchita Shyamprasad
801251006

Abstract

Various investigations show that driver's drowsiness is one of the main causes of road accidents. The development of technologies for preventing drowsiness at the time is a major challenge in the field of accident avoidance. The advance in computing technology has provided the means for building intelligent vehicle systems. The purpose of this study is to detect the drowsiness in drivers to prevent the accidents and to improve the safety on the highways. A system aiming at detecting driver drowsiness or fatigue on the basis of video analysis is presented. A real time face detection is implemented to locate driver's face region. A method of detecting drowsiness in drivers is developed by using a camera that points directly towards the driver's face and capture for the video. As a detection method, the system uses image processing technology to analyze images of the driver's face taken with a video camera. The captured video is done, it is converted into number of frames of images and monitoring of the face region and eyes in order to detect drowsiness. The system is able to monitoring eyes and determines whether the eyes are in an open or shows signs of drowsiness. This detection system provides a noncontact technique for judging various level of alertness and facilitates early detection of a decline in alertness during driving

LIST OF CONTENTS

LIST OF FIGURES

Abbreviations

AI	Artificial Intelligence
AVI	Audio Video Interleave
BAC	Blood Alcohol Content
BMP	Bitmap
B & W	Black and White
CCD	Charge Coupled Device
EEG	Electroencephalograph
EOG	Electrooculograph
FORTRAN	Formula Translation
FL	Fuzzy Logic
HSV	Hue Saturation Value
IR	Infrared
JPEG	Joint Photographic Experts Group
MATLAB	Matrix Laboratory
NHTSA	National Highway Traffic Safety administration
PERSCLOS	Percentage of Eye Closed
RGB	Red Green Blue
SVM	Support Vector Machine
YCBCR	Luminance; Chrome: blue, Chrome: red
	Green (Y), Blue (Cb), Red (Cr)

CHAPTER 1

Introduction

1.1 Drowsiness

Drowsy means sleepy and having low energy [1]. Drowsiness is position of near to sleep, a strong desire for sleep [2]. Drowsiness refers to being unable to keep your eyes open, or feeling sleepy or tired. Drowsiness, also called excess sleepiness. Feeling abnormally sleepy or tired is commonly known as drowsiness. Drowsiness may lead to forgetfulness or falling asleep at inappropriate times. It can be accompanied by weakness, lethargy, and lack of mental alertness. People feel drowsy at some point or another, at improper times, indicates a sleep disorder or other medical problem as well. Depression, sorrow and stress are also associated with compromised sleep. Minimizing or treating these conditions can very much progress the ability to fall asleep and stay asleep [3]. Now drowsiness of person driving vehicle is very important. It may not be due to some medical disorders but long driving by a tired driver. This may cause drowsiness so there is a need to detect this to avoid miss happening.

1.2 Driver Fatigue And Road Accidents

Driver fatigue sometimes results in road accidents every year. It is not easy to estimate the exact amount of sleep related accidents but research presents that driver fatigue may be a contributing reason in up to 20% in road accidents. These types of accidents are about 50% more expected to result in death or serious hurt. They happen mainly at higher speed impacts. And the driver who has fallen asleep cannot brake [4]. Drowsiness reduces response time which is a serious element of secure driving. It also reduces alertness, vigilance, and concentration so that the capacity to perform attention-based activities i.e. driving is impaired. The speed at which information is processed is also reduced by drowsiness. The quality of decision-making may also be affected. It is clear that drivers are aware when they are feeling sleepy, and so make a conscious decision about whether to continue driving or to stop for a rest. It may be that those who persist in driving underestimate the risk of actually falling asleep while driving. Or it may be that some drivers choose to ignore the risks in the way drivers drink. Crashes caused by tired drivers are most likely to happen on long journeys on monotonous roads, such as motorways, between 2pm and 4pm especially after eating or taking an alcoholic drink, between 2am and 6am, after having less sleep than normal, after drinking alcohol, it driver takes medicines that cause drowsiness and after long working hours or on journeys home after long shifts, especially night shifts [4].

1.3 Motive Of Detection Of Problem

Driver drowsiness is a serious hazard in transportation systems. It has been identified as a direct or contributing cause of road accident. 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. In industrialized countries, drowsiness has been estimated to be involved in 2% to 23% of all crashes. Systems that detect when drivers are becoming drowsy and sound a warning promise to be a valuable aid in preventing accidents.

1.4 Solution Approach

Two kind of monitoring systems are named as vehicle oriented system and driver oriented system.

1.4.1 Vehicle oriented system

Drowsiness is detected by analyzing the driver’s behaving using information measured by sensors located in the vehicle, such as its position on the road, steering wheel movements, pressure on the driving pedals or the variability of the vehicle’s speed. The main disadvantages of this approach are that driving behavior may be very different from driver to driver. This makes it difficult to construct a “correct driving” model that can be used to detect variations in driving behavior. This model has to be learnt for each driver [5].

1.4.2 Driver oriented system

There are two types of driver oriented system which are named as-

(a) Instructive monitoring system based on biological indicators

Drowsiness is detected using physiological information. It is measured by sensors located on or around the driver. The physiological information is eye activity, cerebral activity, yawns, facial expressions, or gaze direction. These systems are more reliable because physiological drowsiness signs are known and are similar to one driver or another driver. There is one drawback with placements of sensors on the driver's body. They may not bother driver while driving. Another drawback is that measurements may be difficult because the driver is constantly moving. This system is bulky to implement [5].

(b) Non-instructive monitoring system based on face analysis

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 most important features of the human face, human eyes play an important role in face recognition and facial expression analysis. In actuality, the eyes can be considered salient and relatively stable feature on the face in comparison with other facial features. Therefore, when detecting 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. 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 [5].

1.5 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.

1.6 Thesis Overview

This drowsiness detection system while driving final thesis is combination of seven different chapters. Each of the chapters elaborates details regarding different aspects. The included aspects are Introduction, Literature Review, Drowsiness detection technique and methodology to detect drowsiness: A case study, Result and Discussion, Future work and Conclusion.

Chapter 1: Introduction

Chapter 2: Literature Review

CHAPTER 2

Literature Review

Willem B. Verwey et. al., (1999), had investigated in an advanced driving simulator whether drivers' alertness could be maintained in drowsiness-including conditions by a special game-like system, a 'gamebox'. Drowsiness was assessed by self-rating and eye-closures. Mental effort was assessed by a subjective workload rating scale and by a physiological measure i.e., the 0.1 Hz component of heart rate. Driving quality and safety were assessed movements, time-to-line crossing, and by the occurrence of safety-related driving errors-solid line crossing, driving off-road incidents and accidents. When driving with the gamebox, drivers reported a lower degree of drowsiness and fewer instances of sleep episodes as compared to a control condition. The quality of vehicle control deteriorated progressively over the course of the session, but less so in the gamebox condition. So, the results corroborate the notion that mental activity counteracts drowsiness in prolonged driving. This study corroborated the notion that mental activity might well be a means of counteracting driver drowsiness and, so, that a challenging 'activity-box' might be a viable and promising method for improving safety during long monotonous, night driving [6].

David M. Zaidel et. al., (2000), had done analysis on 26 participates. These 26 participates drove at night for 135 min on a simulated two lane rural road with lighr traffic and filled out a battery of queationnaires. Six drivers left the road entirely and ten others left the roadway with one or two wheels. Drivers scoring high on an "extraversion-boredom" personality group were more possible to depart from the road due to falling asleep. Drivers scoring high on a "disinhibition-honesty" group were more possible to cross solid lane marking but did not seem to fall asleep. The best predicting measures for poor driving were the frequency of eye-closures exceeding 1 s and the number of times that time-to-line crossing were below 0.5 s. the participants' own judgments on susceptibility to drowsiness was a poor predictor. This study was investigative because of the large number of dependent variables and the limited number of participants, it does present a coherent picture of the relationships between several behavioral and personality variables and vigilant driving performance [7].

Jian-Da Wu et. al., (2007), developed and investigated a warning system while driving using image processing technique with fuzzy logic interface. This system was based on facial images analysis for warning the driver of drowsiness or inattention to prevent traffic accidents. The facial images of driver were taken by a CCD camera which was installed on the dashboard in front of the driver. A fuzzy logic algorithm and an interface were proposed to determine the level of fatigue by measuring the blinding duration and its frequency, and warn the driver accordingly. The experimental works were carried to evaluate the effect of the proposed system for drowsiness warning under various operation conditions. The experimental results indicated that the proposed expect system was effective for increasing safe in drive. This study proved the feasibility of applies image processing technique to safety of vehicle. In this system, besides judging the driver's level of fatigue, it also allowed the head of driver moving within an acceptable region [8].

Tiesheng Wang et. al., (2005) had developed a system based on yawning detection for determining driver drowsiness. A system had an aim to detect driver drowsiness or fatigue on the base of video analysis which was presented. The main object of this study was on how to extract driver yawning. A real face detector was implemented to trace driver's face region. In this study, mouth window was traced. In which face region and degree of mouth openness was extracted to find driver yawning in video. This method was computationally capable because it ran at real-time on average. When the driver moved his head away by lack of concentration, the eyes and mouth might be occluded and might be detected. There was another situation should be reminded of the driver. For this other methods must be found to deal with it [9].

Zheng Gangtie et. al., (2009) had performed the drowsiness prediction by employing Support Vector Machine(SVM) by means of eyelid related parameters extracted from EOG data which were collected in driving simulator provided by EU project SENSTION. The dataset was firstly divided into three incremental drowsiness levels. To identify how the parameters were associated with drivers' sleepy condition by a paired t-test. A SVM drowsiness detection model was constructed with the help of all the features. Using this method, it was found that the drowsiness detection accuracy was quite high specially when the subjects are very sleepy [10].

Antonie picot et.al., (2012) had presented a drowsiness detection system using both brain and visual activity. The brain activity was monitored using a single electroencephalographic

(EEG) channel. An EEG-based drowsiness detector using diagnostic techniques and fuzzy logic were proposed. Visual activity was monitored through blinking detection and characterization. Blinking features were extracted from an electrooculographic (EOG) channel. Features were merged using fuzzy logic to create an EOG-based drowsiness detector. The features used by the EOG-based detector were voluntary restricted to the features that could be automatically extracted from a video analysis of the same accuracy. Both detection systems were then merged using cascading decision rules according to a medical scale of drowsiness evaluation. Merging brain and visual information made it possible to detect three levels of drowsiness: “awake,” “drowsy,” and “very drowsy.” [11].

Pia M. Forsman et. al., (2013) had focused to develop a method for detecting driver drowsiness at more moderate levels of fatigue, well before accident risk was imminent. Eighty-seven different driver drowsiness detection metrics proposed in the literature were evaluated in two simulated shift work studies with high-fidelity simulator driving in a controlled laboratory environment. Twenty-nine participants were subjected to a night shift condition, which resulted in moderate levels of fatigue; 12 participants were in a day shift condition, which served as control. Ten simulated work days in the study design each included four 30-min driving sessions, during which participants drove a standardized scenario of rural highways. Ten straight and uneventful road segments in each driving session were designated to extract the 87 different driving metrics being evaluated. The dimensionality of the overall data set across all participants, all driving sessions and all road segments was reduced with principal component analysis, which revealed that there were two dominant dimensions: measures of steering wheel variability and measures of lateral lane position variability. The latter correlated most with an independent measure of fatigue, namely performance on a psychomotor vigilance test administered prior to each drive. It can be replicated findings across eight curved road segments used for validation in each driving session [12].

Prof. V.K.Banga et. al., (2013) had developed a vehicle driver drowsiness warning system using image processing technique with neural network is proposed. The proposed system was based on facial images analysis for warning the driver of drowsiness or inattention to prevent traffic accidents. The facial images of driver were taken by a video camera which was installed on the dashboard in front of the driver. A Neural network based algorithm was proposed to determine the level of fatigue by measuring the eye opening and closing, and worn the driver accordingly. The results indicated that the proposed expert system was effective for increasing safety in driving. Information about the degree of eye closure was obtained through various self-developed image processing algorithms. During the monitoring, the system was able to decide if the eyes were opened, drowsy or closed. When the eyes were drowsy or closed, a warning signal was issued. Neural network provided a completely different, unorthodox way to approach a control problem, this technology was not difficult to apply and the results were usually quite surprising and pleasing. For future scope we suggested that that one could work on more features that could include the change was size and shape of iris when the person was drunk or when there was glossy appearance to eyes or must work on the concept of Horizontal Gaze Nystagmus for better accuracy using other machine algorithm like SVM [13].

Pooneh. R. Tabrizi et. al., (2008) had proposed an easy algorithm for pupil center and iris boundary localization and a new algorithm for eye state analysis, which there was incorporation into a four step system for drowsiness detection: face detection, eye detection, eye state analysis, and drowsy decision. This new system required no training data at any step or special cameras. Their eye detection algorithm used Eye Map, thus achieving excellent pupil center and iris boundary localization results on the IMM database. Novel eye state analysis algorithm detected eye state using the saturation (S) channel of the HSV color space. Analysis algorithm of eye state using five video sequences and show superior results compared to the common technique based on distance between eyelids. An easy algorithm for pupil center and iris boundary localization based on Eye Map and a new algorithm for eye state analysis, which they incorporated into a four step system for drowsiness detection: face detection, eye detection, eye state analysis, and drowsy decision by PERCLOS parameter. Pupil center and iris boundary localization algorithm responded in a wide range of lighting conditions with high accuracy. It also required no training data. For eye state analysis, They proposed a chromatic-based algorithm which had better detection rate for closed eye than the eyelids distance based technique and did not use training data. Proposed system for drowsiness detection was simple, non-intrusive, without the need for training data at any step or special cameras and was safe in comparison with IR illuminators. The main limitation of this system was that it was applicable only when the eyes were visible in the image that means with daylight and without dark sunglasses [14].

Mandalapu Sarada Devi et. al., (2008) had developed a system that can detect oncoming driver fatigue and issue timely warning could help in preventing many accidents, and consequently save money and reduced personal suffering. The authors had made an attempt to design a system that used video camera that points directly towards the driver's face in order to detect fatigue. If the fatigue was detected a warning signal was issued to alert the driver. The authors had worked on the video files recorded by the camera. Video file was converted into frames. Once the eyes are located from each frame, by measuring the distances between the intensity changes in the eye area one can determine whether the eyes were open or closed. If the eyes were found closed for 5 consecutive frames, the system draws the conclusion that the driver was falling asleep and issued a warning signal. The algorithm was proposed, implemented, tested, and found working satisfactorily. A driver monitoring system was implemented which detected the fatigued state of the driver through continuously monitoring the eyes of the driver. The basis of the method used by authors was the horizontal intensity variation on the face. One similarity among all faces was that eyebrows were significantly different from the skin in intensity, and that the next significant change in intensity, in the y-direction, was the eyes. This facial characteristic was the centre of finding the eyes on the face, which will allow the system to monitor the eyes and detect long periods of eye closure [15].

Hireshi Ueno et. al., (1994) had developed technologies to prevent sleepiness at the wheel. This method for accurately detecting a decline in driver alertness and a method for alerting and refreshing the driver. A system that used image processing technology to analyze images of the driver's face taken with a video camera. Diminished alertness was detected on the basis of the degree to which the driver's eyes are open or closed. This system provided a noncontact technique for judging various levels of driver alertness and facilitates early detection in alertness during driving [16].

Richard Grace et. al., (1998) had done on efforts performed at the Carnegie Mellon Driving Research Center to develop such in vehicle driver monitoring systems. Commercial motor vehicle truck drivers were studied in actual fleet operations. The drivers operated vehicles that were equipped to measure vehicle performance and driver psycho physiological data. There were two drowsiness detection methods were being considered. First is a video- based system that measures PERCLOS, a scientifically supported measure of drowsiness associated with slow eye closure. The second detection method is based on a model to estimate PERCLOS based on vehicle performance data. A non-parametric i.e., neural network model was used to estimate

PERCLOS using measures associated with lane keeping, steering wheel movements and lateral acceleration of the vehicle [17].

Danghui Liu et. al., (2010) had developed a system which is based on eyelid movement. The cascaded classifies algorithm was used to detect driver's face and the diamond searching used to trace the face. A simple feature is extracted from temporal difference image and used to analyze rules of eyelid movement in drowsiness. Three criterions are also presented and used to jugde whether a driver is drowsy or not [18].

Jaeik Jo et. al., (2013) had focused on accurate classification of eye state. This research had proposed a new method for eye state classification that combines three innovations: (i) extraction and fusion of features from both eyes, (ii) initialization of driver-specific thresholds to account for differences in eye shape and texture, and (iii) modeling of driver-specific blinking patterns for normal (non-drowsy) driving. The results show that the proposed method achieves significant improvements in detection accuracy [19].

Esra Vural et. al., (2007) had employed machine learning to datamine actual human behavior during drowsiness episodes. Automatic classifiers for 30 facial actions from the facial action coding system were developed using machine learning on a separate database of spontaneous expressions. These facial actions include blinking and yawn motions, as well as a number of other facial movements. Head motion was collected through automatic eye tracking and an accelerometer. These measures were passed to learning-based classifiers such as Adaboost and multinomial ridge regression. The system was able to predict sleep and crash episodes during computer game 96% accuracy within subjects and above 90% accuracy across subjects. The analysis revealed new information about human behavior during drowsy driving [20].

Ivan G. Daza et. at., (2014) had presented a non intrusive approach for monitoring driver drowsiness using the fusion of several optimized indicators based on driver physical and driving performance measures, obtained from Advanced Driver Assistant Systems in simulated conditions. This paper was focused on real-time drowsiness detection technology rather than on long term sleep or awake regulation prediction technology. The system was developed in order to obtain robust and optimized driver indicators able to be used in simulators and future real environments. These indicators were principally based on driver physical and driving performance skills. The fusion of several indicators, proposed in the literature, was evaluated using a neural network and a stochastic optimization method to obtain the best combination. This paper proposed a new method for ground-truth generation based on a supervised Karolinka Sleepness Scale. An extensive evaluation of indicators, derived from trials over a third generation simulator with several test subjects during different driving sessions, was performed [21].

Hyungseob Han et. al., (2014) had proposed a method of drowsiness detection with eyes open using EEG-based power spectrum analysis. In experiments, all electronic devices were turned off to reduce the artifacts, and a noiseless environment was created to cause drowsiness. After the EEG experiment was complete, drowsy periods are classified according to alpha power spectrum changes that were induced by eyes being closed in a drowsy state. Although the subject's eyes were opened for a long time, drowsiness patterns can be detected. Consequently, detection of drowsiness with eyes open was possible by using EEG-based power spectrum analysis and the proper feature vectors by LPC (linear predictive coding) coefficients [22].

K. Dwivedi et. al., (2014) had proposed a vision based intelligent algorithm to detect driver drowsiness. This algorithm made use of features learnt using convolution neural network so as to openly capture various latent facial features and the complex non-linear features interactions. A soft max layer was used to classify the driver as drowsy or non-drowsy. This system was used foe warning the driver of drowsiness or in attention to prevent traffic accidents. This study presents both qualitative and quantitative results [23].

CHAPTER 3

Drowsiness detection technique and methodology to detect drowsiness: A Case Study

3.1 Introduction

This chapter reviews about the case study that has been done before or during the development of this algorithm. And also having the methodology which is being used for the present study to detect of drowsiness.

3.2 Case study

It is the summary of all related study material required in this research. All ideas and concepts yield are to be implemented on the research. This chapter is about the most excellent work that has been done before. As in the first chapter, it is shown that types of monitoring system to detect drowsiness. These are vehicle oriented system and driver oriented system. This chapter is about on driver oriented system in which Non-instructive monitoring system based on face analysis is described [8].

People gradually perform more poorly on tasks performed for extended periods of time at night and following loss or disturbance of sleep. Due to the increase in the amount of automobile in recent years, problems created by accidents have become more complex as well. Poor performance has been attributed to drowsiness, sleeping, fatigue and inattentiveness. Driving with drowsiness is one of the main causes of traffic accidents. Driver fatigue is a significant factor in a larger number of vehicle accidents. Every year, about 15% to 20% of car crashes are due to driver drowsiness. Drowsiness can be defined as the transition between the awake state and the sleep state where one's ability to observe and analyze are strongly reduced. 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 [8].

Tiredness and fatigue can often affect a person's driving ability long before he/she even notices that he/she is getting tired. Fatigue related crashes are often more severe than others because driver's reaction times are delayed or the drivers have failed to make any maneuvers to avoid a crash. The number of hours spent driving has a strong correlation to the number of fatigue related accidents. Figure 1 displays the relationship between number of hours driven and the percent of crashes related to driver fatigue. A study conducted by the Adelaide Centre for Sleep Research has shown that drivers who have been awake for 24 hours have an equivalent driving performance to a person who has a BAC (blood alcohol content) of 0.1 g/100ml, and is seven times more likely to have an accident. In fact, NHTSA has concluded that drowsy driving is just as dangerous as drunk driving. Thus methods to automatically detect drowsiness may help save many lives and contribute to the well-being of the society.

Figure 3.1 shows the relationship between number of hours driven and percent of crashes related to driver fatigue.

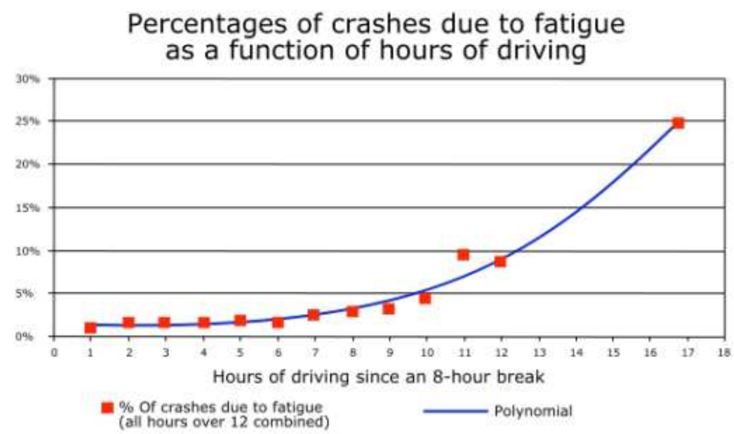


Fig 3.1: Graph between number of hours driven and %of crashes due to drowsy

Possible techniques for detecting drowsiness in drivers can be generally divided into the following categories: sensing of physiological characteristics, sensing of driver operation, sensing of vehicle response, monitoring the response of driver.

Among these methods, the techniques that are best, based on accuracy are the ones based on human physiological phenomena. This technique is implemented in two ways: measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking; and measuring physical changes such as sagging posture, leaning of the driver's head and the open/closed states of the eyes. The first technique, while most accurate, is not realistic, since sensing electrodes would have to be attached directly onto the driver's body, and hence be annoying and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, diminishing their ability to monitor accurately. The second technique is well suited for real world driving conditions since it can be non-intrusive by using optical sensors of video cameras to detect changes. Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. These too are non-intrusive ways of detecting drowsiness, but are limited to vehicle type and driver conditions. The final technique for detecting drowsiness is by monitoring the response of the driver. This involves periodically requesting the driver to send a response to the system to indicate alertness. The problem with this technique is that it will eventually become tiresome and annoying to the driver.

A vehicle driver drowsiness warning system using image processing technique with fuzzy logic inference is developed and investigated. The principle of the proposed system is based on facial images analysis for warning the driver of drowsiness or inattention to prevent traffic accidents. The facial images of driver are taken by a CCD camera which is installed on the dashboard in front of the driver. A fuzzy logic algorithm and an inference are proposed to determine the level of fatigue by measuring the blinding duration and its frequency, and warn the driver accordingly. The experimental works are carried to evaluate the effect of the proposed system for drowsiness warning under various operation conditions.

3.2.1 Principle of Drowsiness warning system

Owing to the great improvement on microprocessor in recent years, a large, two-dimensional image can be easily process by a computer. The image analysis techniques have been greatly accepted and applied. In the proposed design, a without interference drowsiness warning system for driver is sketched as Figure 3.2. A charge coupled device (CCD) camera is installed on the dashboard for taking consecutive facial images of the driver in the format of windows bitmap (BMP). It then used program which is written in C++ code to calculate the positions of the eyes and the eyelid closure duration based on the images taken. Finally, a fuzzy logic is used to determine the driver's alertness. Figure 3.3 shows the main interface of system. The system is capable of taking multiple, consecutive images and analyze them. Figure 3.4 shows the flow chart of the entire process analyzing whether a warning should be signaled.

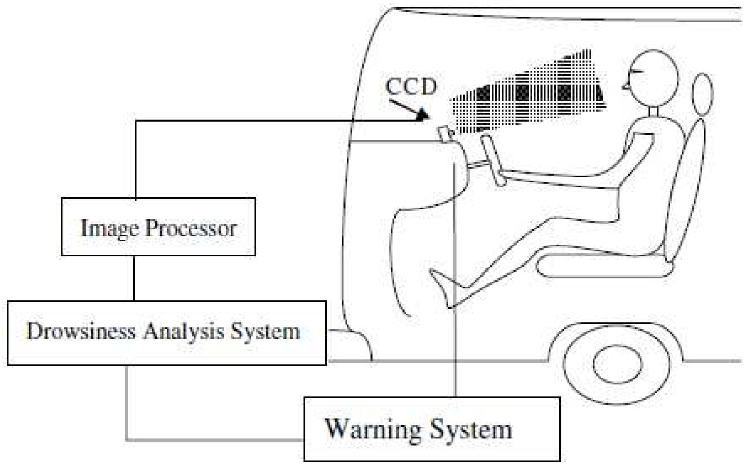


Fig 3.2: Sketch of drowsiness Warning system

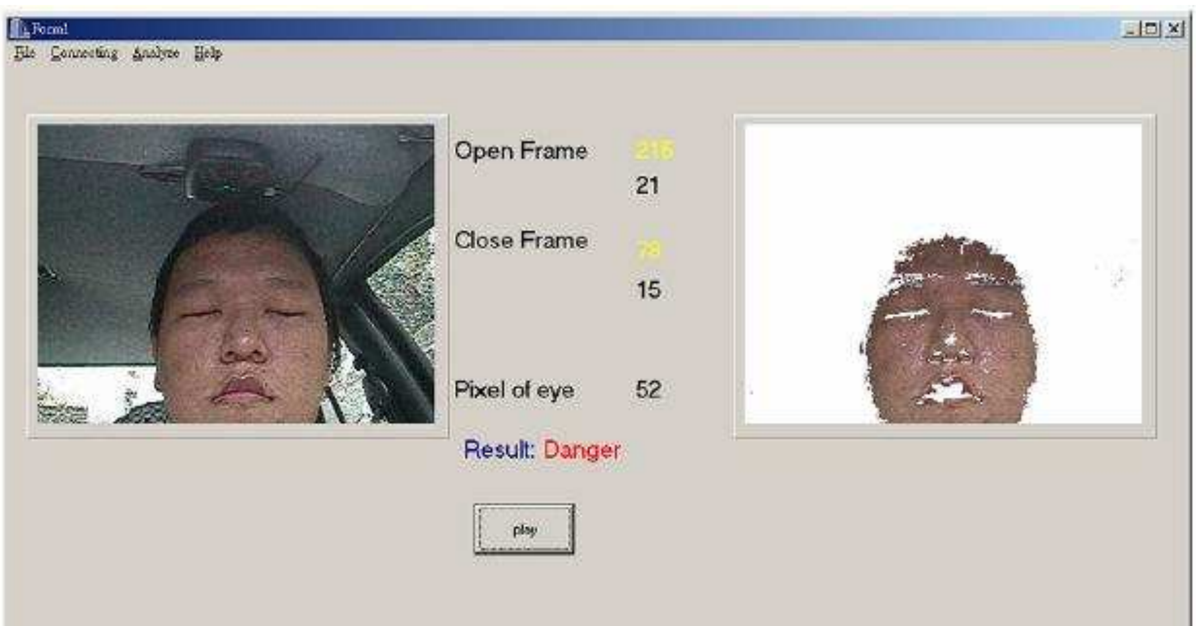


Fig 3.3: Main interface of drowsiness detection system

Above figures 3.2 shows the rough sketch of proposed system in which there are main three phases i.e. image processor, drowsiness analysis system and warning system. And figure 3.3 shows the interface of face with proposed software.

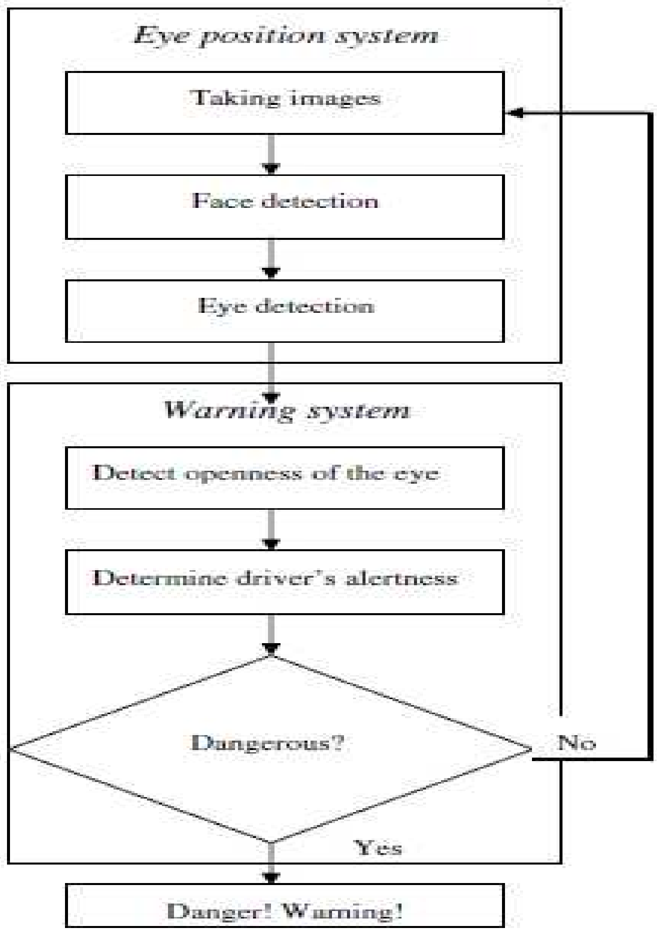


Fig 3.4: Flowchart of proposed drowsiness warning system

Figures 3.5, figure 3.6 and figure 3.7 show an image taken by CCD camera, facial skin region after face detection and eye region before eye detection respectively.

Fig3.5: An image taken by CCD camera

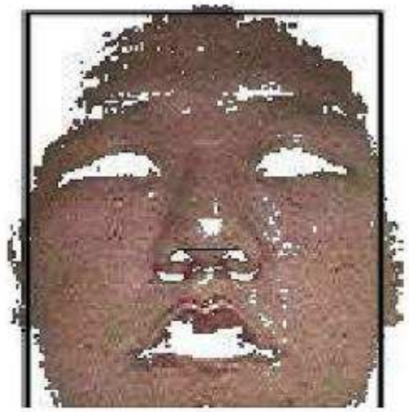


Fig3.6: Facial skin region after face detection

Fig 3.7:Eye region before eye detection

3.2.2 Detection of openness of eyes

For this detection, the concept of threshold is used to detect the openness of the driver's eyes. Thresholding is the operation of setting a pixel to black if the value is below a given threshold. On the other hand, a pixel is set to white if the value is above the threshold. From this process, they can generate a black-and-white image. In the following formula, n is the thresholding value.

$n=\sum g(x,y)$, $i=1$ to t

where g is the image, t is the number of pixels, g(x,y) is coordinates and (x,y) is pixel's grayscale

If (x,y) > n then (x,y) =255

If (x,y) <n then (x,y) =0

This study requires the calculation of the eyelid closure duration. After obtaining the thresholding value based on tests, set the skin pixel to white and the pupil to black. Based on the number of black pixels in an image, the system is able to determine whether the eye is close or open as shown in following fig.8.

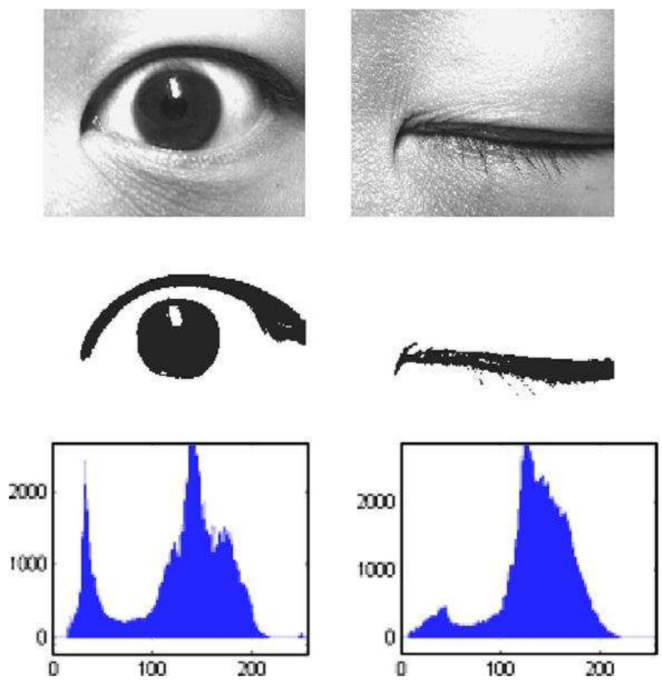


Fig 3.8: Thresholding of eye area

3.2.3 Method of drowsiness level estimation

The principle of fuzzy logic is applied to estimate the level of drowsiness. The concept of fuzzy set is a class with unsharp boundaries. It provides a basis for a qualitative approach to the analysis of complex systems in which linguistic rather than numerical variables are employed to describe system behavior and performance. In this way, a much better understanding of how to deal with uncertainty may be achieved, and better models of human reasoning may be constructed. The concept of fuzzy logic has gained wide acceptance in recent years and have found numerous applications in expert systems and artificial intelligence application. Fatigue is a type of fuzzy bodily state. It cannot be quantified objectively. Thus, the computers are used to apply the fuzzy logic and determine the level of drowsiness. The variable used by the drowsiness detection system encompasses the blinking time and the eyelid closure duration [8].

3.3 Case study undertaken

Drowsiness detection is very important to avoid accidents and can save many lives. In this session, there are descriptions and methods of drowsiness detection technology with details and suitable diagrams.

3.3.1 Methodology

For drowsiness detection, it is necessary to detect the state of driver's eyes which are close or open. For this Digital Image Processing is used. MATLAB toolbox is used for image processing. There are main three steps to follow achieving the aim.

Mainly there are three steps:(i)Face detection

(ii)Eye detection

(iii)Stage of eyes(open/closed)

3.3.2 Digital Image Processing

Digital image processing is the use of computer algorithms to perform image processing on digital images. In the field of digital signal processing, there are many advantages of digital image processing with compare to analog image processing. There is a much wider range of algorithms to be applied to the input data. It can avoid problems like the build-up of noise and signal deformation during processing. Since images are defined over two dimensions, even applied in the case of more dimensions also, digital image processing may be modeled in the form of multidimensional systems [24].

Digital image processing permits the use of much more difficult algorithms. Digital image processing can offer both more complicated performance at simple tasks, and the implementation of methods which would be impossible by analog means. Digital image processing is the only practical technology for classification, pattern recognition, projection, feature extraction and multi-scale signal analysis [24].

Some techniques which are used in digital image processing names as pixlation, principal components analysis, linear filtering, anisotropic diffusion, wavelets, neural networks, independent component analysis, hidden markov model, self-organizing maps and partial differential equation. There is necessary to discuss on Digital Image processing because throughout whole methodology this technique only is used [24].

An image may be defined as a two-dimensional function, f(x,y), where x and y are spatial coordinates, and the amplitude of f at any pair of coordinates (x,y) is called the intensity or gray level of the image at that point. When x.y, and the amplitude values of f are all finite, discrete quantities, the image is called as a digital image. Digital image processing refers to processing digital images using a digital computer. A digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements, image elements, pels, and pixels. Pixel is the term used most widely to denote the elements of a digital image [24].

Vision is the most advanced of among all senses, so it is obvious that images participate the single most vital role in human perception. But unlike humans, who are limited to the visual band of electromagnetic spectrum, imaging machines cover almost the entire electromagnetic spectrum. It has range from gamma to radio waves. They can operate also on images generated by sources that humans do not usually relate with images. These include electron microscopy, ultrasound, and computer-generated images. So, it is easily seen that the digital image processing encompasses a large, huge and wide varied field of applications [24].

There is no general conformity among all writers on the subject of where image processing stops and other interrelated areas, like computer vision and image analysis, begin. Occasionally a difference is made by defining image processing as a regulation in which both the input and output of a process are images. It is belief that to be a limiting and rather artificial boundary. For example, under this meaning, even the minor mission of computing the average intensity of an image would not be considered an image processing operation. But in the other side where there are fields, such as computer vision, whose final goal is to use computers to follow human vision, including learning and being able to make boundary and obtain actions based on visual inputs. This area itself is a branch of artificial intelligence (AI), whose purpose is to follow human intelligence. The field of AI is in its infancy in terms of practical developments, with progress having been much slower than originally anticipated. The area of image analysis or image accepting is in between image processing and computer vision [24].

There are no clear-cut limitations in the range from image processing at one end to computer vision at the other. Conversely, a useful example is to consider three types of computerized process in this range: low-mid-, and high-level processes. Low-level processes occupy primitive operations, for example image preprocessing to lessen noise, contrast enhancement, and image sharpening. A low-level process is characterized by the fact that both its inputs and outputs usually are images. Mid-level process on images occupy tasks for example segmentation means partitioning an image into regions or objects, explanation of those objects to reduce them to a form suitable for computer processing, and classification i.e., recognition of individual objects. A mid-level process is characterized by the fact that its inputs generally are images, but its outputs are attributes extracted from those images e.g., edges, contours, and the identity if individual objects. To end with, high-level processing involves "making sense" of an collection of recognized objects, as in image analysis, and, at the far end of the range, performing the cognitive functions normally associated with human vision [24].

3.3.3 MATLAB: A Review

MATLAB is an interactive software system for numerical computations and graphics. MATLAB is a high-performance language for technical computing. It is particularly designed for matrix computations including solving systems of linear equations, computing Eigen values and Eigen vectors, factoring matrices and many more. It has a mixture of graphical capabilities. It integrates visualization, computation, and programming in a straightforward environment where problems and solutions are expressed in known mathematical notation. Uses of MATLAB include are like this, math and computation, data acquisition, modeling, simulation, prototyping, algorithm development, scientific and engineering graphics, data analysis, exploration, visualization, and application development including building graphical user interface [24].

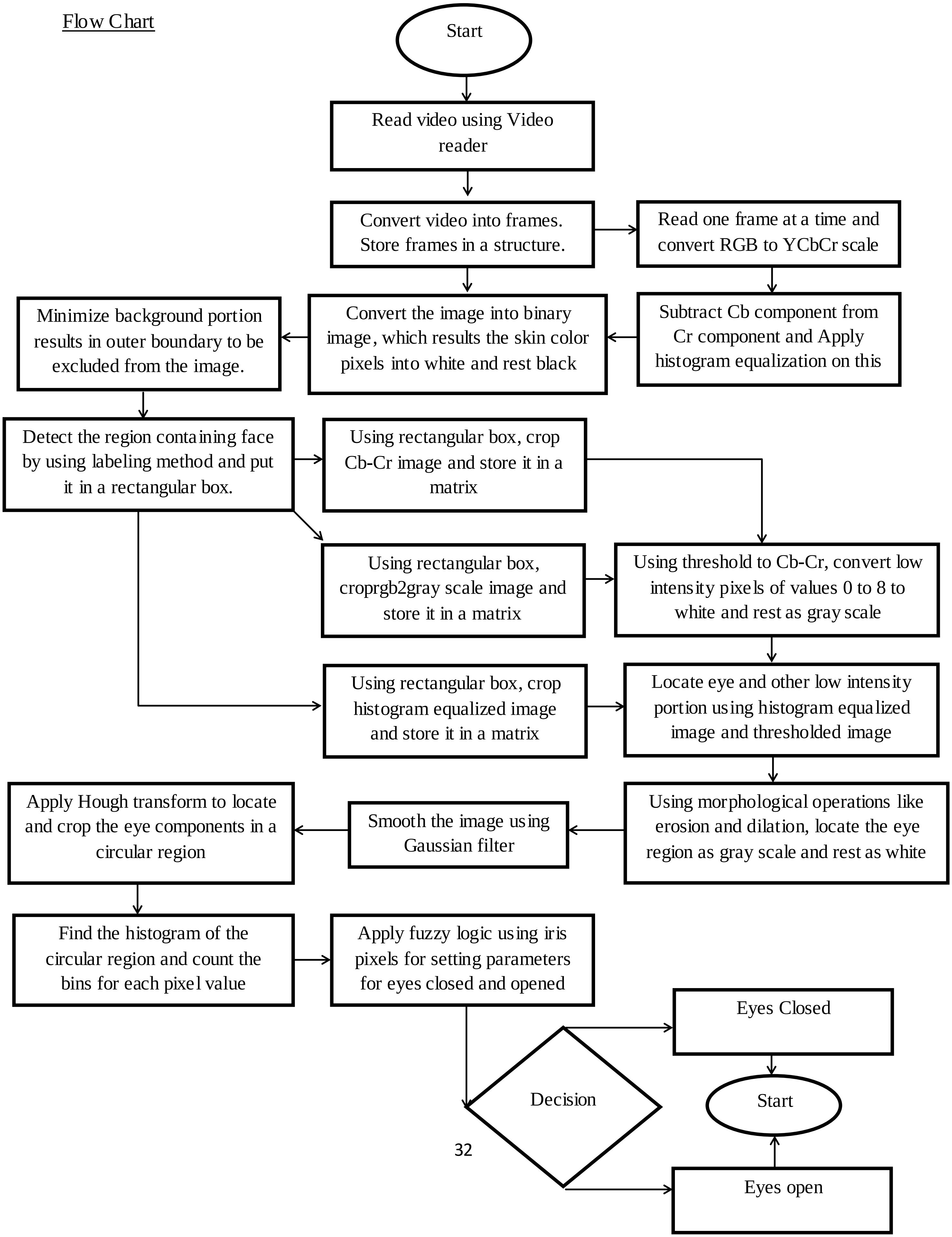
It can be extended through programs written in its own programming language. There are many programs and they are come with system. And these programs extend MATLAB's capabilities for nonlinear problems like the solution of initial value problems for ordinary differential equations. MATLAB is intended to solve problems numerically. The problems like finite-precision arithmetic. So it can produce fairly accurate solutions. MATLAB is an interactive system whose basic data element is a matrix which allows formulating solutions to many technical computing problems, in particular those involving matrix representations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C. The name MATLAB stands for Matrix Laboratory. MATLAB was written originally to provide easy access to matrix and linear algebra software that previously required writing FORTRAN programs to use. Today, MATLAB incorporates state of the art numerical computation software that is highly optimized for modern processors and memory architectures. In university environments, MATLAB is the standard computational tool for introductory and advanced courses in mathematics, engineering, and science, in industry, MATLAB is the complemented tool of choice for research, development, and analysis [24].

MATLAB is complemented by a family of application-specific solutions called toolboxes. The Image Processing Toolbox is a collection of MATLAB functions (called M-functions or M-files) that extend the capability of the MATLAB environment for the solution of digital image processing problems. Other toolboxes that sometimes are used to complement the Image Processing Toolbox are the Signal Processing, Neural Networks, Fuzzy Logic, and Wavelet Toolboxes. The MATLAB & Simulink Student Version is a product that includes a full-featured version of MATLAB, the Image Processing Toolbox, and several other useful toolboxes [25].

3.4 Flow chart

The whole system methodology is somehow complex. It is mandatory to understand all steps to apply for the implementation. For this kind of problem, flowchart or algorithm of system will help effectively to be aware of problem purpose. So making a flowchart is necessary and the system will follow flowchart to achieve the aim. There are numbers of steps which are going to be followed. And many matlab functions are used to achieve the final aim of the study like thresholding, rgb to ycbcr conversation, binarization, segmentation, convert into gray scale from rgb image, cropping, minimizing, histogram equalization, hough transformation and smoothing using Gaussian filter etc.

Flow Chart


Start
Read video using Video reader
Convert video into frames. Store frames in a structure.
Read one frame at a time and convert RGB to YCbCr scale
Subtract Cb component from Cr component and Apply histogram equalization on this
Convert the image into binary image, which results the skin color pixels into white and rest black
Minimize background portion results in outer boundary to be excluded from the image.
Detect the region containing face by using labeling method and put it in a rectangular box.
Using rectangular box, crop Cb-Cr image and store it in a matrix
Using rectangular box, croprgb2gray scale image and store it in a matrix
Using threshold to Cb-Cr, convert low intensity pixels of values 0 to 8 to white and rest as gray scale
Using rectangular box, crop histogram equalized image and store it in a matrix
Locate eye and other low intensity portion using histogram equalized image and thresholded image
Using morphological operations like erosion and dilation, locate the eye region as gray scale and rest as white
Smooth the image using Gaussian filter
Apply Hough transform to locate and crop the eye components in a circular region
Find the histogram of the circular region and count the bins for each pixel value
Apply fuzzy logic using iris pixels for setting parameters for eyes closed and opened
Decision
Eyes Closed
Start
Eyes open

Following the flowchart, record the video of driver while driving. The video should contain the clear face of driver so that image processing can be done easily. Now this video will be preceded in MATLAB toolbox. In this report, there has been recorded few videos while driving with different face and eye expressions of some students of Thapar University, Patiala. Out of these, one video has been taken as a consideration for the study.

3.5 Read the record video using video reader

In MATLAB, the first step is to read the video. Using the video reader function with read method to read video data from a file into the MATLAB workspace. The video reader supports some file formats that vary platform to platform. These platforms are like-All platform those are AVI, including uncompressed, indexed, grayscale, and Motion JPEG-encoded video. All windows, Macintosh, Linux etc. The video reader constructs the desired objective to read video data from the file. If it cannot construct the object for any reason, video reader generates an error. Even video reader can also generate the object with additional options specified by name. This name will be one or more. Another additional option is value. Like name, value will be also one or more [26].

3.6 Convert video into number of frames

After reading the video using video reader function, the video must be converted into number of frames. These all frames are being stored in a structure. To read the frame, also video reader is used. It will read in all video frames from the file connected with objective. The read frame method gives output as a H-by-W-by-F matrix, video. Here H is the image frame height. W is the image width. And B is the number of bands in the image, e.g., 3 for RGB. Lastly, F is the number of frames read [27]. One frame of all, i.e., figure 3.9 is shown in the next chapter 4 that is Results and Discussion.

3.7 Face detection

The face detection is key step of the whole methodology. For the face detection read one frame at a time. Figure 4.1 shows one RGB image. This RGB image will be converted into YCbCr image and binary image. Firstly, ycbcr image is considered for study.

3.7.1 Need of ycbcr image

The function, which converts the RGB values in MAP to the YCBCR color space. MAP must be a M-by-3 array. YCBCRMAP is a M-by-3 matrix that have the YCBCR luminance(Y) and chrominance (Cb and Cr) color values as columns. Each row represents the equivalent color to the corresponding row in the RGB color map. It converts the true color image RGB to the equivalent image in the YCBCR color space. RGB must be a M-by-N-by-3 array. Converted image is given away in next chapter as figure 4.2. For the future further process, subtract cb component from cr component and apply histogram equalization function. To get perfect ycbcr image, histogram equalization function is used. It enhances the contrast of images by transforming the values in an intensity image, or the values in the color map of an indexed image. So that the histogram of the output image approximately matches a specified histogram. After converting rgb image into ycbcr image, the image is converted into binary image [28].

3.7.2 Use of Binary image

Binary image is a digital image that has only two likely values for each pixel. There are two only colors used for a binary image are black and white. Numerically, the two values are often 0 for black, and either 1 or 255 for white. Binary images are frequently produced by thresholding a grayscale or color images, with the purpose of dividing an object in the images from the background. The color of the object, usually white, is referred to as the foreground color. The rest, usually black, is referred to as the background color. On the other hand, depending on the image which is to be thresholded, this polarity might be inverted, in which case the object is displayed with 0 and the background is with a non-zero(1) value [31]. In the document-scanning industry this is often referred to as "bi-tonal". Binary images are also called bi-level or two-level. This means that each pixel is stored as a single bit—i.e., a 0 or 1. The names black-and-white, B&W, monochrome or monochromatic are often used for this concept, but may also designate any images that have only one sample per pixel, such as grayscale images. In Photoshop parlance, a binary image is the same as an image in "Bitmap" mode. Binary images often arise in digital image processing as masks or as the result of certain operations such as segmentation, thresholding, and dithering. Some input/output devices, such as laser printers, fax machines, and bilevel computer displays, can only handle bilevel images [33].

Binary images are used in many applications since they are the simplest to process, but they are such an impoverished representation of the image information that their use is not always possible. But, they are useful where all the information you need can be provided by the outline of the object and when you can obtain the silhouette of that object easily. Few application domains are interpreting text, identifying orientations of objects and identifying objects on a conveyor e.g. sorting balloons. Sometimes the output of other image processing techniques is represented in the form of a binary image, for example, the output of edge detection can be a binary image, edge points and non-edge points. Binary image processing techniques can be useful for subsequent processing of these output images. Certainly the negative image of binary is also a binary image, simply one in which the pixel values have been reversed [32].

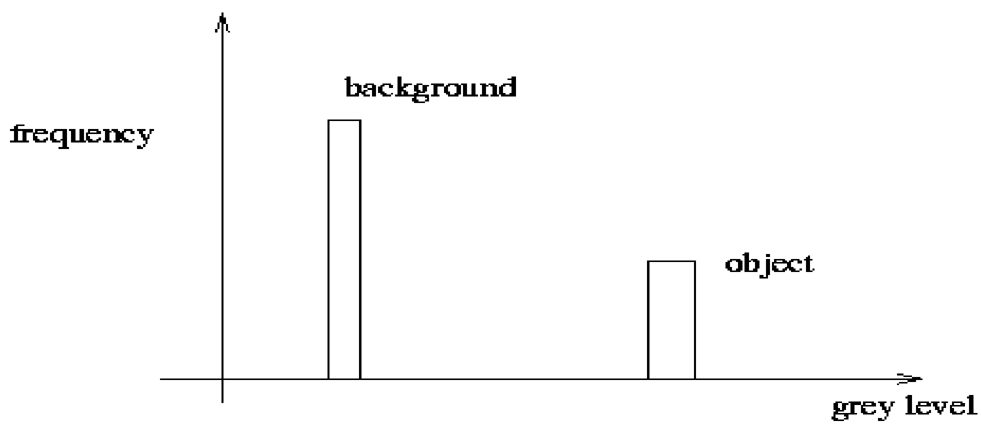


Fig 3.9: Shows the ideal histogram of light object on a darker plain background

The black white image of color image is mentioned in the next chapter named as figure 4.3.

3.7.3 Minimizing background portion

From the binary image, it is easily seen that there is white portion in the background which can create noise during detecting the face. So it is necessary to remove or minimize the background portion from the binary image. Minimizing background portion from the black-white image results in outer boundary to be excluded from the image. The resulted image of minimizing background portion is revealed in the next chapter as figure 4.4.

3.7.4 Recognition of face region

To detect the region of face after minimizing the background extra portion from the image, labeling method is used. In the labeling method, components are connected in 2-D binary image. This function will return a matrix of the same size as binary image. It contains labels for the connected objects in binary image. it can have a value of either 4 where 4 specifies 4-connected objects or 8 where 8 specifies 8-connected objects. If the argument is omitted, it defaults to 8. The elements of matrix are integer values greater than or equal to 0. The pixels labeled 0 are the background. The pixels labeled 1 make up one object; the pixels labeled 2 make up a second object and so forth [34]. After that it is required to measure the properties of image regions. The region properties function is used. This function measures a set of properties for each labeled region in the label matrix. Positive integer elements of matrix correspond to different regions. For example, the set of elements of matrix equal to 1 corresponds to region 1; the set of elements of matrix equal to 2 corresponds to region 2; and so on. The return value is a structure array of length matrix. The fields of the structure array denote different measurements for each region, as specified by properties. Properties can be a comma-separated list of strings, a cell array containing strings, the single string 'all', or the string 'basic'. There are set of valid property strings. Property strings are case insensitive [35]. The recognized face region is put in a rectangle box. Resulted image is shown in the chapter 4 as figure no 4.4. This rectangle box is used to store different operated images. And these operated images are three kind of. First operated image which is stored as matrix in rectangle box is cropped cb-cr image. Second image is gray image which is converted from color image. Third image is histogram equalization image which is stored as matrix in rectangle box. These all three images are mentions clearly in chapter 4 as listed figure 4.6, figure 4.7 and figure 4.8. Using thresholding function on cb-cr crop image by converting low intensity pixels of values that is 0 to 8 into white and rest all pixels are in gray scale. In many applications, sometimes it needs to be separate out the regions of the image corresponding to objects from the regions of image that communicate to background. Thresholding provides an easy and convenient way to perform the segmentation on the basis of the different intensities or colors in the foreground and background regions of an image. It is used to see what areas of an image consist of pixels whose values lie within a specified range, or band of intensities or colors. For thresholding, generally grayscale or color image is input. And output is binary image which represents the segmentation. Black pixels correlate to background and white pixels correlate to foreground. It is also applicable for vice versa. The segmentation is determined by a single parameter, which is known as the intensity threshold. Each pixel in the image is compared with this threshold. If the pixel's intensity is higher than threshold, the pixel is set as white in the output in the binary image. if it is less than threshold, it is set to black. This phenomena for single pass. For multiple thresholds, band of intensity values can be set to white while everything else is set to black [36]. The segmentation resulted image is mentioned as figure 4.9 in chapter 4.

3.8 Eye Detection

The face region is completely recognized. And now next major step is eye detection. To detect the eyes, previous two resulted images named as histogram equalized image figure 4.6 and threshold image, figure 4.9 are used. Using these two images, the eyes and low intensity portion of face are located for the further process. The resulted image with locate eye and low intensity portion are mentioned in the next chapter as figure 4.11. To darken the eye region some morphological operations like erosion and dilation are used [37]. Morphology is a method of image processing based on shapes. The value of each pixel in the output i.e., binary image is based on a comparison of the equivalent pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, it can be constructed a morphological operation. This operation is sensitive to specific shapes in the input image. Using morphological functions, there are many image processing tasks like contrast enhancement, thinning, filling, noise removal, segmentation and skeletonization are performed. Some morphological operations are erosion, dilation, opening, closing and boundary extraction [38]. Erosion and dilation are the fundamental operations of morphological image processing. In this report, erosion and dilation are applied. The erosion function erodes the grayscale, binary or packed binary image and returns eroded image. Erosion shrinks or thins objects in a binary image [39]. When dilation is an operation that grows or thickens objects in an image. Both functions use a specific element which does both operations of erosion and dilation [40]. The achieved image is shown in the next chapter as figure 4.12.

3.8.1 Smoothing the image

The next step is smoothing. It is done by the filtering. Filtering means smoothing or reducing or discarding the noise.

3.8.2 Need of Image Filtering

When an image is acquired by camera or any other imaging system, there are many chances that the vision system for which it is proposed is unable to use it directly. The image may be corrupted by random variations in illumination, variations in intensity, or poor contrast that must be dealt with in the early stages of vision processing. To eliminate these undesirable characteristics, image filtering is used. They are numbers of filters named as- average filter, laplacian filter, Gaussian filter, disk filter, log filter, motion filter, prewitt and sobel filter. These all filters are having different uses and criteria. Here, Gaussian filter is used.

3.8.3 Use of Gaussian filter

Gaussian filter is used for mainly smoothing. To locate the eye position, the surrounding location of eye must be smoothen [41]. If there is noise, it will be difficult to define the stage of eye whether it is open or close. Gaussian filtering is used to blur images and remove noise and detail. The Gaussian function is used in frequent study areas those are- defining a probability distribution for noise or data, smoothing operator and using in mathematics. The Gaussian filters work by using the 2D distribution as a point-spread function. This function is achieved using convolving the 2D Gaussian distribution function with the image. There is need to produce a discrete approximation to the Gaussian function. An infinitely large convolution kernel is required. The Gaussian distribution is non-zero everywhere and distribution has approached very close to zero. The Gaussian filter is a non-uniform low pass filter. The kernel coefficients reduce with increasing distance from the kernel's centre. Central pixels have a higher weighting than those on the edge. Larger values of standard derivation produce a wider peak to get greater blurring. Kernel size must increase with increasing standard derivation to maintain the Gaussian nature of the filter. Gaussian kernel coefficients depend on the value of standard derivation. These coefficients must be close to 0 at the edge of the mask. The kernel is rotationally symmetric with no directional bias. Gaussian kernel is separable and it allows fast computation. Gaussian filters might not preserve image brightness. Gaussian kernel coefficients are sampled from the 2D Gaussian function.

$$G(x,y)= \frac{1}{2\Pi\sigma 2}\, e^{\frac{-x2+y2}{2\sigma 2}}$$

Where **σ** is the standard deviation of the distribution derivation of the distribution. This distribution is assumed to have a mean of zero. The Gaussian functions are stored as discrete pixels continuously by discretizing. An integer valued 5 by 5 convolution kernel approximating a Gaussian with a **σ** of 1 is shown in the following figure 3.10 [42]. And the smoothing image is mentioned in chapter 4 as figure 4.13.

1/273

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Figure 3.10 Gaussian filter

3.9 Stage of eyes (open/closed)

After smoothing using Gaussian filter, it is clearly seen that the region of eye is detected. To find out the stage of eye whether it is close or open, it is necessary to locate exact location of eye. To trace the accurate spot of eye, apply the circular Hough transform function. Figure 4.14 shows the exact region of eye. The Hough transform is used to detect lines, circles or other parametric curves. It is computed on binary image. This function returns the Hough transform matrix with additional parameters i.e., theta in degrees and rho. These parameters are the arrays of rho and theta values over which the Hough transform generates the matrix [45]. The binary image can be logical or numeric. The image must be real and 2-D which is listed as figure 4.14 in the next chapter. It has been found the exact region of eyes. Humans must know by watching the image whether the eyes are open or closed. But MATLAB toolbox or software does not know whether the eyes are open or close. To get the absolute result, it is necessary the conversation of resulted last image into graphical form. To covert the image into graphical form, histogram function is used. To represent the allocation of data in a data set, a histogram is used. Each data point is placed into a bin based on its value. The histogram is a plot of the number of data points in each bin. A histogram shows the distribution of data values. For characterizing the spread of data from repeated trial and for determining the probability of measurement, histograms are widely used. Histogram processing is also used for computationally adjusting the contrast. Histogram method can be applied to numerous problems including color balance or tone transfer. There are mainly three functions of histogram function. First function introduces basic pixel operations that hoe they do change histograms. Showing a number of schemes to stretch a histogram to cover the full range of pixel values. Second function of histogram is histogram equalization. This function focuses on spreading out the pixel values consistently over some range. Last but not least the function of histogram controls modifying the pixel values. It can be used to match any arbitrary distribution [45]. The final step of detecting is analysis the number of histograms of resulted last image frame. In which, the study of histograms is very important to define the detection of eye stage. Histogram of image shows that when the eyes are open, the level of intensity between two random numbers is high. And at remain numbers, the intensity is almost to zero. Whenever the eyes are open, the random numbers in which the high intensity comes will be repeated. And whenever the eyes are close, the intensity comes low all along the path. To find the eyes are open or closed, apply the Fuzzy logic for setting the parameters.

3.9.1 Concept of Fuzzy Logic

Fuzzy Logic is a problem-solving control system methodology. It lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster. Fl is different from conventional control methods. FL incorporates a simple, rule-based if x and y then z approach to a solving control problem rather than attempting to model a system mathematically. The FL model is empirically-based, relying on an operator's experience rather than their technical understanding of the system. For example, rather than dealing with temperature control in terms such as "sp =500f", "t <1000f", or "210c <temp <220c", terms like "if (process is too cool) and (process is getting colder) then (add heat to the process)" or "if (process is too hot) and (process is heating rapidly) then (cool the process quickly)" are used. These terms are imprecise and yet very descriptive of what must actually happen. Consider what you do in the shower if the temperature is too cold: you will make the water comfortable very quickly with little trouble. FL is capable of mimicking this type of behavior but at very high rate [46]. Final image of result is mentioned in the next chapter as figure 4.15.

CHAPTER 4
Results And Discussion

This chapter is about all resulted images and discussion over them to understand the process. Initially, video reader read the video and frame of video at a time. And one rgb image frame is shown as below figure 4.1 .

Fig. 4.1 : Rgb (Red, Green, Blue) image frame

Color digital images are made of pixels, and pixels are made of combinations of primary colors. And these primary colors are- red, green and blue. RGB channels roughly follow the color receptors in the human eye, and are used in computer displays and image scanners. If the RGB image is 24-bit, each channel has 8 bits, for red, green, and blue—in other words, the image is composed of three images (one for each channel), where each image can store discrete pixels with conventional brightness intensities between 0 and 255. If the RGB image is 48-bit, it is very high resolution; each channel is made of 16-bit images [29].

Figure 4.1 is converted into ycbcr image. Y: Luminance; Cb: Chrominance-Blue; and Cr: Chrominance-Red are the components. Luminance is very similar to the grayscale version of the original image. Cb is strong in case of parts of the image containing the sky (blue), both Cb and Cr are weak in case of a colour like green, and Cr is strong in places of occurrence of reddish colours. The Cb and Cr components of the YCbCr, or YCC, color space are not immediately physically intuitive. Cb and Cr respectively represent the blue-difference and red-difference chroma signals. Chromaticity represents the perceptual deviation from the neutral, i.e. grayscale, so the greater the deviation, the higher the intensity of chroma. An image with low chroma is less colorful, and conversely. And so, Cb and Cr are one representation of changes in blue and red "colorfulness", respectively. Each colorspace has different advantages, mostly related to how sensitive channels to changes. For example, YCbCR is widely popular for its compressibility in the Cb and Cr channels by subsampling. Or, when doing things in computer vision like image matching using color-based methods, it is important to use an rg-chromaticity space with illumination invariance so that accuracy doesn't fluctuate dramatically when lighting changes [30].

Fig. 4.2: YCbCr image (Luminance and Chrominance image)

Figure 4.1 is also converted into binary image. Binary images are images whose pixels have only two possible intensity values. They are normally displayed as black and white. Numerically, the two values are often 0 for black, and either 1 or 255 for white. Binary images are often produced by thresholding a grayscale or color image, in order to separate an object in the image from the background. The color of the object usually white is referred to as the foreground color. The rest usually black is referred to as the background color. However, depending on the image which is to be thresholded, this polarity might be inverted, in which case the object is displayed with 0 and the background is with a non-zero value [33]. These images are mentioned as below names figure 4.2 and figure 4.3.

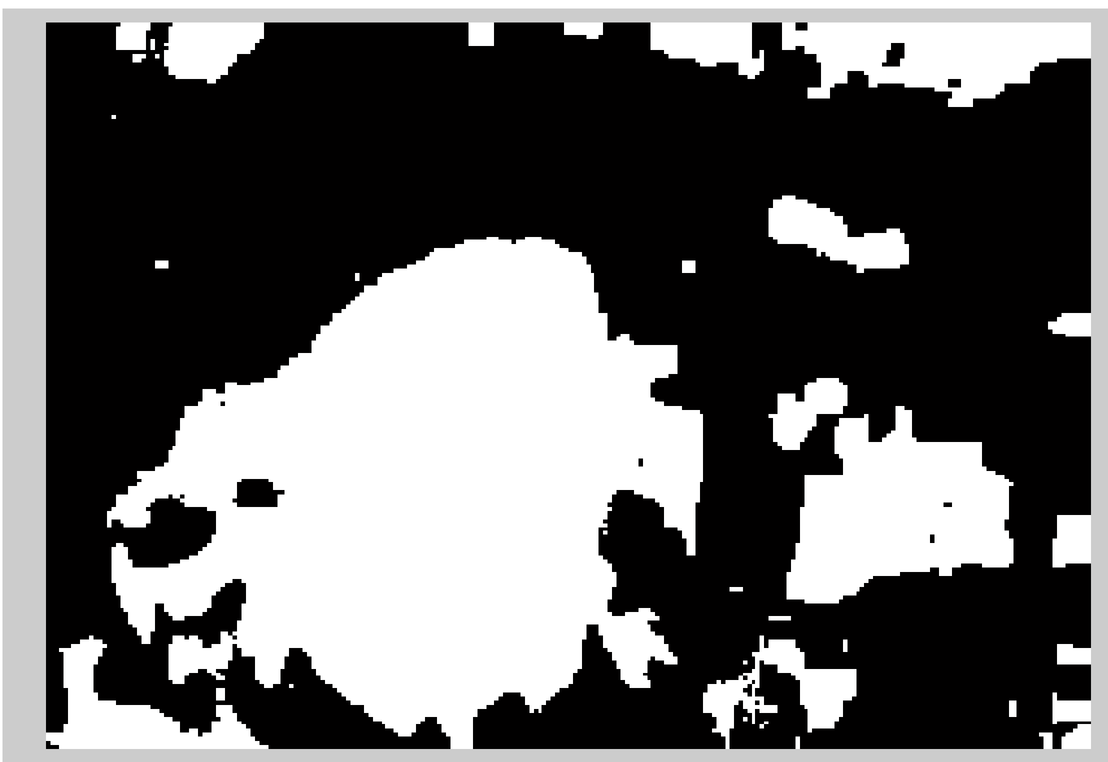


Fig. 4.3: Binary image

From figure 4.2, ycbcr image, substract cb component from cr component and apply histogram equalization function for the further process. And from figure 4.3, binary image, minimizing the background portion, resulting image is figure 4.4.

Fig. 4.4: Minimize background portion from binary image

Labeling method is used for the recognition of face region. This face region is put in rectangle box. In the labeling method, components are connected in 2-D binary image. This function will return a matrix of the same size as binary image. it contains labels for the connected objects in binary image. it can have a value of either 4 where 4 specifies 4-connected objects or 8 where 8 specifies 8-connected objects. If the argument is omitted, it defaults to 8. The elements of matrix are integer values greater than or equal to 0. The pixels labeled 0 are the background. The pixels labeled 1 make up one object, the pixels labeled 2 make up a second object and so forth. The resulted image is shown as figure 4.5.

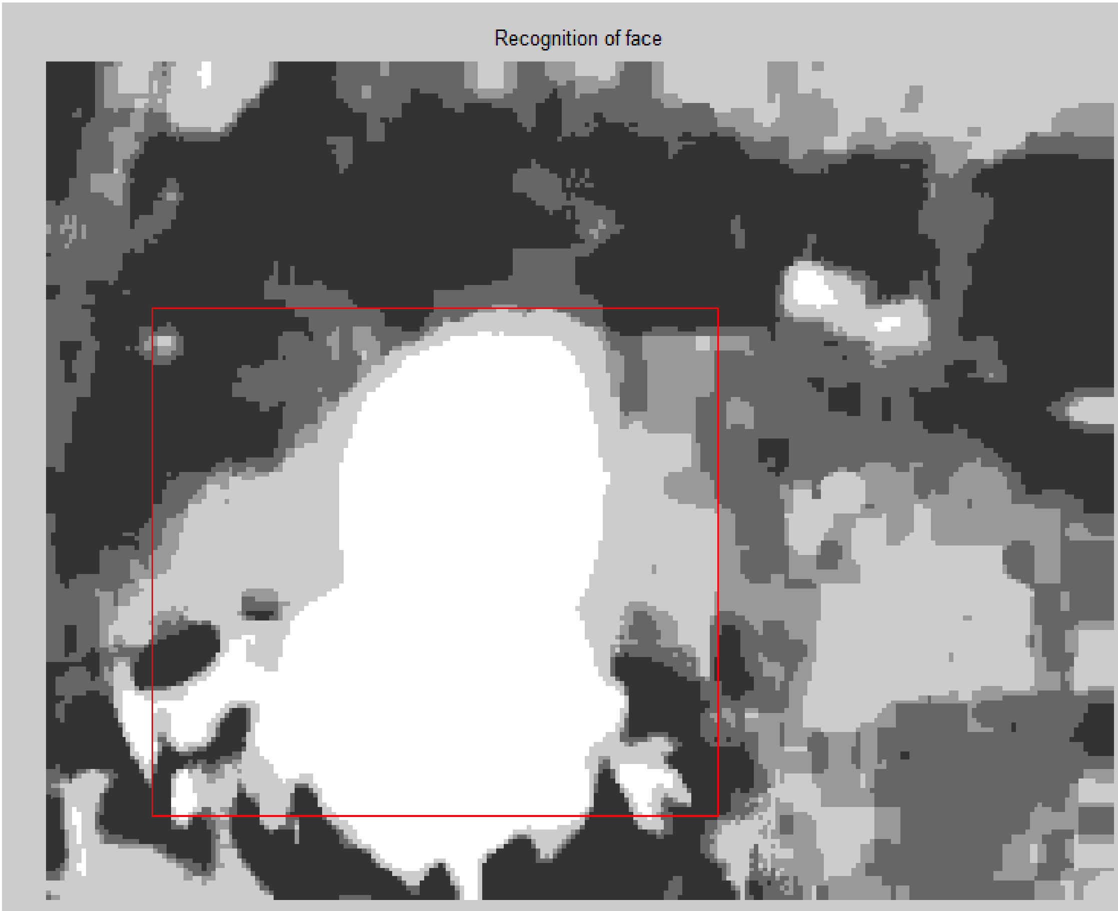


Fig. 4.5: Recognition of face region

This rectangle box is used for storing three different types of operated images for the face detection. There are like- cropped cb-cr image, gray image and cropped histogram equalized image. All these images are stored in rectangle as matrix form. Figure 4.6, figure 4.7 and figure 4.8 are shown the resulted images.

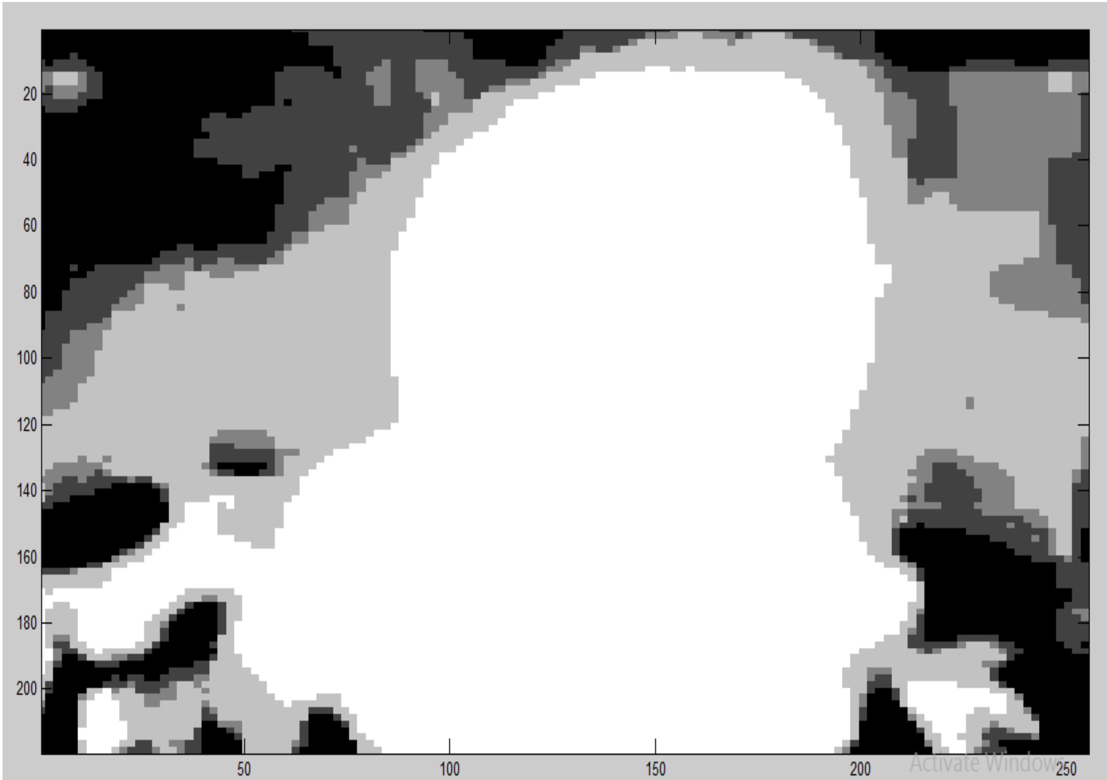


Fig. 4.6: Histogram equalization image

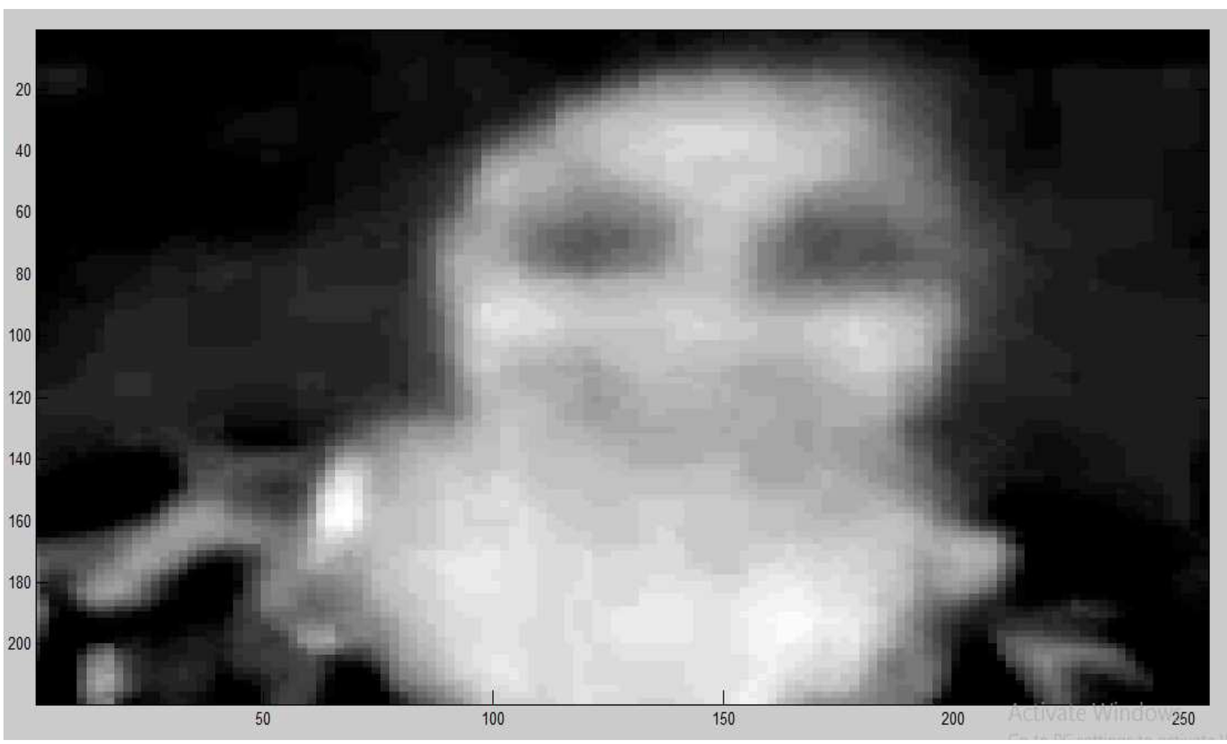


Fig. 4.7: Cropped cb-cr image from ycbcr image

Fig. 4.8: Gray image

Using thresholding function on cb-cr crop image by converting low intensity pixels of values that is 0 to 8 into white and rest all pixels are in gray scale which is figure 4.9 and figure 4.10 as below.

Fig. 4.9: Threshold image

Fig. 4.10: Cropped background from gray scale

For the eye detection, histogram equalization image and threshold image are used to locate the eye and other low intensity portion of face. Figure 4.11 shows resulted image.

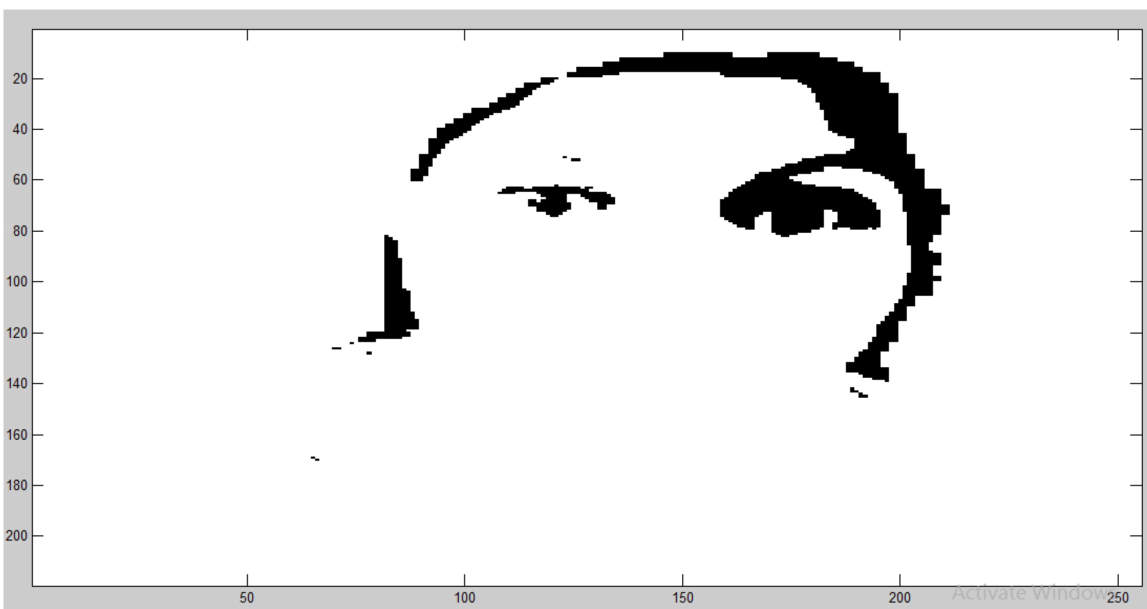


Fig. 4.11: Location of eye region

To darken the eye region some morphological operations like erosion and dilation are used. Morphology is a method of image processing based on shapes. The value of each pixel in the output i.e., binary image is based on a comparison of the equivalent pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, it can be constructed a morphological operation. This operation is sensitive to specific shapes in the input image. Erosion and dilation are the fundamental operations of morphological image processing. The erosion function erodes the grayscale, binary or packed binary image and returns eroded image. Erosion shrinks or thins objects in a binary image. When dilation is an operation that grows or thickens objects in an image. Both functions use a specific element which does both operations of erosion and dilation.

The figure 4.12 shows eroded and dilated image.

Fig. 4.12: Eroded and dilated image

The next step is smoothing. It is done by the filtering. Filtering means smoothing or reducing or discarding the noise. They are numbers of filters named as- average filter, laplacian filter, Gaussian filter, disk filter, log filter, motion filter, prewitt and sobel filter. These all filters are having different uses and criteria. Here, Gaussian filter is used. Gaussian filter is used for mainly smoothing. Gaussian filtering is used to blur images and remove noise and detail. The Gaussian function is used in frequent study areas those are- defining a probability distribution for noise or data, smoothing operator and using in mathematics. The smoothen image is figure 4.13 as below.

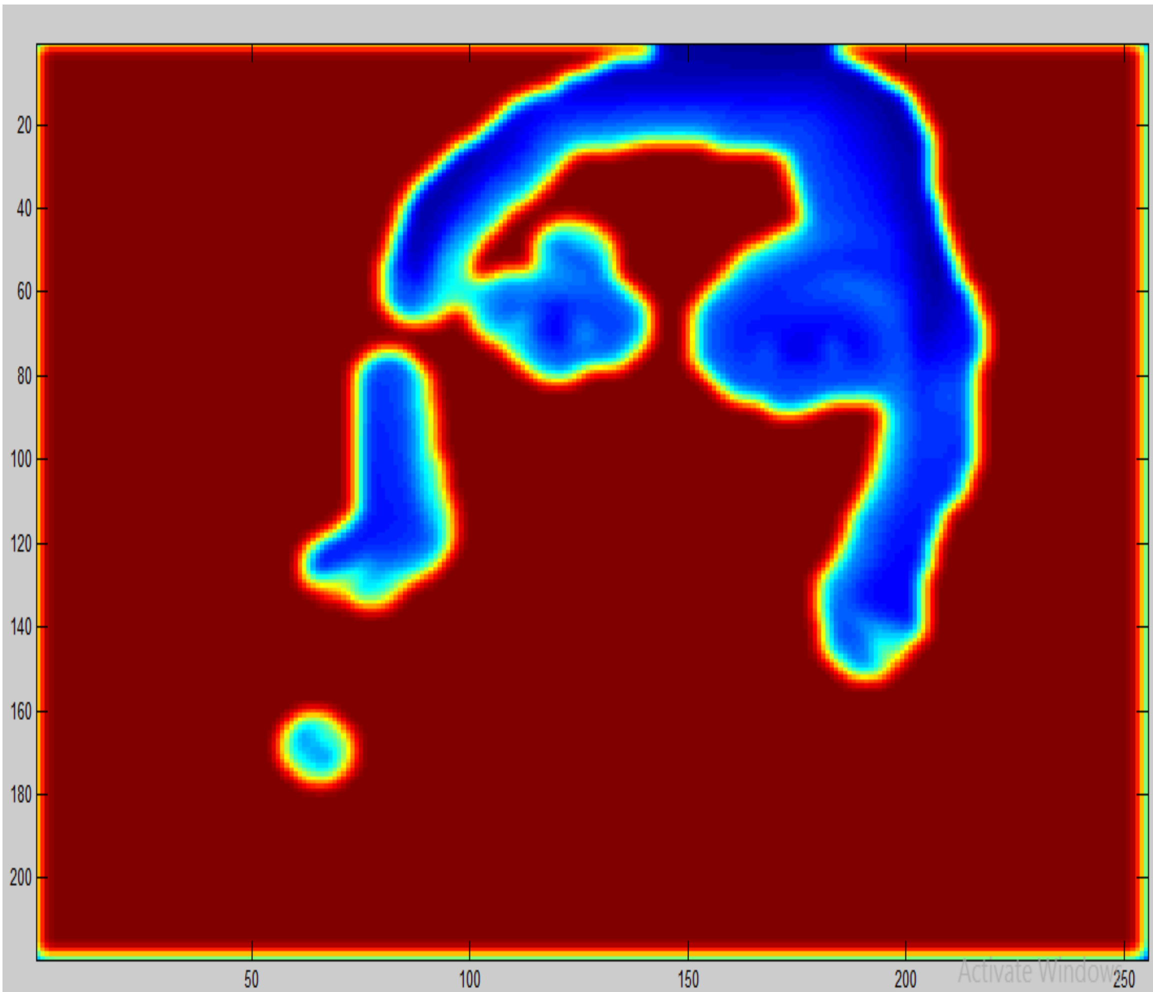


Fig. 4.13: Filtered Image

To find out the stage of eye whether it is close or open, it is necessary to locate exact location of eye. To trace the accurate spot of eye, apply the circular Hough transform function.

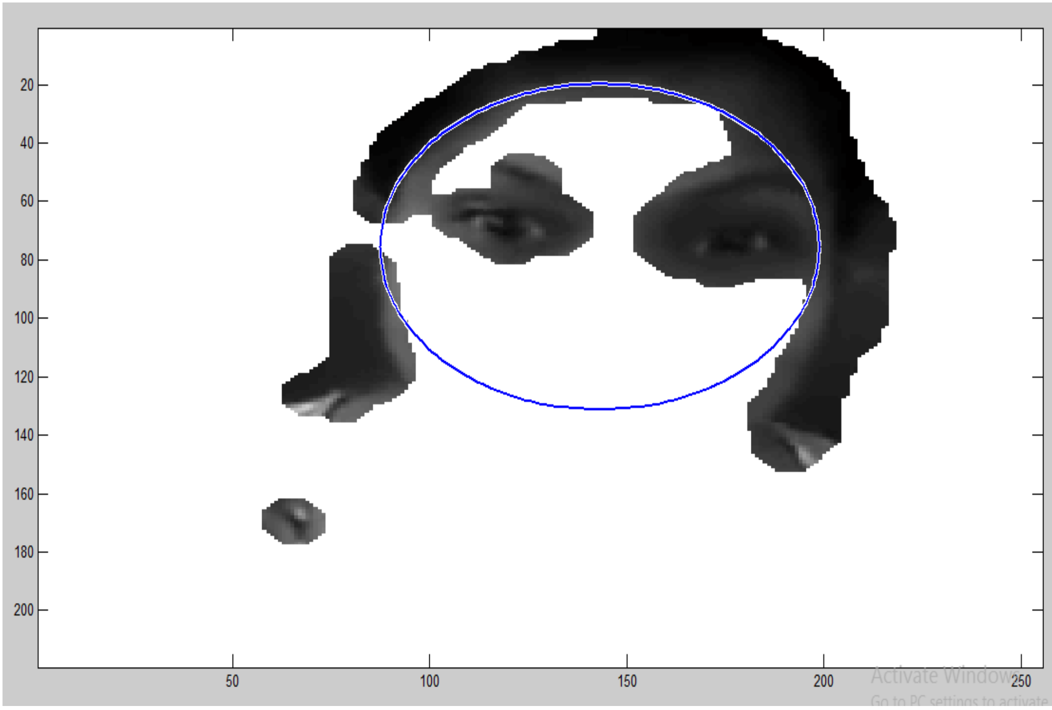


Fig. 4.14: Cropped eye region

At last, find the histogram of the circular region and count the bins for each pixel value. There is distribution of data on the x-axis. There is easily seen that the intensity level at some points are high and at some points the intensity level is low or almost zero. This graphical representation is of one frame among of all frames. Whenever the eyes are open, the intensity comes high otherwise low. And this intensity comes high in between two points. These two points will be repeated. The analysis of all the images of only eyes' region shows that the eyes will be open only in between these two points.

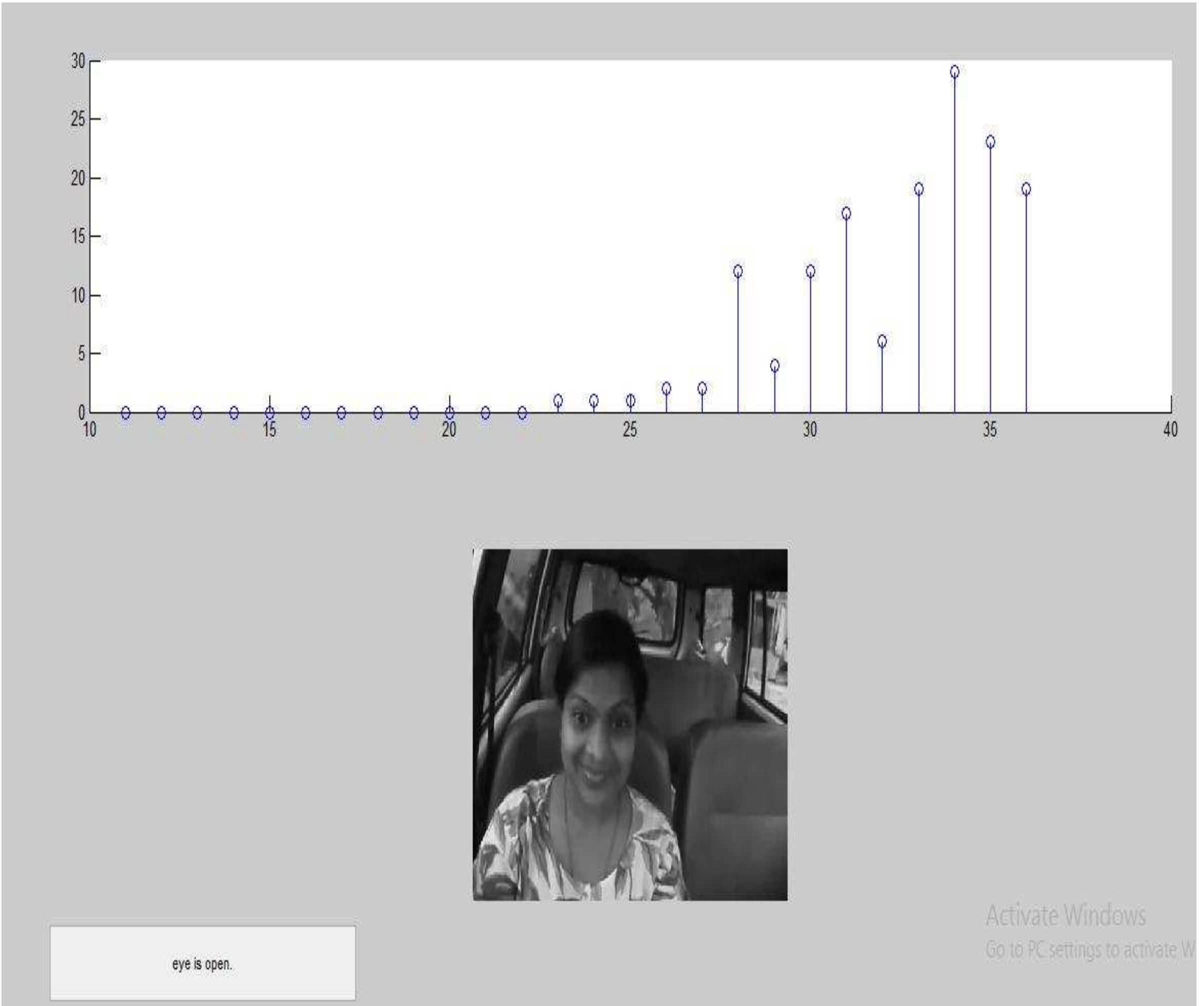


Fig. 4.15: Resulted image of drowsiness

Apply fuzzy logic using this pixels for setting parameters to detect whether eyes are open or closed. Fuzzy Logic is a problem-solving control system methodology. It lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster. Fl is different from conventional control methods. Last figure 4.15 shows final goal of problem solution.

CHAPTER 5
Conclusion And Future Scope

5.1 Conclusion

This is the study that uses a large set of spontaneous facial expressions for the detection of drowsiness. Previous approaches to drowsiness detection primarily make pre-assumptions about the relevant behavior, focusing on blink rate, eye closure, and yawning. Here there is implementation of learning methods to determine actual human behavior during drowsiness episodes. Spontaneous expressions have a different brain substrate than posed expressions. They also typically differ in morphology and dynamics. This study reveals that facial expressions are very reliable indicators of driver drowsiness and facial expressions can be used to do fine discrimination in the different levels of drowsiness and reliably predict the time to crash. In laboratory conditions computer vision expression recognition systems can be used to reliably detect drowsiness and predict crash with high reliability. Field studies are needed to evaluate the performance of these systems in actual driving environments. Spontaneous facial expressions under drowsiness are very different from posed expressions of drowsiness. A non-invasive system is able to localize the eyes and monitor fatigue was developed. Information about the face and eyes position is obtained through various self-developed image processing algorithms. During the monitoring, the system is able to decide if the eyes are opened or closed.

5.2 Future Work

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 looks 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. This can be corrected by having an adaptive light source. The adaptive light source would measure the amount of light being reflected back. If little light is being reflected, the intensity of the light is increased. Darker skinned individual need much more light, so that when the binary image is constructed, the face is white, and the background is black. In the real time driver fatigue detection system it is required to slow down a vehicle automatically when fatigue level crosses a certain limit. Instead of threshold drowsiness level it is suggested to design a continuous scale driver fatigue detection system. It monitors the level of drowsiness continuously and when this level exceeds a certain value a signal is generated which controls the hydraulic braking system of the vehicle. Sometime there is a problem with to achieve the optimum range between face and camera. When the distance between face and webcam is not at optimum range then certain problems are arising.When face is too close to webcam (less than 30 cm), then the system is unable to detect the face from the image. So it only shows the video as output as algorithm is designed so as to detect eyes from the face region. This can be resolved by detecting eyes directly using detect objects functions from the complete image instead of the face region. So eyes can be monitored even if faces are not detected. When face is away from the webcam (more than 70cm) then the backlight is insufficient to illuminate the face properly. So eyes are not detected with high accuracy which shows error in detection of drowsiness. This issue is not seriously taken into account as in real time scenario the distance between drivers face and webcam doesn't exceed 50cm. so the problem never arises. Considering the above difficulties, the optimum distance range for drowsiness detection is set to 40-70 cm. If more than one face is detected by the webcam, then system gives an erroneous result. So it is required to develop such system that will give result even though having multiple faces. The last but not the least future scope is developing a algorithm which can work with driver having spectacles. This issue has not yet been solved and is a challenge for almost all eye detection systems.

CHAPTER 6

Check For Originality

The dissertation report presented here has been checked for its originality using online plagiarism checker "Paper Rater", available at "http://www.paperrater.com/plagiarism_checker". Various theoretical concepts are explained as per the references from different technical books which I studied during my engineering graduation and post graduation studies. Thanks to all those who are already present in my references text.

REFERENCES

[1] The definition of drowsy is available at www.vocabulary.com/dictionary/drowsy

[2] The meaning of drowsiness is available at http://en.wikipedia.org/wiki/Somnolence

[3] The symptoms of drowsiness is available at http://www.healthline.com/symptom/drowsiness

[4] The driver fatigue problem is available at http://www.rospa.com/roadsafety/adviceandinformation/driving/driverfatigue/factsheet.aspx

[5] Antoine Picot, Sylvie Charbonnier, and Alice Caplier, "On-line Detection of Drowsiness Using Brain and Visual Information", IEEE Transactions on systems, man, and cybernetics-part A: systems and humans, vol.42, pp.764-775, May 2012

[6] Willem B. Verwey, David M. Zaidel, "Preventing drowsiness accidents by an alertness maintenance device", Elsevier, Accident Analysis and Prevention, vol.31, pp.199-211, 1999

[7] Willem B. Verwey, David M. Zaidel, "Predicting drowsiness accidents from personal attributes, eye blinks and ongoing driving behavious", Pergamon, personality and individual differences vol.28, pp.123-142, 2000

[8] Jian-Da Wu, Tuo Rung Chen, "Development of a drowsiness warning system based on the fuzzy logic images analysis", Elsevier, Expert System with Applications, vol.34, pp.1556-1561, 2008

[9] Tiesheng Wang, Pengfei Shi, "Yawning Detection for determining driver drowsiness", IEEEInt, Workshop VLSI Design & Video tech. Suzhou, China, May 28-30, 2005

[10] Hu Shuyan, ZhengGangtie, "Driver drowsiness detection with eyelid related parameters by support Vector Machine", Elsevier, Expert System with Applications vol.36, pp.7651-7658, 2009

[11] Antoine Picot, Sylvie Charbonnier, and Alice Caplier, "On-line Detection of Drowsiness Using Brain and Visual Information", IEEE Transactions on systems, man, and cybernetics-part A: systems and humans, vol.42, pp.764-775, May 2012

[12] Pia M.Forsman, Bryan J.Vila, “Efficient driver drowsiness detection at moderate levels of drowsiness”, Elsevier, Accident Analysis and Prevention vol.50, pp.341-350, 2013

[13] Itenderpal Singh, V.K. Banga, “DevelopmentOf A Drowsiness Warning Systerm Using Neural Networks”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol.2, pp.36143623, August 2013

[14] PoonehR.Tabrizi, Reza A.Zoroofi, “Open/Closed Eye Analysis for Drowsiness Detection”, IEEE, image Processing Theory, Tools & Applications, 2008

[15] MandalapuSaradadevi, Preeti R Bajaj,”Driver Fatigue Detection Based on Eye Tracking” , IEEE, First International Conference on Emerging Trends in Engineering and Technology, pp.649-652, 2008

[16] Hiroshi Ueno, Masayuki Kaneda, Masataka Tsukino, “Development of drowsiness detection system”, Vehicle navigation & information systems conference proceedings, pp.15-20, 1994

[17] Richard Grace, Vicky E. Byrne, Damian M. Bierman, Jean-Michel Legrand, David Gricourt, Robert K. Davis, James J. Staszewski, Brian Carnahan, “A drowsy driver detection system for heavy vehicles” IEEE, 1998

[18] Danghui Liu, Peng Sun, YanQing Xiao, Yunxia Yin, “Drowsiness Detection based on eyelid movement”, IEEE, second internation workshop on education technology and computer science, pp.49-52, 2010

[19] Jaeik Jo, Sung Joo Lee, Kang Ryoung Park, Ig-Jae Kim, Jaihie Kim, “Detecting driver drowsiness using feature-level fusion and upper-specific classification”, Elsevier, Expert system with application, vol.41, pp.1139-1152, 2014

[20] Esra Vural, Mujdat Cetin, Aytul Ercil, Gwen Littlewort, Marian Bartlett and Javier Movellan, “Drowsy driver detection through facial movement analysis”, Human-computer interaction lecture notes in computer science, vol.4796, pp,6-18, 2007

[21] Ivan G. Daza, Luis M. Bergasa, J. Javier Yebes, Javier Almazan and Roberto Rrroyo, “Fusion of optimized indicators from advanced driver assistance systems for driver drowsiness detection”, Sensors, vol.14, no.1, pp.1106-1131, 2014

[22] Hyungseob Han, Uipil Chong, “Detection of drowsiness with eyes-open using EEG”, ISSN, vol.9, no.1, pp.2326-3636, 2014

[23] K. Dwivedi, K. Biswaranjan, A. Sethi, “Drowsy driver detection using representation learning”, IEEE, International Advance Computing Conference, pp.995-999, Feb-2014

[24] Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins, “digital Image Processing Using MATLAB” second edition, 2010

[25] The short introduction of MATLAB is available at “http://www.math.mtu.edu/~msgocken/intro/node2.html#SECTION00020000000000000000”

[26] About Video reader function is available at “http://www.mathworks.in/help/matlab/import_export/read-video-files.html”

[27] How to read frame is available on the website of “http://www.mathworks.in/help/matlab/ref/videoreader.read.html”

[28] The brief introduction about ycbcr and how ycbcr is used are available on the website of “http://makarandtapaswi.wordpress.com/2009/07/20/why-the-rgb-to-ycbcr/”

[29] The basic introduction on rgb is available on the website of “http://en.wikipedia.org/wiki/Channel_(digital_image)”

[30] The basic information and properties of ycbcr image is available on the site of “http://stackoverflow.com/questions/17369660/what-do-blue-difference-and-red-difference-chroma-components-mean-in-ycbcr-color”

[31] The summary about binary images is available on the website of “http://homepages.inf.ed.ac.uk/rbf/HIPR2/binimage.htm”

[32] The introduction about binary image and details with graph is available on the website of “http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/OWENS/LECT2/node3.html”

[33] Short notes of binary image is on “http://en.wikipedia.org/wiki/Binary_image”

[34] The introduction of labeling method and uses are available on the website of "http://nf.nci.org.au/facilities/software/Matlab/toolbox/images/bwlabel.html"

[35] The introduction of region properties and uses of region properties are available on site of "http://nf.nci.org.au/facilities/software/Matlab/toolbox/images/regionprops.html"

[36] About Thresholding is available on "http://homepages.inf.ed.ac.uk/rbf/HIPR2/threshld.htm"

[37] About morphological operations are and their functions are on the website of "http://www-rohan.sdsu.edu/doc/matlab/toolbox/images/morph.html"

[38] The brief introduction of morphological operations like erosion and dilation are available on "http://www-rohan.sdsu.edu/doc/matlab/toolbox/images/morph3.html#12508"

[39] About erosion is on "http://www-rohan.sdsu.edu/doc/matlab/toolbox/images/imerode.html"

[40] About dilation is on "http://www-rohan.sdsu.edu/doc/matlab/toolbox/images/imdilate.html"

[41] The introduction of Gaussian smoothing function is available on the website of "http://homepages.inf.ed.ac.uk/rbf/HIPR2/gsmooth.htm"

[42] The information of the Gaussian filtering with details and appropriate diagram is on "https://www.cs.auckland.ac.nz/courses/compsci373s1c/PatricesLectures/Gaussian%20Filtering_1up.pdf"

[43] The introduction about the fspecial command with information of its using is available on "http://dali.feld.cvut.cz/ucebna/matlab/toolbox/images/fspecial.html"

[44] The Introduction of Hough Transform is on http://www.mathworks.in/help/images/ref/hough.html

[45] The tutorial of histogram function with proper diagrams and details are available on the "http://isites.harvard.edu/fs/docs/icb.topic1032465.files/Matlab%20Tutorials/Matlab%20tutorial%202%20Histograms.pdf"

[46] The fundamental introduction about fuzzy logic is available on the website at "http://www.seattlerobotics.org/encoder/mar98/fuz/fl_part1.html#INTRODUCTION"