Development of Driver Aiding System Using Image Processing

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Abstract

The development of technologies for preventing drowsiness behind the wheel is a major challenge in the field of accident averting systems. Preventing drowsiness during driving requires a method for precisely detecting a decline in driver alertness and a method for alerting and stimulating the driver. As a detection method, a prototype has been designed that uses image processing technology to analyze images of the driver's face taken with a video camera. Diminished alertness is detected on the basis of the degree to which the driver's eyes are open or closed. This detection system provides a technique for judging driver alertness and facilitates early detection of a decline in alertness during driving.

CERTIFICATE FOR CORRECTNESS AND APPROVAL

It is certified that the work contained in the thesis – Development of Driver Aiding System Using Image Processing carried out by GC Asif Raza, GC Babar Ali Pasha, GC Muhammad Naeem and FC Muhammad Younis Sefaw under the supervision of Assistant Professor Dr. Mir Yasir Umair for partial fulfillment of Degree of Bachelor of Electrical Engineering is correct and approved.

Approved by

Asst. Prof Dr. Mir Yasir Umair

EE DEPARTMENT
MCS

DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

In the name of Allah, the Most Merciful, the Most Beneficent.
To our parents, without whose unflinching support and unstinting cooperation, a work of this magnitude would not have been possible.

ACKNOWLEDGMENT

First of all thanks to almighty for giving us the capabilities and the resources to carry out this project in the best manner possible. We would like to thank all our instructors who gave us there support and generous advice for this project. We would also like to extend gratitude to our project supervisor Dr. Mir Yasir Umair for giving us his invaluable advice whenever and wherever needed. A gesture of thanks to our course mates (TE-49 B) as well for their motivation throughout the project.

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Chapter 1 : Introduction

Safety is a major part of man’s life. High accident cases occur daily on the major roads in all parts of the developed and developing countries, thus more awareness is needed for research in the designing an efficient Driving Aiding System. It is estimated that if such a gadget is planned and integrated into our cars as a road safety device, it will diminish the incidents of accidents on our roads and various places, with consequent decline in loss of life and property.

In order to keep the driver alert and attentive Driver Aiding System will be developed to minimize risk on road to other commuters and driver himself/herself. Driver Aiding System would monitor the eyes of the driver by continuously capturing the frames of the video taken by camera using digital image processing technique. System would prevent the imminent accident by giving the visual and audible warnings to the drowsy driver through the LCD and the audible buzzer and flash light. Driver Aiding System would apply the brakes if the driver could not wake up even after the audible and visible warnings.

1.1 Problem Statement

Sleepiness and driving is a dangerous permutation. Most people are conscious of the dangers of ingestion and driving. The people don’t realize that snoozing driving can be just as lethal, for example:

Sr.	Repercussions of Sleepiness
1.	Slows Reaction Time
2.	Decrease Awareness
3.	Impairs Judgment
4.	Increase Risk of Crashing

Table 1: Repercussions of Sleepy Driving Behavior

There are many essential causes of sleepiness for example exhaustion and drowsy driving. It includes the sleep loss from the limitation interruption or patchy sleep; persistent sleep deficiency; circadian factors associated with driving patterns or work schedules.

Studies propose that about 20% of all road accidents are fatigue-related [1].Tiredness behind the wheel is the major input to fatal accidents. Sleep or tiredness was a causal factor in 27.4% of all accidents in 2010 in Pakistan [2].According to the 2007 version of the Small report on the road accidents due to sleep or lethargy statistics in Pakistan suggest that a total of 6,035 people were killed in 2000 and the fatality spring up to 6,287 in 2006 from accident cases reported in 250,429 and 341,252 cases of accident for 2000 and 2006 respectively [2].

[1] http://www.dawn.com/news/1158648
[2] http://www.dawn.com/news/1143784

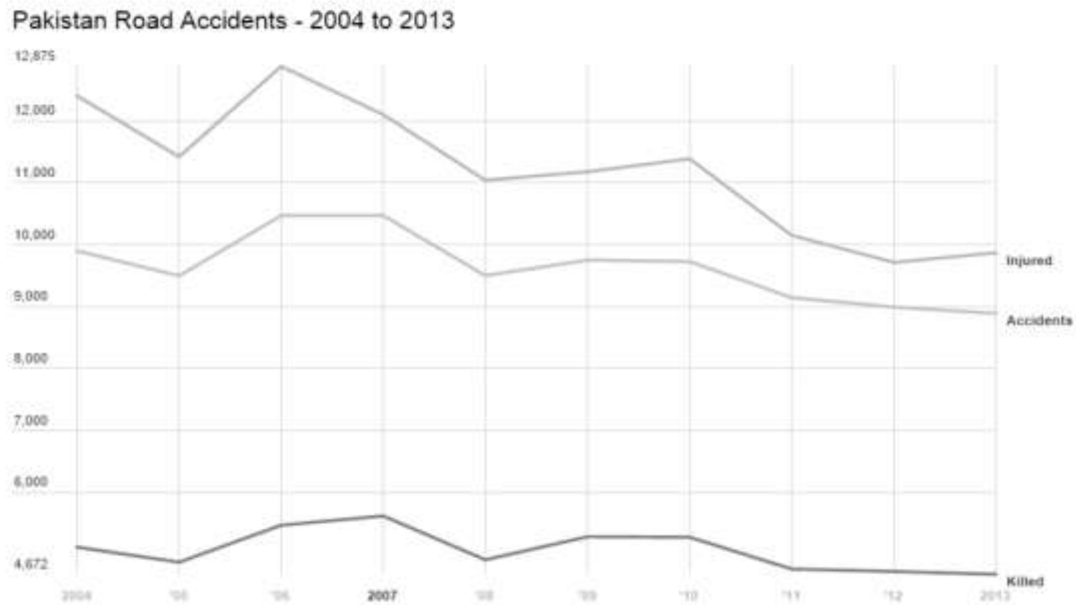

Figure 1: Pakistan Road Accidents deaths[3]

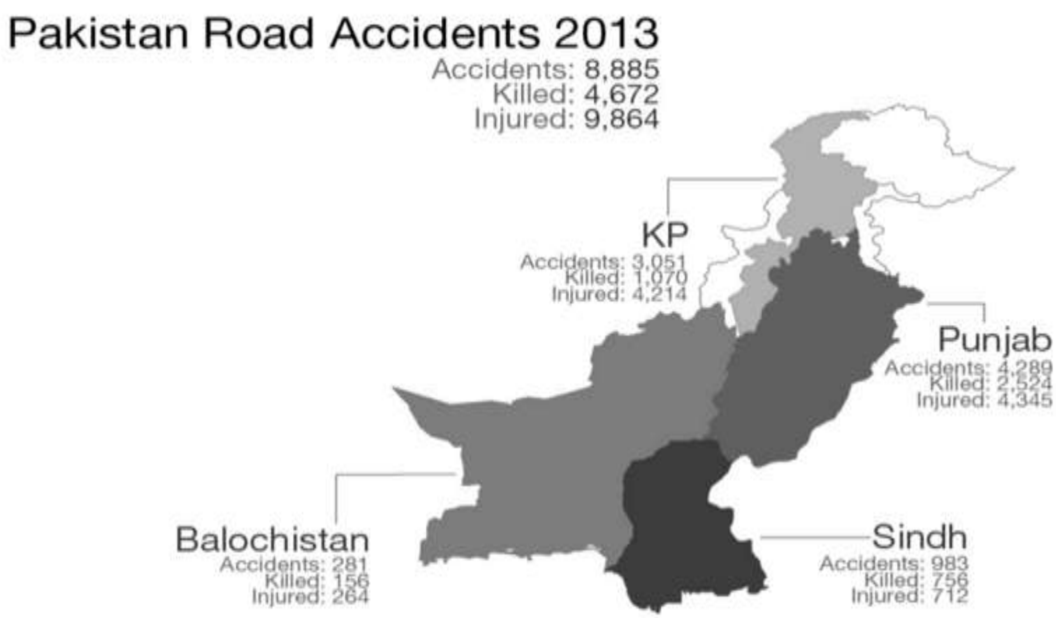

Figure 2: Road Accidents all over Pakistan[4]

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[3] Statistics from Pakistan Bureau of Statistics (www.pbs.gov.pk/) .
[4] Figure1 and Figure 2 courtesy of Dawn News (http://www.dawn.com/news/1143784)

1.2 Background

Maturity of technologies to incessantly monitor the state of the driver is critical in order to provide suitable services for assorted driving situations. For the past decades a variety of driver state monitoring techniques have been proposed from many studies. Driver alertness state monitoring systems would generally work based on driving patterns and driver's physiological signals. Driver's driving patterns are handy to acquire, but to assess driver state accurately is a challenging task because these methods assess the driver state indirectly. On the other hand, analysis based on driver's physiological signals has long been carried out to monitor the state of the driver directly, but the sensors were not preferred due to the sensor's low usability in vehicle atmosphere. It was noted that drowsy drivers typically did not "drop off" immediately. Instead, there was a foregoing period of measurable performance decrement with connected psycho physiological signs. Drowsiness can be detected with realistic precision using driving performance measures such as "drift-and-jerk" steering and fluctuations in vehicle tangential lane position. Many efforts have been reported in the literature for developing an active safety system for reducing the number of automobiles accidents due to reduced alertness. Drowsiness Signs in drivers can be generally divided into the following categories:

Sr .	**Human Characteristics**	**Vehicular Characteristics**
1.	Sensing of physiological characteristics	Sensing of driver operation
2.	Monitoring the response of driver	Sensing of vehicle response

Table 2: Methods to determine Sleepy Driver

Among these methods, the techniques based on human physiological phenomena are the most accurate. This technique is implemented in two ways:

1. Measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking.

2. And measuring substantial changes such as floppy posture, leaning of the driver’s head and the open/closed states of the eyes.

While the first technique, though most accurate, is not practical, since sensing electrodes would have to be attached directly on to the driver’s body, and therefore be irritating and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, reducing their ability to observe accurately. The second technique is well suited for real world driving conditions since it can be non-intrusive by using video cameras to detect changes.

1.3 Scope of Work

The proposed project aims at developing a standalone Driver Aiding System to minimize the loss of property and life thus resulting in improved road safety standards. It prompts for consistent monitoring of the state of visual alertness of driver by monitoring the eyes of the driver.

1.4 Proposed Solution

Fatal road accidents caused due to the driver's drowsiness are proposed to decrease by equipping the vehicles with the Driver Aiding System and thereby avoiding the loss to drivers and their vehicles. Initially drowsiness was detected using an IR sensor; however false alarms and lesser efficiency resulted in to the detection of drowsiness by image processing.

1. Driver Aiding System is proposed which would monitor the eyes of the driver by continuously capturing the frames of the video taken by camera using digital image processing technique.

2. Driver Aiding System would prevent the imminent accident by giving the visual and audible warnings to the drowsy driver through the LCD and the audible buzzer.

3. Driver Aiding System would apply the brakes if the driver could not wake up even after the audible and visible warnings.[5]

[5]Brakes was not applied in real car however a brake model was prepared which showed the working of an actual car

1.5 Project Specifications

Development of a user friendly and cost effective prototype by blending digital image processing and control system fields to enhance road safety. It can be deployed in an actual vehicular system to keep the driver alert.

The prototype will work as follow:

1. A Camera will continuously capture video of the driver
2. It will then send the captured frames to the Beagle bone for processing
3. The Beagle bone will process the received data by applying image processing technique
4. The code in python language is burn on the board
5. Beagle bone will automate the warnings if the driver goes to sleep
6. A python language program responsible for monitoring feedback from sensors and issuing triggering control mechanisms
7. A system comprising of a camera and control mechanism
8. A drive system attached to Beagle bone black will mechanically handle the brake system

1.6 Project Deliverables

The Driver Aiding System prototype will be implemented on Beagle Bone Black Rev C

1. An intrusive system[6] designed solely for safety of both driver's life and vehicle
2. Making the driver attentive as he feels drowsiness by generating warnings i.e. producing sounds through buzzer
3. Besides audible warning array of LED and LCD will also be part of warning system
4. Appling brakes to the car after warnings being generated will avoid accident leading to a big mishap
5. The designed is made as user friendly as possible

[6] An intrusive system is a system which intrudes the body of the driver i.e. the system will be mounted on driver.

Chapter 2 : Literature Review

A background study was carried out for the Infrared Sensor[7] and Image Processing techniques[8] used to measure the state of alertness of driver.

2.1 Infrared Sensor

IR (infrared) sensor[9] is the principal sensor of our design. IR sensor comprises of a transmitting and receiving led. An infrared sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is similar to human's creative senses, which can be used to detect obstacles and it is one of the common applications in real time. Infrared radiation is the portion of electromagnetic spectrum having wavelengths longer than visible light wavelengths, but smaller than microwaves, i.e. the region roughly from 0.75µm to 1000 µm is the infrared region. Infrared waves are invisible to human eyes. The wavelength region of 0.75µm to 3 µm is called near infrared, the region from 3 µm to 6 µm is called mid infrared and the region higher than 6 µm is called far infrared.

[7] Refer to Bibliography for reference papers
[8] Refer to Bibliography for reference papers
[9] http://www.sensorsinc.com/technology/why-swir

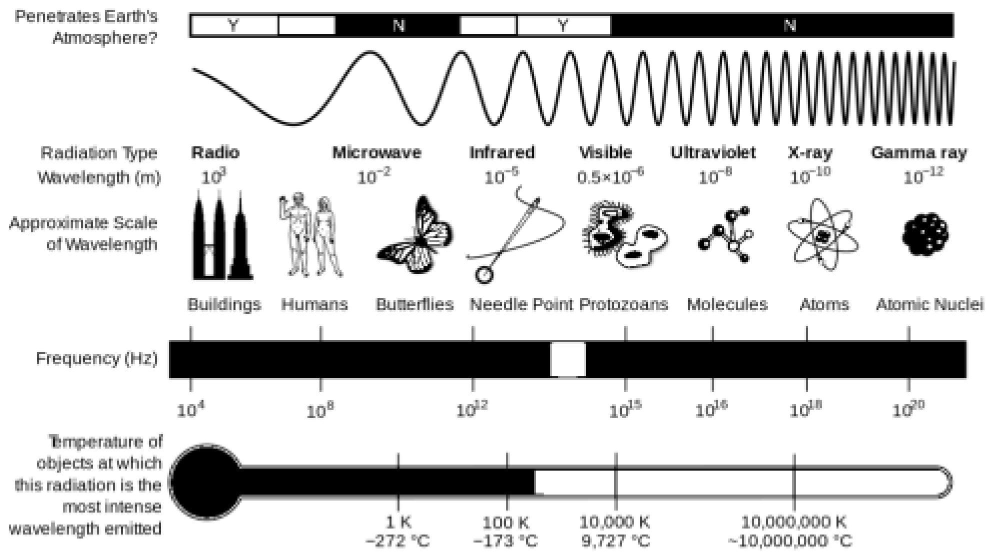

Figure 3: Infrared Spectrum

The object detection using infrared sensor is show in diagram below

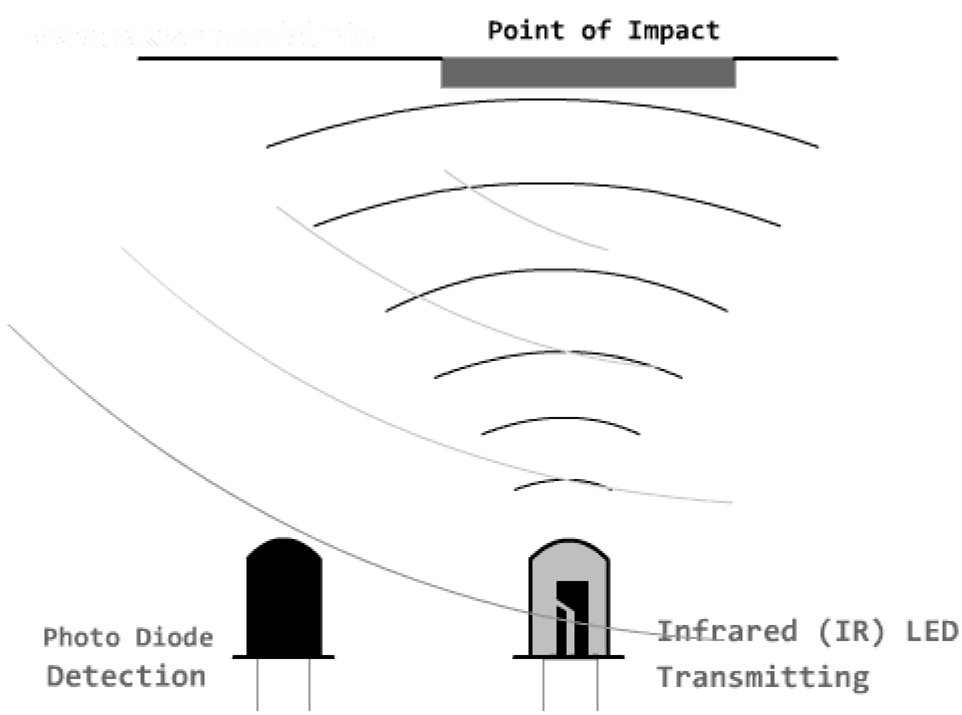

Figure 4: Object Detection using IR sensor

Using this principle of object detection state of alertness in the driver can be determined. The step by step process of the image detection can be shown as

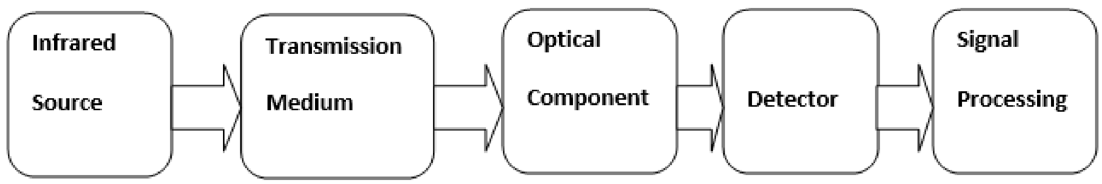

Figure 5: IR sensor working

2.2 Digital Image Processing

In imaging world, digital image processing is dispensation of images using mathematical operations by using any form of signal processing for which the input should be an image, a series of images, or a video, such as a photograph or video frame; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing methods involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Images can also processed as three-dimensional signals where the third-dimension being time or the z-axis.

Image processing usually refers to digital image processing, but ocular and analog image processing also are possible. In modern sciences and technologies, images also gain much broader scopes due to the ever growing importance of logical revelation (of often large-scale complex scientific/experimental data). Examples include microarray data in genetic research, or real-time multi-asset assortment trading in economics.

2.2.1 Face Detection In image Processing

Face detection in digital Images and video sequences has become an essential part of the recognition. For the face to be recognized, detection is must when multiple faces are present in an image. However the correct suited face detection is still in demand since false detection leads to wrong face detection and wastage of computational power as well as time. Most of the face detection techniques used the Viola Jones Algorithm based on Haar Cascade Classifiers. Open CV is the Open Source Computer visualization Library provided by Intel. It has numerous implemented and optimized algorithms of Image Processing usage. Among all, one of the most popular algorithms is Viola Jones algorithm which is capable of Detecting Face and numerous objects. The project proposes detection of tilted faces by Viola Jones. The Viola Jones Algorithm is not able to detect the tilted faces. Thus, for tilted faces, the eyes are used for detecting the faces.

2.2.2 Viola Jones Algorithm for face detection

Viola Jones Algorithm[10], Viola Jones Object Detection agenda Proposed by Paul Viola and Michael Jones was one of the premature methods to offer object detection at very fast rates. It is the method for swift and correct object detection through Adaboost machine learning. The major features of Viola Jones Algorithm are:

1. Integral Image Demonstration: Rapid Detection of Objects requires calculation of haar features and in order to compute them, integral image is required. Integral

[10] http://www.cs.ubc.ca/~lowe/425/slides/13-ViolaJones.pdf

hj

image is obtained using few operations per pixel. After this computation, Haar features of any type can be computed in stable time.

2. The Adaboost Learning algorithm creates efficient classifiers from set extracting important visual features. For fast categorization, learning must eliminate a majority of irrelevant features available in the image. This algorithm extracts critical features while dumping all other unimportant features.

3. Cascade Classifier focuses on object like parts and rejects the background. Cascade is a type of mechanism that knows its region of interest and discarded region are not likely to contain any object. This is very fast in real time detection.

Chapter 3 : Design and Development

Design and development of two approaches was carried out i.e. the IR sensor based model and Image Processing based model.

3.1 Infrared Sensor Model

3.1.1 Development

In this model, the transmitter segment includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this inconsistency cannot be analyzed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that the non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow. When the IR receiver module receives signal to the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100), R2 (10k) and R3 (330) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k) is used to adjust the output terminals. Resistor VR1 (preset=10k) is used to set the sensitivity of the circuit diagram. The schematic for this arrangement is given as

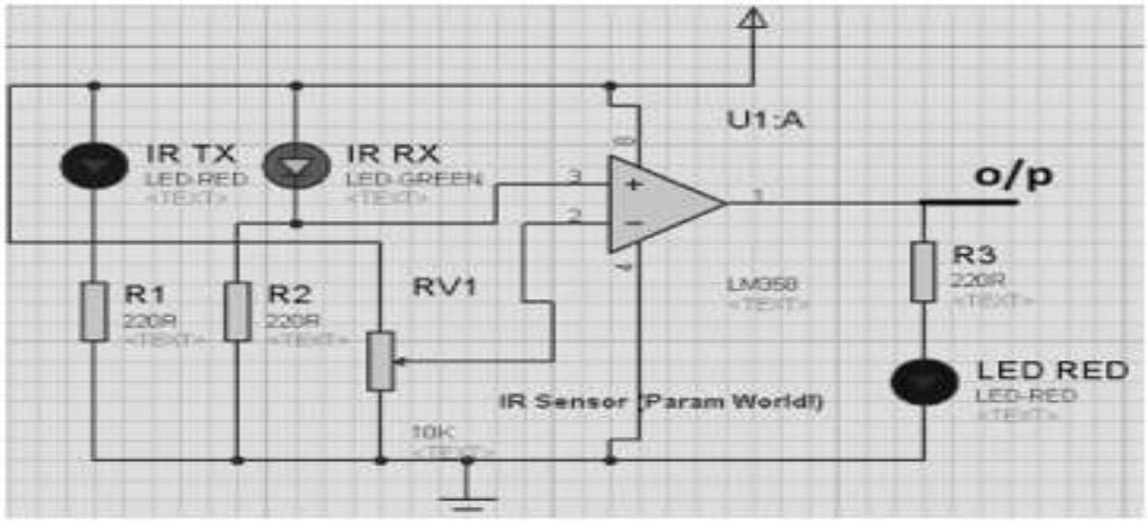

Figure 6: Schematic of IR Sensor Module

Simulated in Proteus Simulation Software

This circuit comprises of the following components:

1. LM358 IC2 IR transmitter and receiver pair
2. Resistors of the range of kilo ohms.
3. Variable resistors.
4. LEDs (Light Emitting Diode)

Arduino is an open source computer hardware and software embark. The board is based on a family of microcontroller board designs. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the processing project, which includes support for C, C++ and Java programming languages.

Arduino Mega 2560 is like a microcontroller board based on the ATmega2560 . It contains 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Thus it contains everything needed to support the microcontroller; simply can be connected to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. Arduino Mega2560 can be made to reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega2560 via a 100 nanofarad capacitor. When this line is asserted the retune line drops long enough to reset the chip. The Arduino software uses this potential to allow us to upload code by simply pressing the upload button in the Arduino environment.

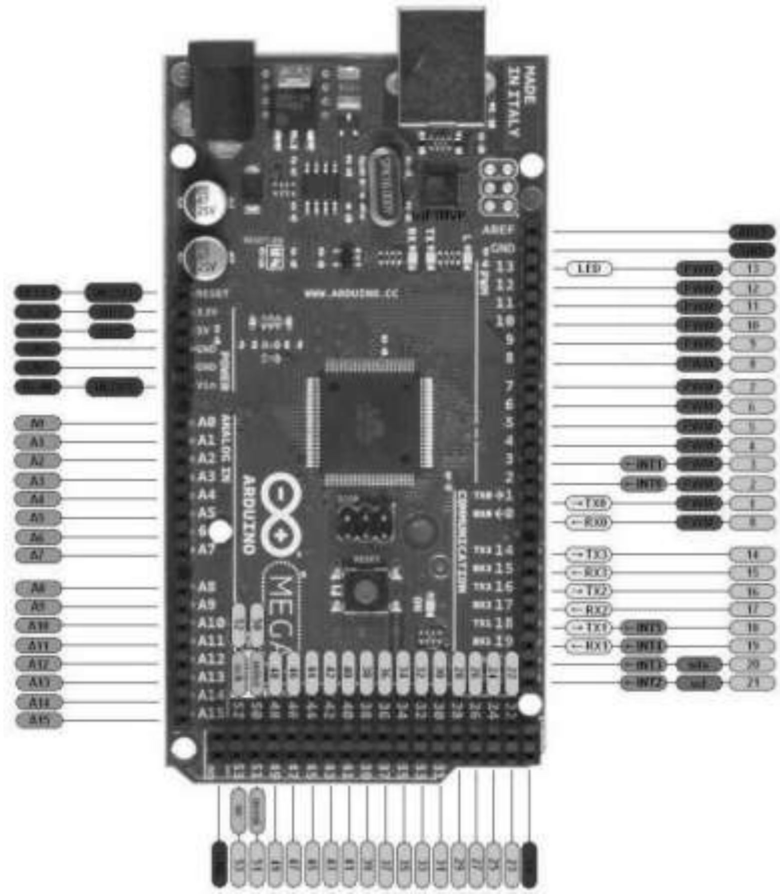

Figure 7: Pin Configuration of Arduino Mega

3.1.2 Advantages and Disadvantages of IR based System

The advantages and disadvantages of IR system are given in tabular form .

Sr.	**Disadvantages**
1.	In collision avoidance system driver is not warned, directly brakes are applied.
2.	Possibility of wrongly interpreted signals in case of GPS due to delay factor and high inaccuracy.
3.	In collision alleviation system action is not taken instantly.

Table 3: Disadvantages of IR based prototype

Sr.	**Advantages**
1.	Two layers of security i.e. warning and applying brake (last resort).
2.	Warning layer includes three warning checks further.
3.	Data communication between sensors and Arduino mega will be via Bluetooth.
4.	Simple and user friendly drive aiding system.
5.	Cost effective

Table 4: Advantages of Image Processing based Prototype

3.1.3 Hardware Design

Driver Aiding System is going to employ IR sensor as its primary source of input. The IR sensor will be continuously sensing the eye motion of the driver. The IR sensors will be connected to Arduino. The Arduino will be continuously receiving feedback from IR sensors. As the driver falls asleep sensor will no longer sense motion of eyes which will result in no feedback to Arduino. The Arduino will be connected to a drive circuit. Arduino will then trigger the audible and visible warnings in the form of string of LED's, LCD and buzzer to give wakeup call to driver. This drive circuit will finally apply the brakes in pulses which in turn will slow down or stop the vehicle. The model has been divided into two modules which are discussed in depth in coming paragraphs.

3.1.3.1 MODULE 1

The first module will comprise of an IR sensor at the driver end. IR sensor contains two main components i.e. transmitter and receiver. Here operational amplifier is used as comparator to compare the voltages of transmitter and receiver end of IR sensor. In case of high voltage at receiver the IR sensor gives feedback to the Arduino, which in turn triggers the audible and visible warnings through the drive circuits. Special glasses have been designed in which IR sensor will be mounted in a manner which will be driver friendly .This IR sensor will sense the motion of eyelid of driver. As long as the eyelid is open and driver is in normal condition it will send message to Arduino but once the driver sleeps its feedback response will change.

3.1.3.2 MODULE 2

In the module 2 a mechanism followed by the sensor and Arduino will be used which will actually apply brake bringing the vehicle to halt. Since applying sudden brake can be dangerous so brake will be applied in pulses. The basic and important component of second module is the drive system which acts as an interface between mechanical system of the car and module 1. Since Arduino can’t stop a mechanically moving system so the drive system will be controlling the motion of tires by applying brakes.

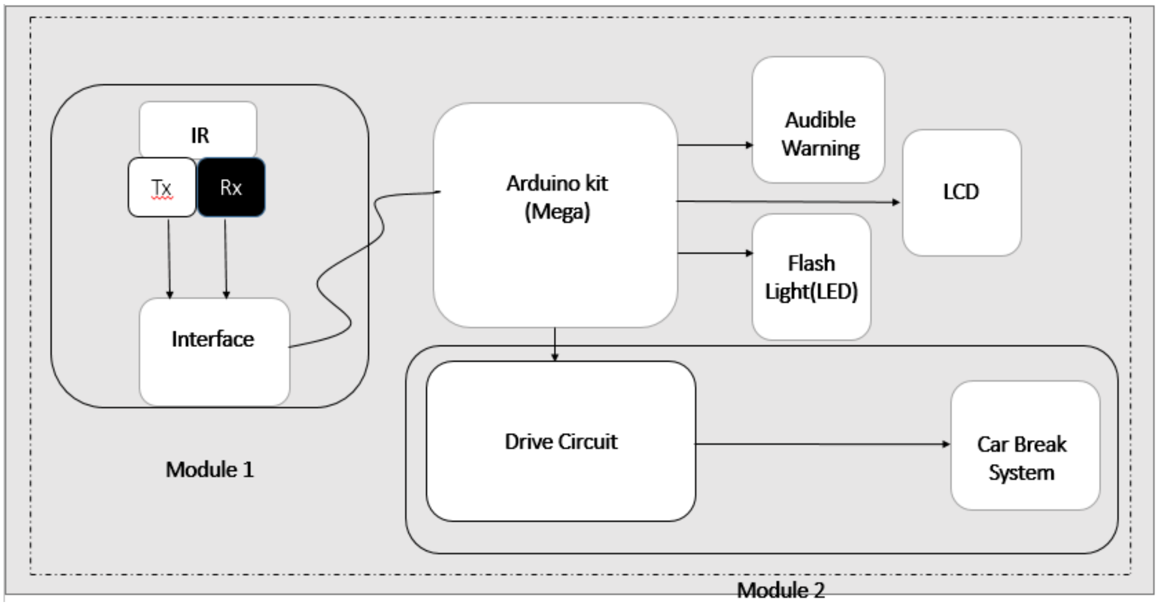

Figure 8: Schematic of IR based system

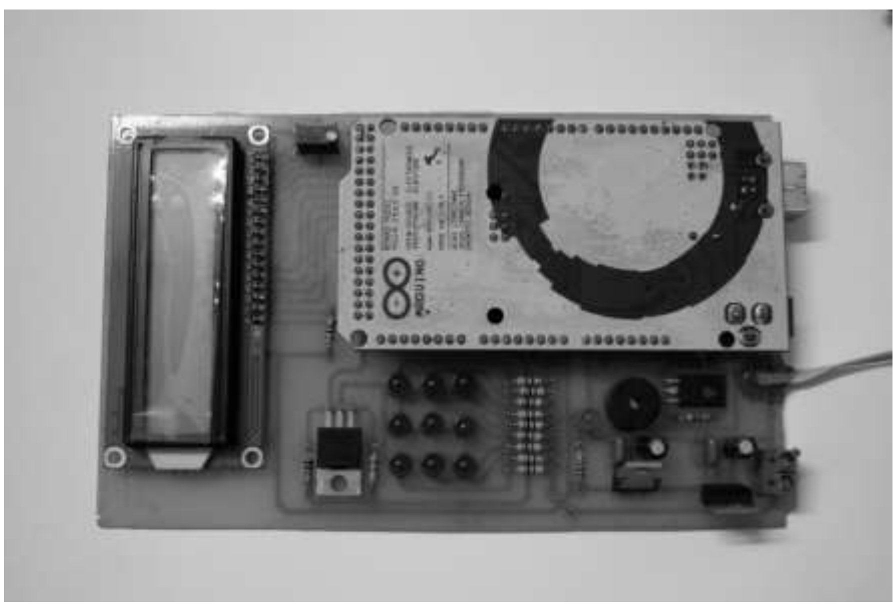

Figure 9: IR sensor based Prototype

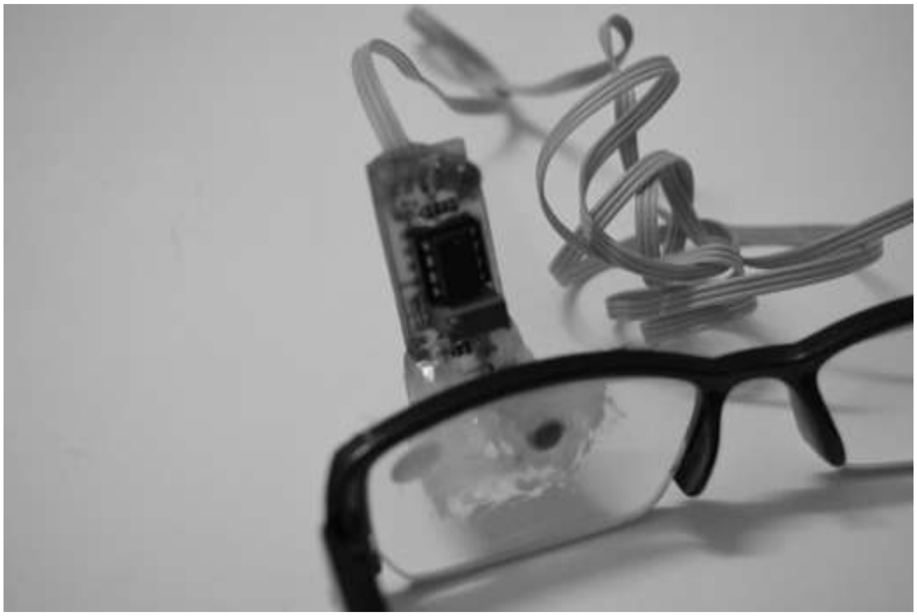

Figure 10: IR sensor mounted on spectacles

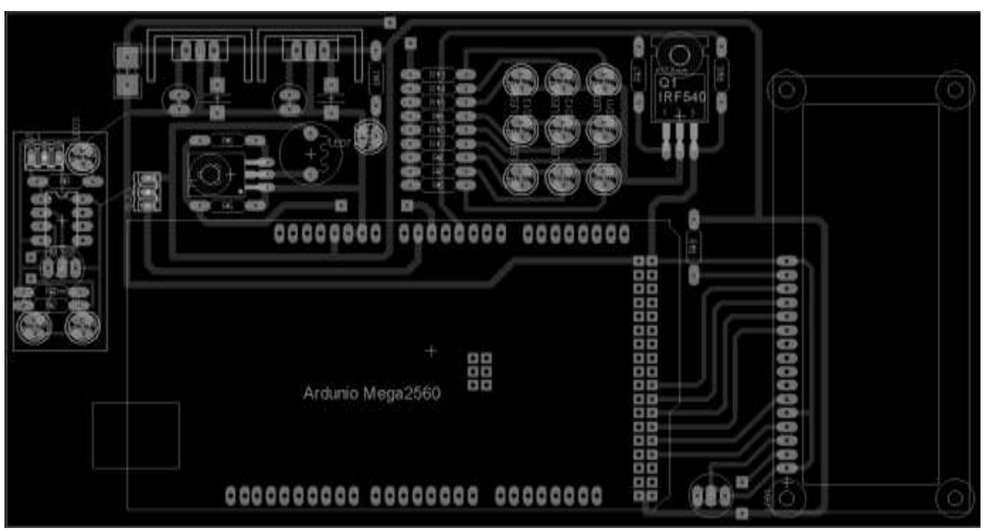

Figure 11: PCB layout simulated in EAGLE Software

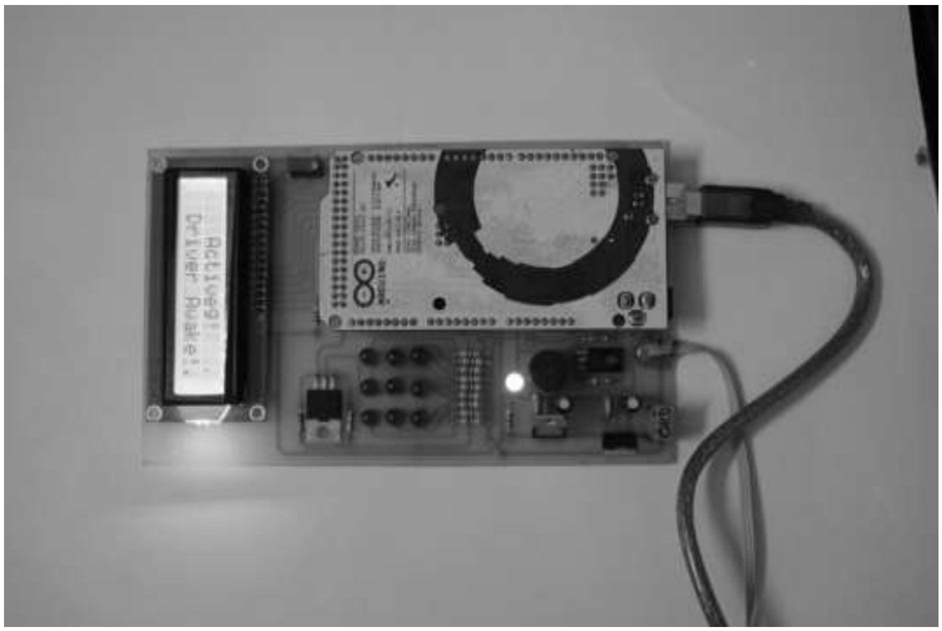

Figure 12: Working

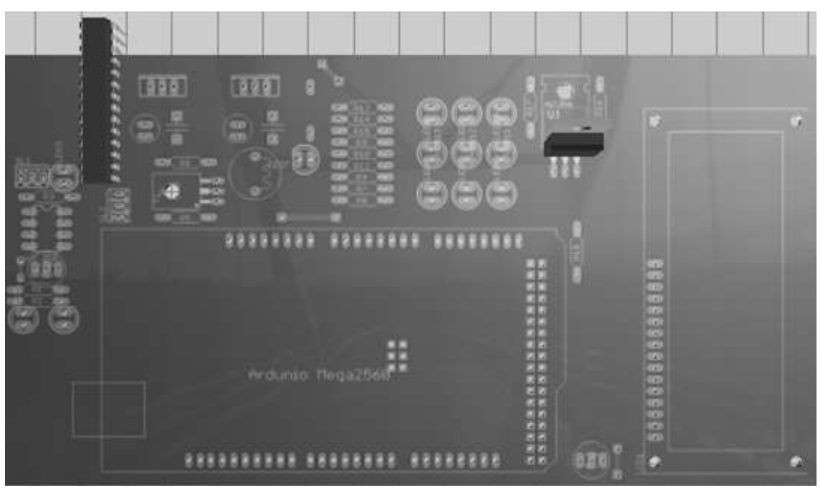

Figure 13: 3-D Simulation of PCB

3.1.3 Software Design

Both Module 1 and Module 2 were interfaced with the Arduino mega kit . The software process is explained below :

- **Step1** — Initialization of process
- **Step 2** — Sense the data from eye blink sensor
- **Step 3** — Data acquired by IR Sensor
- **Step 4** — Process the sensed data
- **Step 5** — Check the mode
- **Step 6** — Normal mode else sleeping mode
- **Step 7** — Normal mode
- **Step 8** — No Warning
- **Step 9** — Else if sleeping mode
- **Step 10** — Buzzer on, LCD display sleeping message, String of LED’s glitters to awake the driver
- **Step 11** — If Driver still is asleep
- **Step 12** — Apply brakes

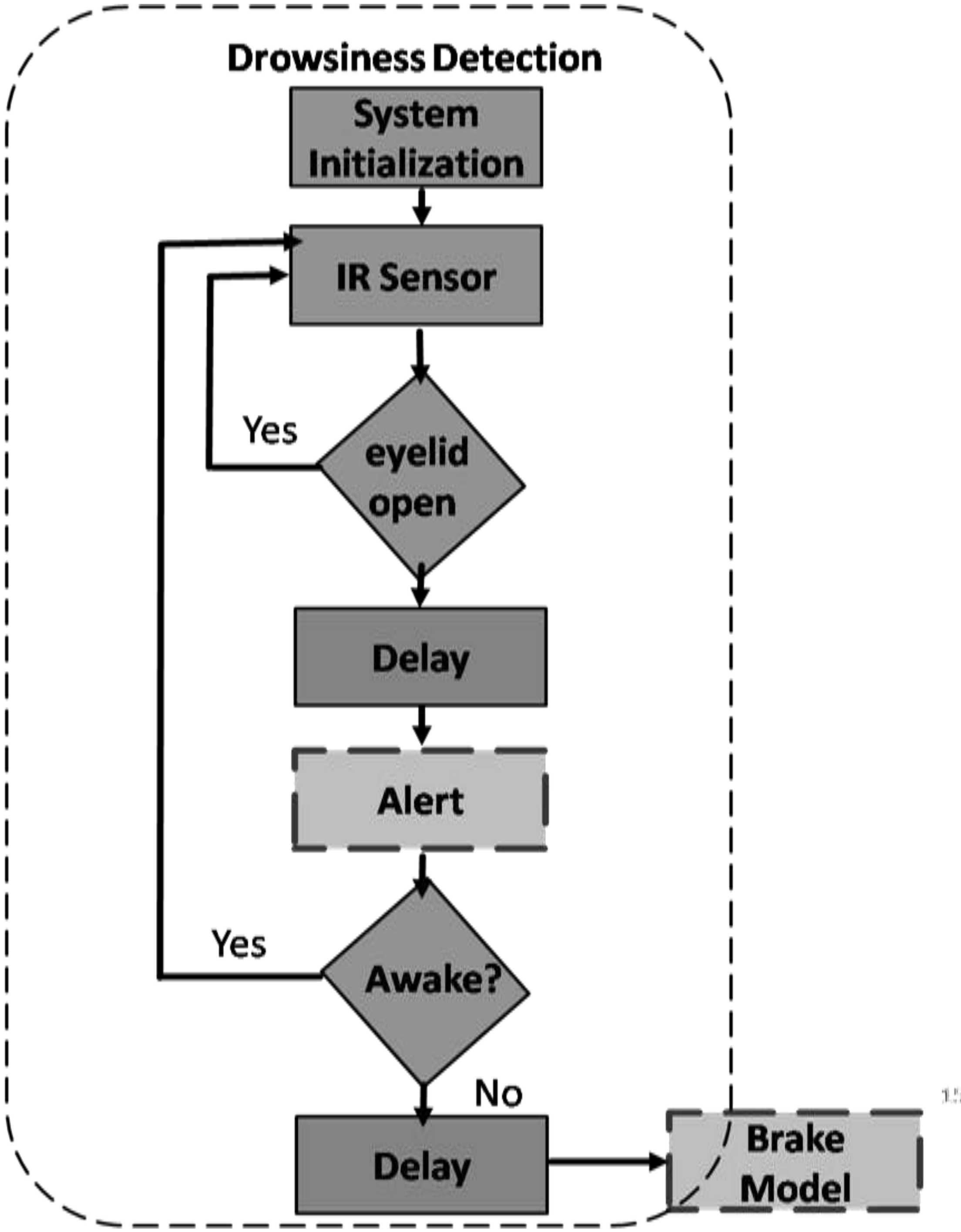

Figure 14: Software Process of IR based System

3.2 Digital Image Processing based Model

3.2.1 Development

After implementing the IR sensor based approach Digital Image Processing was applied. Image Processing was implemented using Open CV , a open source library for image Processing, and Beagle Bone Black Rev C.

Beagle Bone Black Rev C

Since image processing requires fast processing and computational speed and some memory for storing the information about the desired features in an image so specific board was required to serve the purpose. Thus Beagle bone board was preferred over the arduino or the raspberry pi. The Beagle bone board is a low power open source hardware single board computer produced by Texas Instruments in association with Digi-Key and Newark element14. The board was urbanized as an edifying board that could be used in colleges around the world to teach open source hardware and software capabilities. Beagle Bone Black ships with the Debi a GNU/Linux in onboard FLASH to start estimation and expansion. Many other Linux distributions and operating systems are also supported on Beagle Bone Black including:

Sr.	Linux Operating Systems
1.	Ubuntu
2.	Android
3.	Fedora

Table 5: Compatibility of Beagle Bone Black with Linux Operating Systems

Beagle Bone Black's capabilities can be made supreme by using plug in boards called “capes” that would be plugged into Beagle Bone Black's two forty six-pin dual-row extension headers. Capes are available for, VGA, LCD, motor control, prototyping, battery power and other functionality.

The Beagle Board measures in at “82.55 X 82.55” mm and has a CPU core clocked at 1 GHz, RAM 512, onboard Ethernet jack, and four port USB hubs. The accumulation of the Camera port to the -xM provides a simple way of importing video via Leopard Board cameras.

Specifications

Sr.	Specifications
1.	1 GHz Processor
2.	512 MB DDR3 RAM
3.	48GB 8-Bit MMC on board flash storage
4.	3D graphics accelerator
5.	NEON floating point accelerator
6.	2xPRU 32 bit microcontrollers

Table 6: Specifications of Beagle Bone Black

Connectivity

Beagle Bone Black Rev C has multiple options for connectivity. Connectivity options for beagle bone black are listed in table below

Sr.	**Connectivity**
1.	USB client for power & communications
2.	USB host
3.	Ethernet
4.	2x 46 pin headers
5.	HDMI

Table 7: Connectivity options of Beagle Bone Black

Software Compatibility

Beagle Bone Black Rev C being the latest in succession of its kind offers a wide range of sustain to different platforms. Beagle Bone Black Rev C is attuned with following software platforms.

Sr.	**Platforms**
1.	Android
2.	Ubuntu
3.	Cloud9 IDE

Table 8: Compatible Platforms with Beagle Bone Black

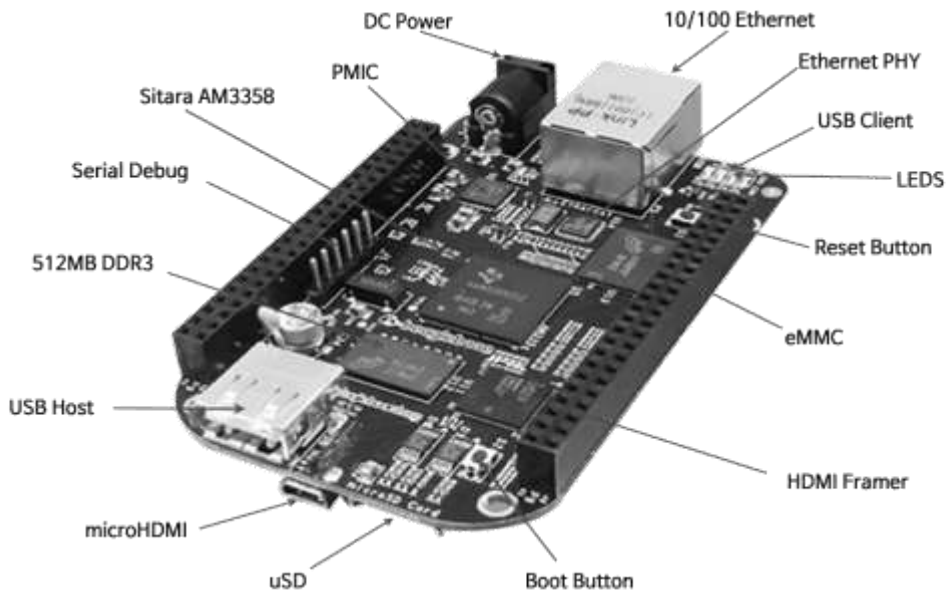

Figure 15: Beagle Bone Black Rev C

3.2.2 Hardware Design

Driver Aiding System is going to employ face detection using the image processing method while continuously capturing the frames from video taken by the camera. The camera will be connected to the Beagle bone board. The Beagle bone board will be continuously receiving feedback from camera's frames of the video. While detection of faces in using Open CV's implementation of Viola Jones algorithm, the tilted faces usually go undetected. Our proposed project is focused on detection of tilted faces by using eye detection. First, the standard faces are detected using the basic Viola Jones face detector and then false positives are removed using the skin detection method. Through these correctly detected faces, the middling face size and standard distance between eyes is planned. For detection of tilted faces, the eye detection over the image is performed. Pair of eyes is chosen in accordance with the data calculated before and face areas are constructed. All these face areas are then checked for skin percentage threshold, and then marked as tilted faces in normal circumstance the frames will show the eyes open while if the driver falls asleep then the frames will show the closed eyes.

The Beagle bone board will be connected to a drive circuit. Beagle bone board will then trigger the audible and visible warnings in the form of LCD and buzzer to give wakeup call to driver. This drive circuit will finally apply the brakes to slow down or stop the vehicle.

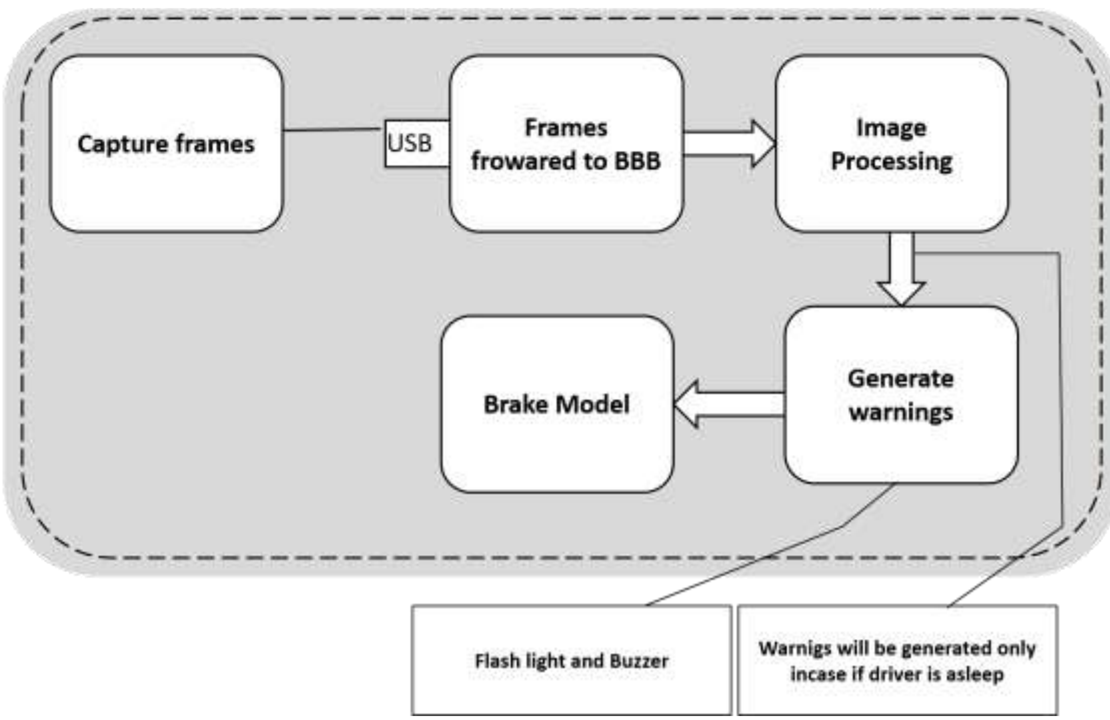

Figure 16: Hardware Schematic Diagram

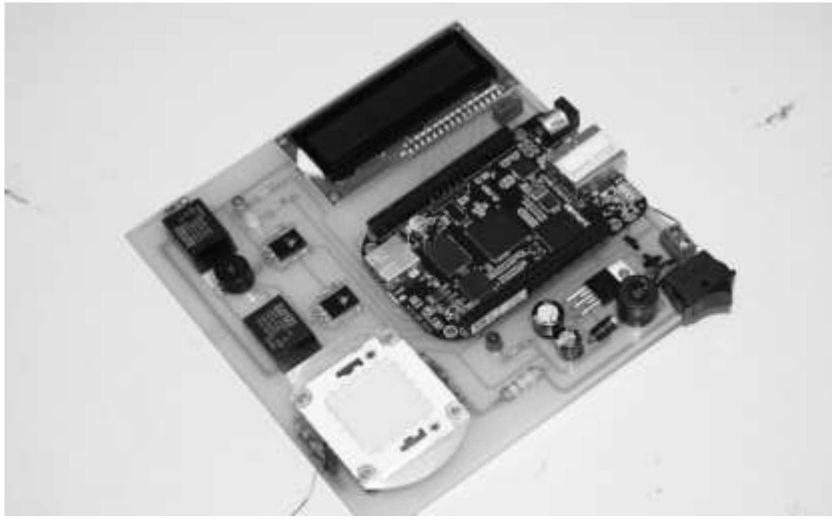

Figure 17: PCB of Image Processing System

Figure 18: Model for Image Processing Prototype

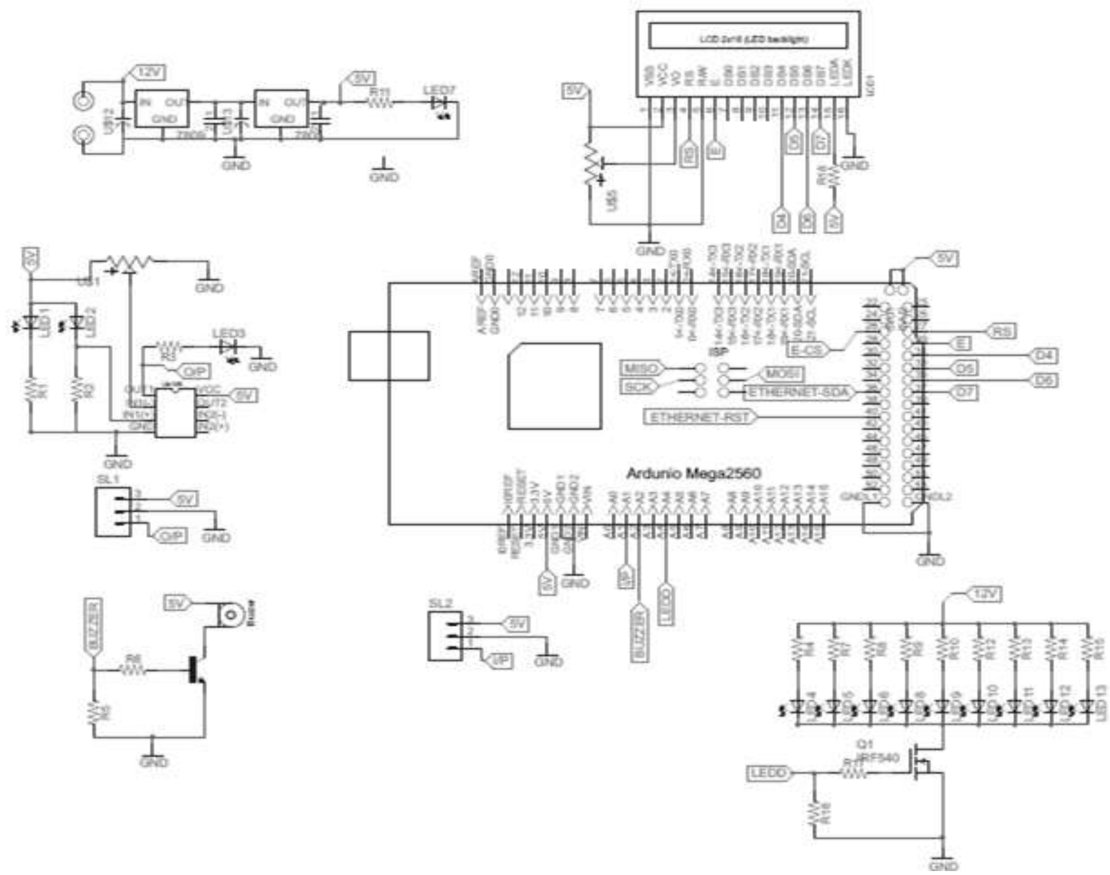

Figure 19: Pin Configuration of Beagle Bone Black for Image Processing System

3.2.3 Software Design

Programming for the desired purpose is done in Python language and the code is burned on to the Beagle bone board. Entity detection using Haar feature-based cascade classifiers is an efficient object detection method. It is a machine learning based method where a cascade function is firstly trained with a lot of positive and negative images. It is then used to detect objects in other images. In the purposed project we will work with face detection. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we extract features from it. For this, Haar features shown in below image was implemented. They are just like our convolution kernel. Thus each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

Now all probable sizes and locations of each kernel can be used to calculate profusion of features. For each feature calculation, we need to find sum of pixels under white and black rectangles. To solve this, the concept of integral images was used. It simplified calculation of sum of pixels, and thus made things super fast.

But among all these features we calculated, most of them were irrelevant. For example, consider the image below. Top row shows two good features. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region of the nose and cheeks. The second feature selected relies on the property that the eyes are darker than the bridge of the nose. But the same windows applying on cheeks or any other place is irrelevant. Thus all such features were ignored by us. For this, we applied each and every feature on all the training images. For each feature, it found the best threshold which will classify the faces to positive and negative. But obviously, there would be errors or misclassifications. We selected the features with minimum error rate, which means they are the features that best classifies the face and non-face images. Each image is given an equal weight in the beginning. After each classification, weights of misclassified images are increased. Then again same process is done. New error rates and new weights were calculated. The process continued until required accuracy or error rate was achieved or required number of features was found.

In an image, most of the image section is non-face region. So it was certain to adopt a simple method to check if a window is not a face region. If it is not, discard it in a single shot and not to process it again. For this the concept of Cascade of Classifiers was used. Instead of applying all the features on a window, group the features into different stages of classifiers and apply one by one. If a window failed in the first stage, we discarded it. We did not consider remaining features on it. If it passed, we applied the second stage of features and continue the process. The window which passed all stages was classified as a face region.

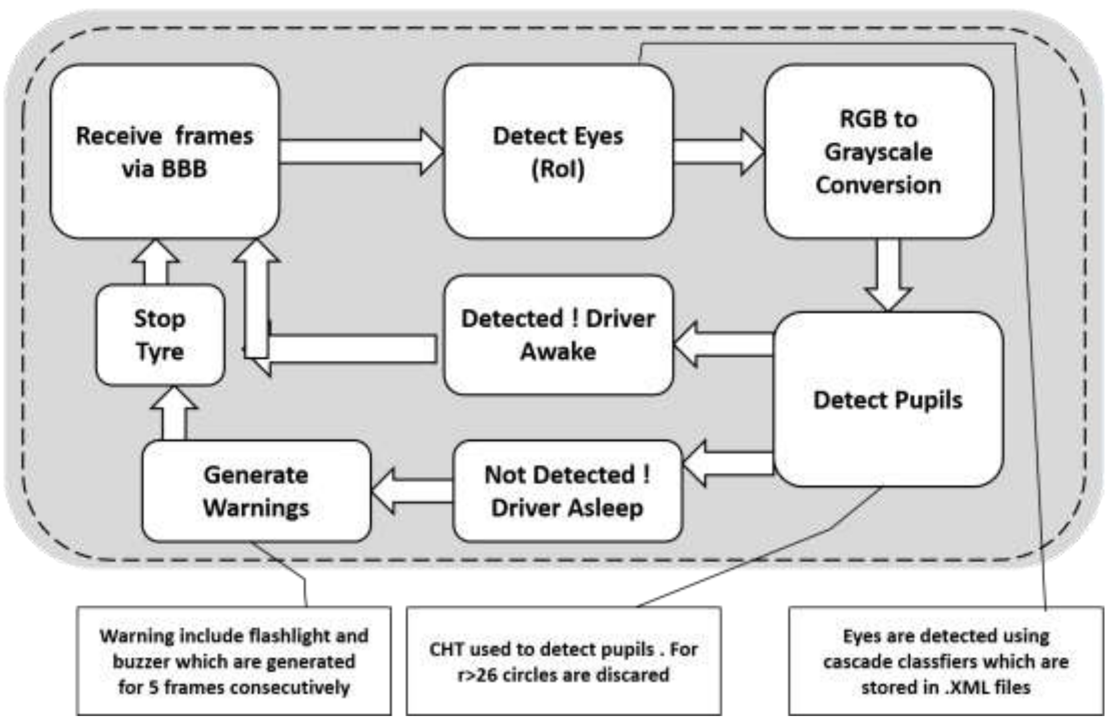

Figure 20: Schematic of Software Process

Steps of Algorithm:

The steps of algorithm are as follows:

Step1
- Initialization of process

Step 2
- Beagle Bone Black capturing the frames from video taken by the camera

Step 3
- Detection ofeyes using cascade classifier stored in XML files

Step 4
- Detection of pupil using Circle Hough Transform in Region of Interest (RoI)

Step 5
- Determine the radius of the eyes

Step 6
- If radius detected is less than 26 mm then it will be taken as a pupil otherwise not

Step 7
- If detected then driver awake i.e.Normal mode: No drowsiness detection: No Warning

Step 8
- Else if sleeping mode

Step 9
- Buzzer on, LCD display sleeping message to awake the driver

Step 10
- If Driver is still asleep

Step 11
- Apply brakes model

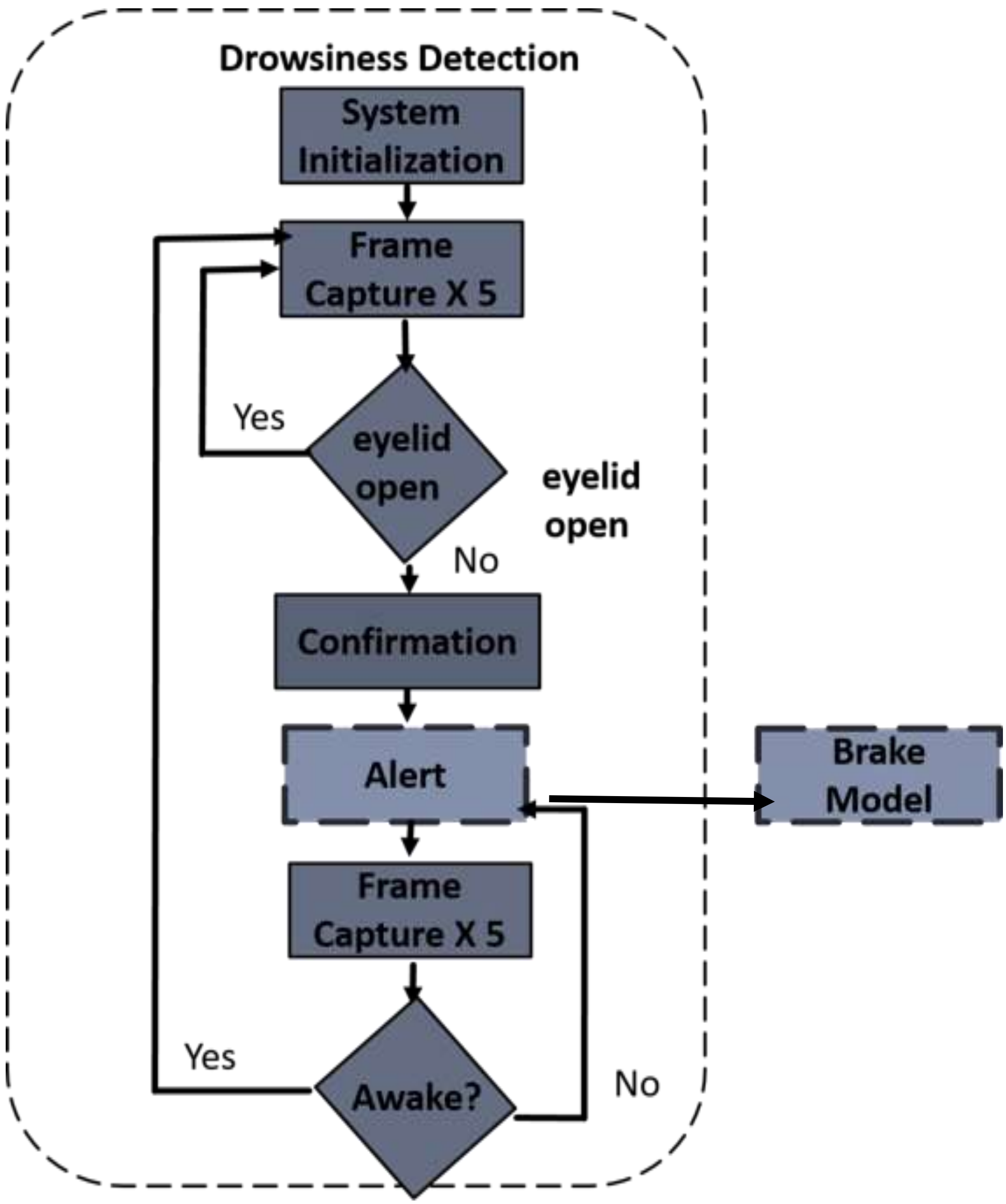

Figure 21: Software Process of Image Processing System

Chapter 4 : Analysis and Evaluation

Both systems have been evaluated on following criteria which are :

1. Design
2. User Friendliness
3. Processing Time

4.1 IR based System

4.1.1 Design

IR system design has following advantages and disadvantages

Sr.	Advantages
1.	Simple to fabricate
2.	Cost Effective
3.	Very low maintenance

Table 9: Design Advantages of IR system

The disadvantages are as

Sr.	Disadvantages
1.	Very sturdy glass frame
2.	Reduce field of vision for driver

Table 10: Design Disadvantages of IR system

4.1.2 User Comfort

The user comfort in this prototype is not appropriate as the driver's field of vision has been reduced due to the placement of IR sensor module on the glasses. This can cause a feeling of uneasiness for driver. The glasses are show below

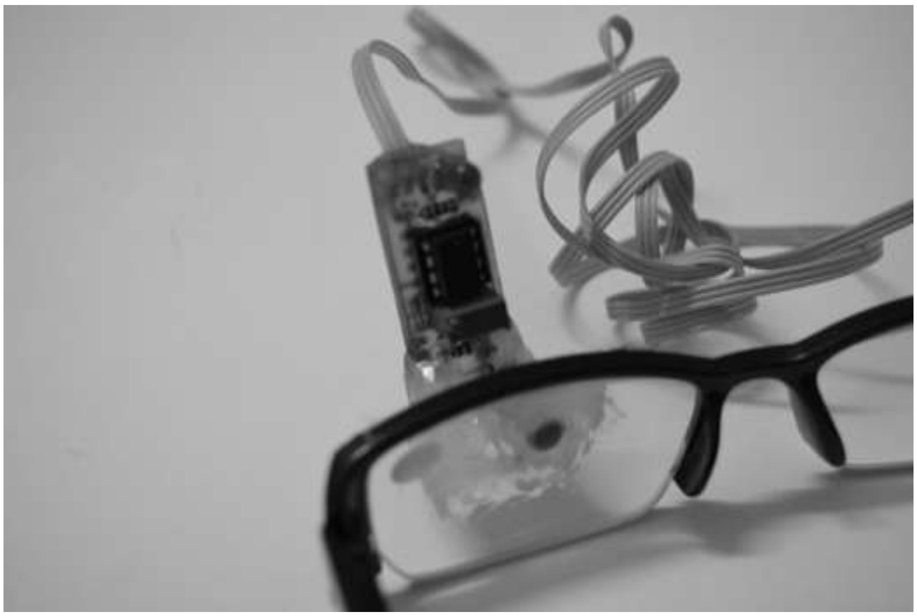

Figure 22: Reduced Field of vision for due to placement of IR sensor onto glasses

Further more drivers had to wear the glass frame in order for the system to detect the drowsiness. It would pose problem in following scenarios

Sr.	**Problems faced by driver while wearing glasses**
1.	Feeling of discomfort
2.	A driver wearing sun glasses has to take them off to use the system
3.	A driver with sightedness renders the system ineffective

Table 11: Problems for driver while using IR prototype

4.1.3 Processing Time

The processing time required in this system is very low. Rather this system was much more responsive than the Image Processing based system.

4.2 Digital Image Processing based System

4.2.1 Design

The design for this system remained pretty much the same when compared to image processing based system. One new addition made was the inclusion of camera on the frame.

Further more IR module was removed from the glasses. This improved the driver's field of vision while driving. The improved glass frame is shown below

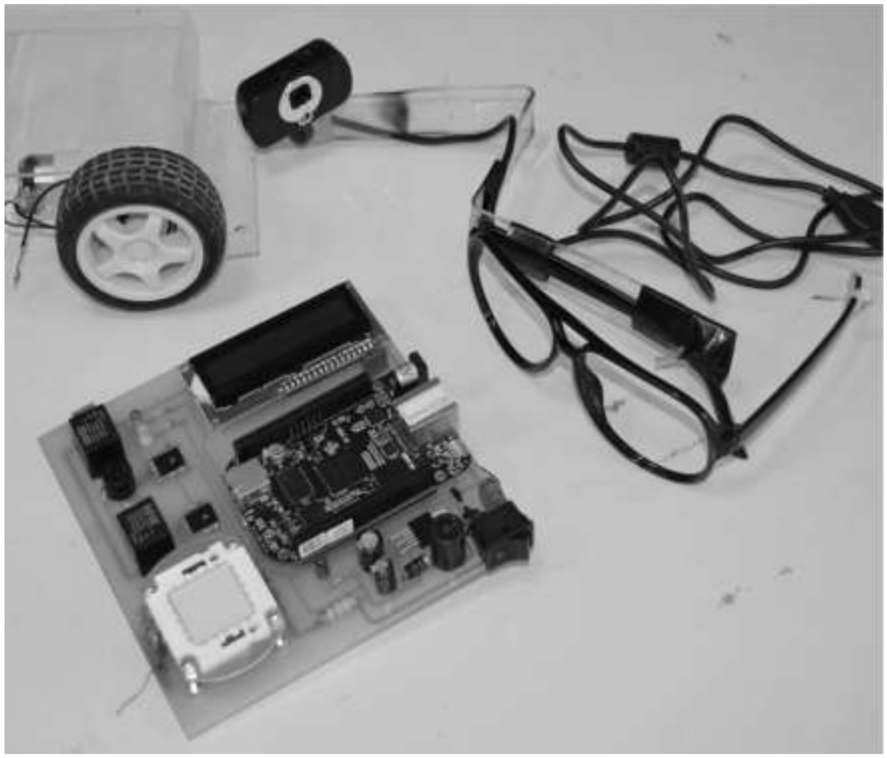

Figure 23: Glass frame for Image Processing Prototype

4.2.2 User Comfort

The user comfort of driver has increased in this system with regard to field of vision. But since this system has the same issue of wearing the glass frame it posses the same problems as mentioned in table 11.

4.2.3 Processing Time

The processing time was 15 % more than the IR based system as it had to perform the processing hungry task of localizing eyes and carrying out the algorithms fed in Beagle Bone Black.

Chapter 5 : Future Work

A prototype, Driver Aiding System, has been designed with two approaches as per project specifications. Recommendations for future work are listed below:

1. For testing and analysis purposes the camera is mounted on to the glasses. In future a standalone model for Driver's Aiding System can be devised which would be more users friendly and will be more convenient to use as the camera will be shifted from the glasses to a more convenient place for the driver.
2. The device will be extrusive as the camera will be fixed or attached to any convenient point/location inside the vehicle.
3. Moreover efficiency of the project can be further enhanced by using commercial frame grabber and CMOS camera which is very expensive but it is ten times more sensitive than the CCD camera.
4. Furthermore to reduce the delay time duration between the two states of driver's alertness (awake or sleep) Intel Edison board can be used instead of Beagle bone black as it is latest model having processor faster than that of Beagle bone black, but it too is expensive and it does not support the video and image processing utilities as does the Beagle bone black.
5. A specialized light weight from can be designed if one wants to go with intrusive approach for drowsiness detection.
6. A specialized camera can be ordered having the lens only.

7. The project is not having night time capability of detection the state of driver , it can be incorporated using IR cameras . One can buy them or make it in electronics lab.
8. Project is currently interfaced with any car. It can be interfaced to alert driver in real time.

Chapter 6 : Conclusion

An persistent system 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. When the eyes have been closed for too long, a warning signal is issued. In addition, during monitoring, the system is able to automatically detect any eye localizing error that might have occurred. In case of this type of error, the system is able to recover and properly localize the eyes. The following conclusions were made:

1. Image processing achieves highly accurate and reliable detection of drowsiness.
2. Image processing offers invasive approach to detecting drowsiness without the annoyance and interference.
3. A drowsiness detection system developed around the principle of image processing judges the driver’s alertness level on the basis of continuous eye closures.

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APPENDIX A

The source code of the Image processing based system in python language .

```
import cv2

importnumpy as np

fromtimeimport sleep

eye_cascade = cv2.CascadeClassifier('haarcascades/haarcascade_lefteye_2splits.xml')

cap = cv2.VideoCapture(0)

ret=cap.set(3,320)

ret=cap.set(4,240)

#circles =cv2.HoughCircles(gray,cv2.cv.CV_HOUGH_GRADIENT,1.2,180)

i = 0

active = 0

non_act = 0
```

APPENDIX A

```
while (True):

ret ,img = cap.read()

gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)

eyes = eye_cascade.detectMultiScale(gray,1.1)

i = i + 1

iflen(eyes)>0:

for (ex,ey,ew,eh) in eyes:

#print("eye detected")

roi_gray_eye = gray[ey:ey+eh,ex:ex+ew]

#crpp = cv2.blur(roi_gray_eye, (11, 11))

roi_color_eye = img[ey:ey+eh,ex:ex+ew]

#cv2.imshow("EYE",roi_color_eye)

#cv2.rectangle(img,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)
```

```
img_eye = cv2.medianBlur(roi_color_eye,5)

gray_eye = cv2.cvtColor(img_eye,cv2.COLOR_BGR2GRAY)

#ret, Eye_state = cv2.threshold(gray_eye, 140, 255, cv2.THRESH_BINARY)

circles=cv2.HoughCircles(gray_eye,cv2.cv.CV_HOUGH_GRADIENT,1.2,200,para
m1=70,param2=30,minRadius=0,maxRadius=0)

##  #circles =cv2.HoughCircles(gray,cv2.cv.CV_HOUGH_GRADIENT,3.5,250)

if circles is not None:

circles = np.round(circles[0,:]).astype("int")



#print("circles:%f"%i)

for (x,y,r) in circles:

#print(r)

if (r < 26):
```

APPENDIX A

```
#cv2.circle(roi_color_eye,(x,y),r,(0,255,210),2)

active = active + 1

elif (r > 50):

non_act = non_act + 1

# cv2.imshow("output",roi_color_eye)

#cv2.imshow("output",img)

if (i>5):

print("active:%f"%active)

print("non active:%f"%non_act)

i = 0

if (active >non_act):
```

```
print("eye open")

active = 0

non_act = 0

elif (non_act> active):

print("eye closed")

active = 0

non_act = 0

if cv2.waitKey(1) & 0xFF == ord('q'):

break
```