

DESIGN & DEVELOPMENT OF ANTI-SLEEP ALARM FOR DRIVERS

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

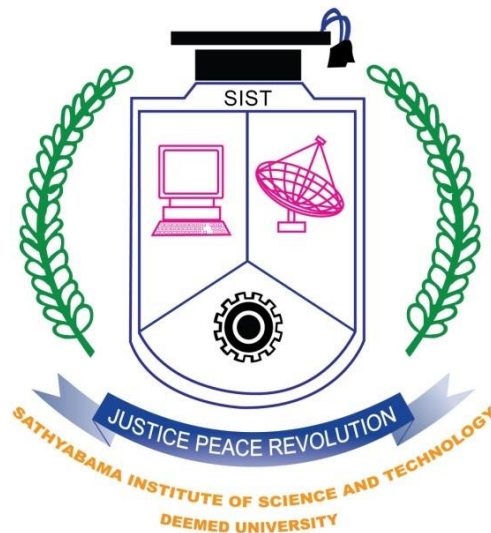
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **AKASHKUMAR.A**(Reg.No.39140001),**ROHIT**(Reg.No.39140047),**SANJAY.K**(Reg.No.39140048) and **SRIDHAR.P**(Reg. No. 39140055) who carried out the project entitled "**ANTI-SLEEP ALARM FOR DRIVERS**" under our supervision from November 2021 to May 2022.

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DECLARATION

We **AKASHKUMAR.A**(Reg.No.39140001), **ROHIT**(Reg.No.39140047), **SANJAY.K**(Reg.no 39140048) and **SRIDHAR.P**(Reg.no 39140055) hereby declare that the Project Report entitled “**ANTI-SLEEP ALRM FOR DRIVERS**” done by us under the guidance of **Dr. W.ABITHA MEMALA** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1.

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DATE: 29/04/2022

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1. Introduction

1.1. Project motivation and purpose

The goal of this project is to develop a system that can accurately detect sleepy driving and make alarms accordingly, which aims to prevent the drivers from drowsy driving and create a safer driving environment. The project was accomplished by a Webcam that constantly takes image of driver, a beagle board that implement image processing algorithm of sleepy detection, and a feedback circuit that could generate alarm and a power supply system.

1.2.Functions and Features

This system has many features that make it unique and functional. These features include:

1. Eye extraction, use open and close to determine sleepiness
2. Daytime and night detection
3. Real time image processing and detection
4. Sound and flashing LED warning system to redraw driver's attention
5. Little inference and potential hazard to driver's normal driving
6. Portable size with car cigarette charger socket power supply

1.3 Hardware system overview/ block diagram

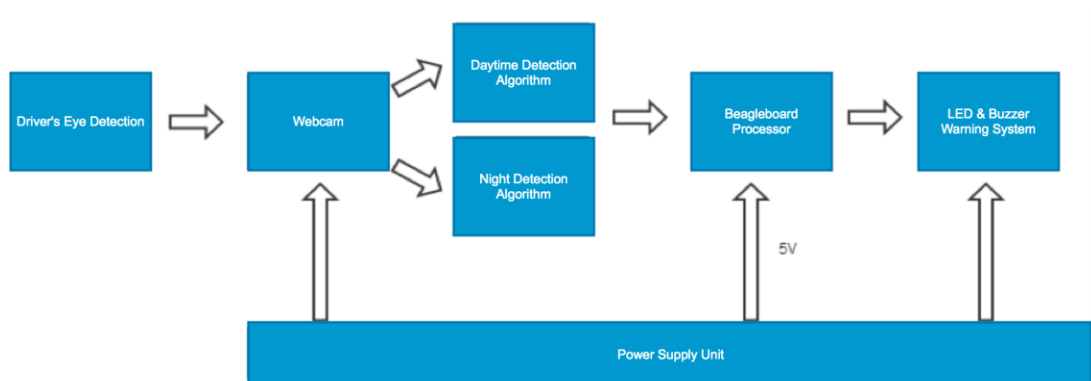


Figure 1. The systematic level block diagram

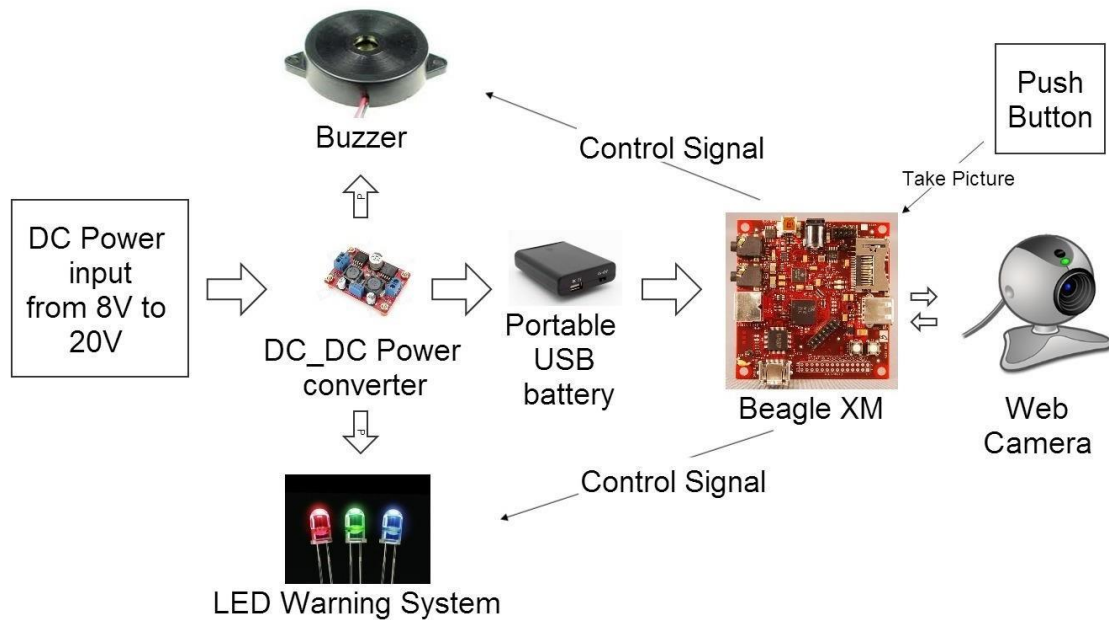


Figure 2. Hardware system connection

2. Design of Project

2.1. General design alternatives

The first alternative design between the final implementation and the initial plan, for the software part, is the choice of the camera. The first alternative design between the final implementation and the initial plan, for the software part, is the choice of the camera. So we used regular Day-Night web camera which is used for security purposes for accurate Detection. For the requirement of power supply of Beagle Board and Webcam, a USB battery module is used intermediately. This solution is the product more portable and

sustainable since the Battery can be easily and constantly charged by the dc-dc power converter. Meanwhile, the dc power converter can be supplied by cigarette power jack installed on the car, which turns this alternative into an advantage.

2.2. Block description

2.2.1 Software flow chart and algorithm description

The algorithm aims to accurately detect the sleepiness of the driver by open eye and close eye recognition. The sleepy detection algorithm is built on C++ and OpenCV library. The test was first implemented and tested on the computer, then on the Beagleboard. The algorithm includes two parts: daytime detection and night detection. First and Foremost, based on the average intensity of pixels, the algorithm classifies the environment as daytime or night. For daytime, the image quality is good enough, therefore no image enhancement is required; for night, because the poor contrast of the images, histogram equalization, a method to expand the color range of the image from 0 to 255, is implemented. In this case, we need a light to slightly illuminate the driver.

In the next step, as soon as the driver has entered the car, two base images are recorded automatically – open eye as well as close eye. These two images are used as the base for further determination of whether the drivers' eye is open or close.

Afterwards, the driver could start driving. The detection algorithm is in real time and the eye portion is extracted by using the iterative Haar Classifier. After the current eye portion is extracted, we use template matching function built in OpenCV to determine if the eye is open or close. If the eye has been closed for more than two seconds, sleepiness is detected and the program will send a signal to Beagleboard. The detailed flow chart of the algorithm is shown below.

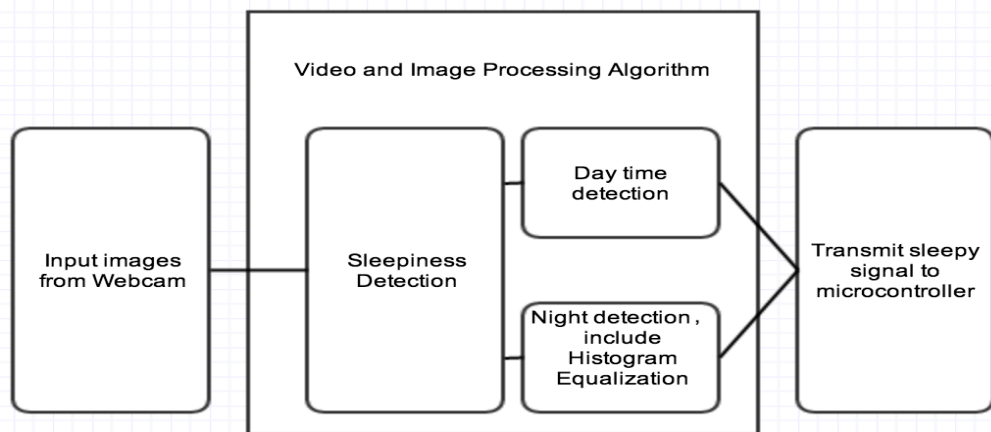


Figure 10. Framework of Algorithm

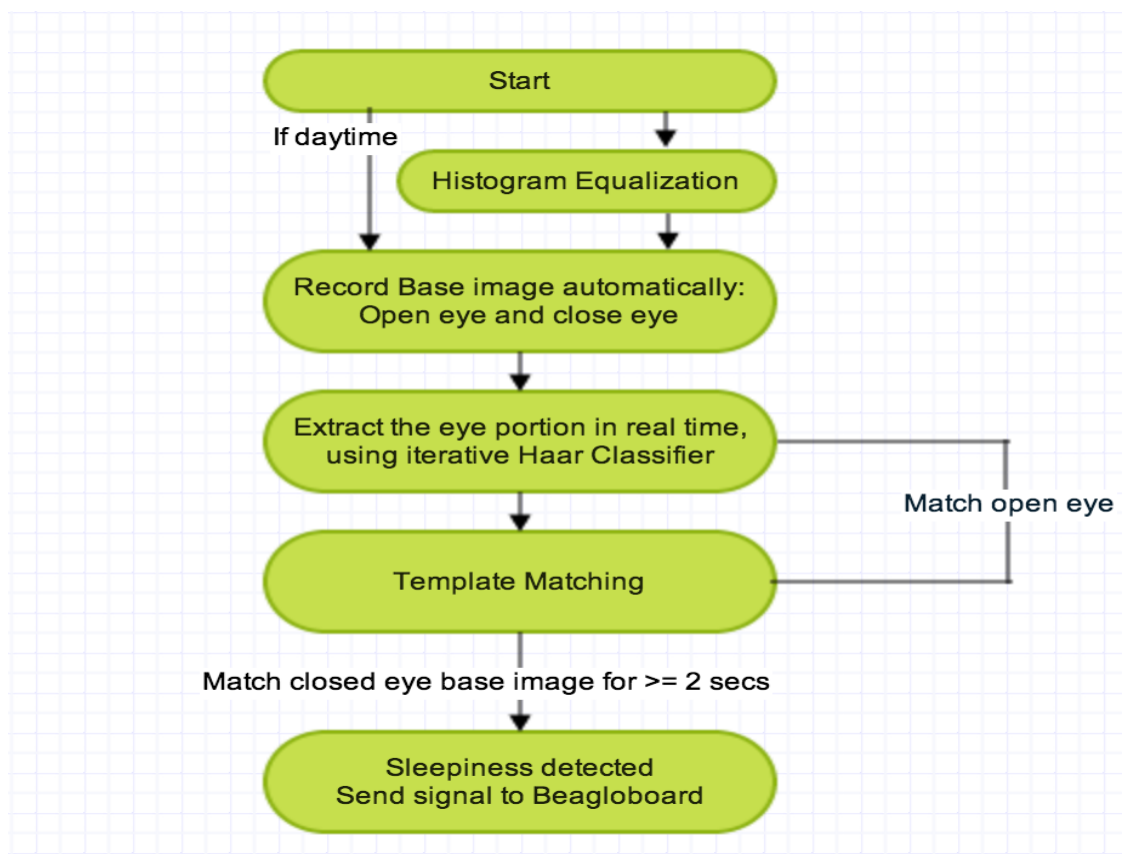


Figure 11. Flow chart for algorithm

Histogram Equalization:

The histogram Equalization is an image enhancement algorithm that could effectively expand the color contrast. Due to the poor quality of contrast, this algorithm is specifically used for night detection. Traditional histogram

equalization is implemented on black and white images; for our design, we used it for each channel of the images, which are R, G, and B. In detail, a cumulative distributive function of the image is generated and we get a statistical model, then we assign new value to each pixel so that the CDF can be more evenly distributed in the range from 0 to 255. The flow chart is shown below.

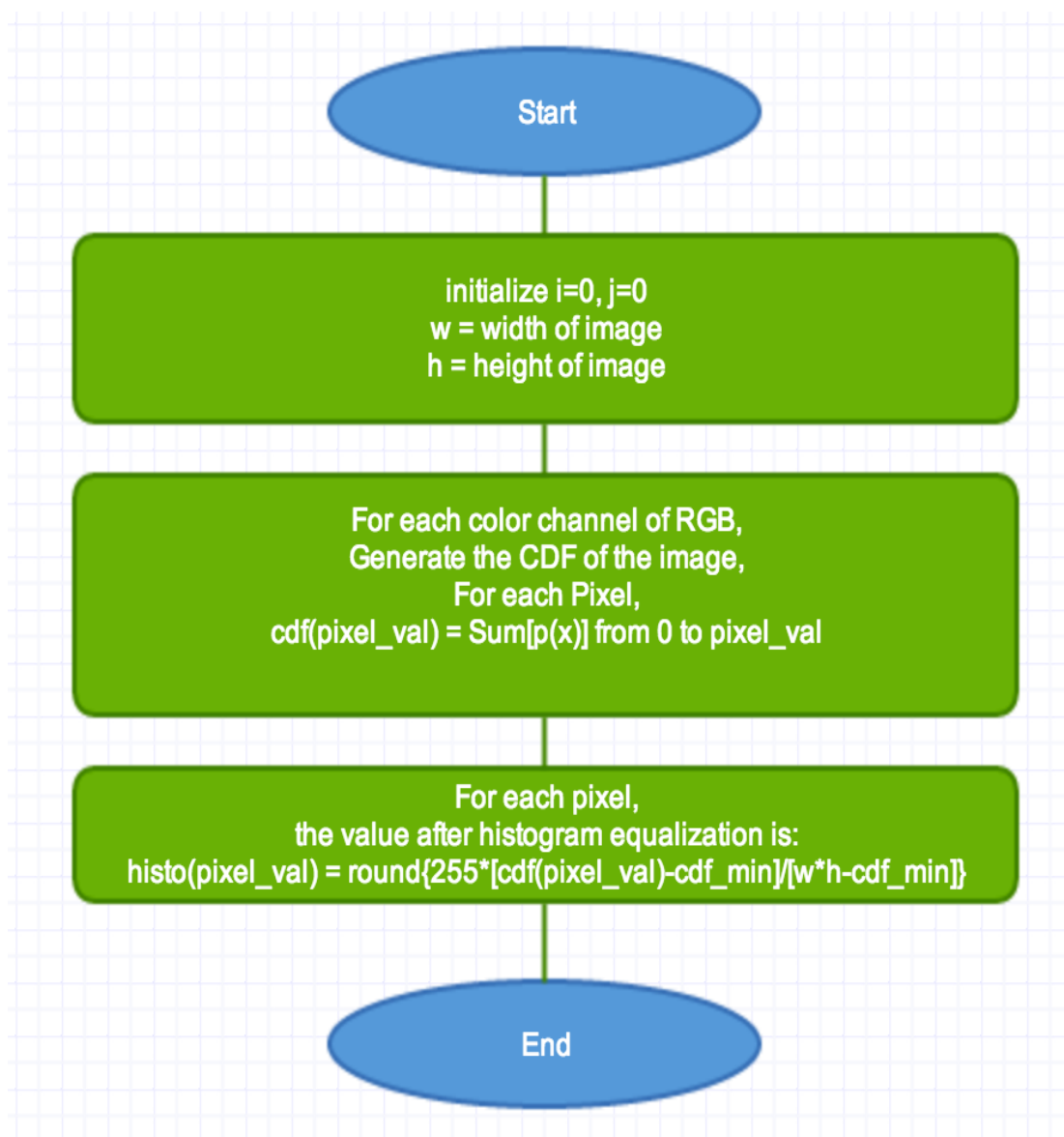


Figure 12. Flow chart for histogram equalization

2.2.2 Hardware components

Webcam

The Webcam is the input device used to monitoring the driver by capturing the

face images. The images are then sent to the Beagle board for processing. The camera will be placed in front of the driver.

BeagleBoard

The Beagle Board would operate as the controller for all other components. First, it will send and collect information from the webcam. Then it would perform algorithms to determine the status of the driver to see whether his/her eyes are closed or not. Last it will send out 1.8V control signals to LED array and buzzer to control them. In order to collect information, analyze data, and send out feedback, we need to install Linux and openCV on the board and build corresponding drivers for other components. Even though power to BeagleBoard can be supplied via the USB OTG connector, the USB Host ports cannot supply power to our webcam. Therefore we used the DC power jack to supply power for BeagleBoard, using a Generic USB to 5.5 mm/2.1 mm 5 Volt DC Barrel Jack Power Cable that connected with the DXPOWER USB battery.

Our BeagleBoard will power and communicate with webcam using one of the four USB Host ports. We'll install Ubuntu on the board and use openCV library to support our algorithms. Most of the program is in C++ and compiled by g++, with a few bash commands to interact with the GPIO pins.

As for the input from buttons and output to alarming systems, we plan to use GPIO pins on the Beagleboard. Currently, we are using pin3(GPIO_139) and 5(GPIO_138), on the Expansion Header to control the LEDs, pin9(GPIO_136) for buzzer, and pin 7(GPIO_17) for the button. When the button is pressed, our system would continue running our program and record images of open and closed eyes. After the initialization is done, the board will run our algorithm to detect the driver's eyes, and notify the user by LED and buzzer when a dangerous signal appears.

Power Supply/Control Unit

For the final design, in order to make the overall system portable, the power source is provided by the car cigarette power outlet, which typically has 12V DC

supply. Occasionally it also provides 24 V DC. The power supply unit can tolerate 8V to 24 V inputs and provide a filtered steady 5 V output to supply the USB battery which is used to power up the Beagle board and the camera. Also, it is used to power up the Buzzer and to illuminate the LED array by connecting appropriate resistors. One or Two USB receptor ports will be used to retrieve power and one USB outlet will be connected to Beagle board. This module also provides one control signal to beagle board managed by the pushbutton. The pushbutton will control the beagle board and camera to take users' initial reference photos when it is pressed. The estimated working power consumption for the beagle board and camera is estimated to be 12 W, which is 2.4 A maximum current with output voltage of 5V. Additionally, a slide switch is installed in order to disable the alarming system when it is not needed.

Alarming system

Buzzer

The buzzer is chosen to work under 4V to 7V DC with 2.4 KHz alarming sound. It will directly connect to the power bus but not DC-DC converter output since it has a relatively large tolerance of functional voltage. Also, it can mitigate the load of the regulator.

Four through hole LED lights

There will be four LED on the PCB board in total. These LED are used for alarming purpose. There are three red LEDs put in series. In color selection is based on the minimum inference of driver by warm color light. The typical working voltage of these LEDs is 2.1 V. The power supply of LED will be from the power bus connected from USB input. In order to limit the voltage, a series resistor is used to prevent LED from damage of over voltage. In order to achieve the adjustable frequency of the LED flashing, each LED is controlled by a NMOS switch, which is described as below.

NMOS switch

The control signal of the Gate for NMOS directly comes from Beagle board. The

beagle board can provide a digital signal up to 1.837 V. Therefore, this voltage is able to drive the NMOS to implement on-off behavior to control the LED. The same design is used for buzzer. The only different for buzzer design is that resistor is not required for voltage limit purpose.

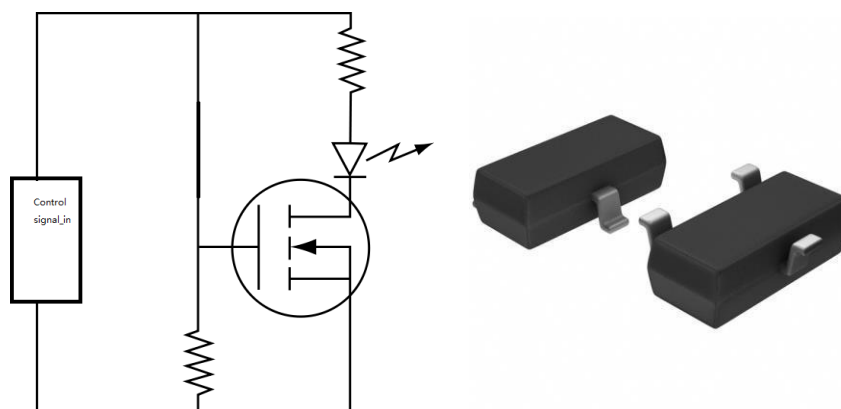


Figure 13. The LED –NMOS control circuit implementation and NMOS image
Mechanical switches

Two types of mechanical switches would be used in the design. As the figure 8 show on the left, the slide switch is used to control the power of whole system. It serves the power on-off button. Two push buttons are used in order to send commend signals to Beagle board for information acquisition purpose. The system power switch has current limit up to 6A and the signal buttons have the limit of 100 mA (Off-MOM). The resistor is needed to limit the current flow for the signal buttons.

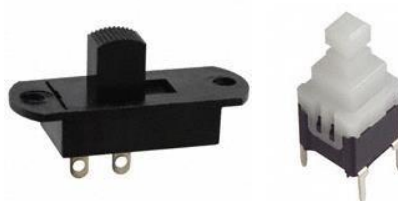
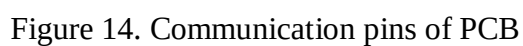


Figure 14. Slide switch (left) and push button switch (right)

2.3. Schematics with components

PCB schematic and layout design

The PCB design tool used is Cadence Orcad and Allegro. The reason why I don't choose Eagle is because in most industrial design, Allegro Cadence is recommended.



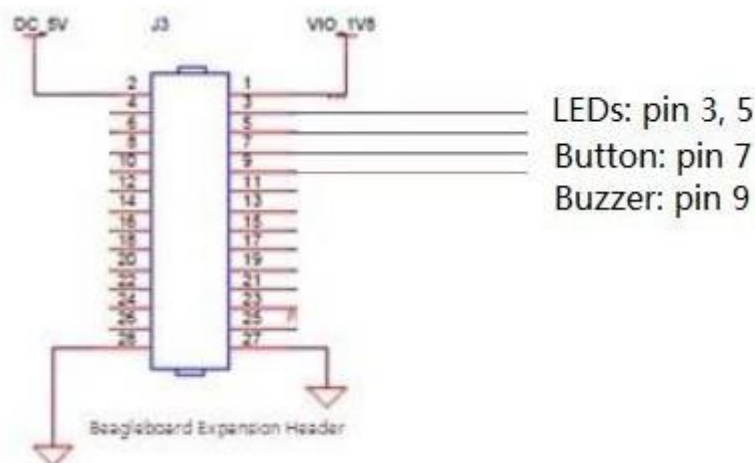


Figure 16. GPIO pins for input/output control signals

3. Verifications

3.1 Testing procedure

Software:

The test was initially executed on the computer and then on the Beagleboard. To verify the eye portion algorithm, the tester stood 0.2 to 0.3 away from the Webcam which was located in front of the tester at an angle with $\pm 15^\circ$. The image of the eye section was extracted successfully and was highlighted by a red rectangle.

To test the daytime detection, we controlled the environment light intensity to be 80W and the tester stood at the same detection position as above. When the tester closed the eye for more than two seconds, the program showed “eye closed” at terminal as required. In addition, when the tester blinked the eye, nothing happened as expected. To test the night detection, the only difference is that we controlled the surrounding light intensity to be 20W. We successfully got the same detection result as daytime.

Beagleboard:

We compiled our code on the Beagleboard and ran with webcam connected. For each of our main loop we tried to capture an image and analyze it, a timer is used to record the time for each loop. The average time is within 0.33 second as satisfied our

requirement. For the GPIO pin output, we were able to send out a control signal varying from 1.788V to 1.835V which satisfied our requirement($1.8V \pm 5\%$). These control signals were able to drive LEDs and buzzer successfully. For the GPIO pin output, we fed a control signal of 0V to the pin and our program is able to identify that the pin is set to low, which meets our requirement.

Power supply and alarming system:

Requirements	Testing procedure and result
Power/Control Unit: I. Able to receive control signals from BeagleBoard via GPIO. II. Able to supply an output via USB port with 5V voltage with 5% tolerance when input of the Power supply unit varies $\pm 3V$. High frequency signal noise in the supply voltage should be suppressed by the regulator into 10% of its magnitude. III. The LED are able to illuminate normally with 57 lm ~ 62 lm under typical voltage 3 V and the buzzer can make sound 88dB under 5V supplyvoltage.. IV. Able to turn off the alarming system by switch. V. Able to send GND control signal	I. Tested by the precise control of LED and Buzzer behavior by sending signal from Beagle board. II. The output terminals is connected to the oscilloscope. The output wave form is obtained with certain load. Verified by waveform measurement. III. When the signal sent from Beagle board become high, the LED and buzzer can behave as requirements described. It is verified by the functionality of the system during the demo and regular tests. IV. Tested and verified by sliding the switch off, the LED warning system can be turned off.

to Beagle board in order to take initial pictures for driver for reference.	V. Tested and verified by pressing the button to see the response from Beagle board. The beagle board successfully receives the GND signal.
Alarming devices I. LEDs are able to flash at same frequency in different sequences. The frequencies include 1Hz, 2Hz, and 4Hz. (4 LED in total). II. Under 5V input voltage, the buzzer sound can be heard from users who are within 0.5m	The Led and buzzer functionalities are tested and verified by proper behavior when control signal is high from sendfrom Beagle Board.

3.2. Discussion of results and performance

The software detection algorithm part is implemented successfully. The performance is fast, efficient and very accurate. The program can run smoothly on the computer in real time with no delays. In addition, we tested the algorithm for 200 times, the accuracy achieves 93% in daytime and 82% at night, which is very high compared with the products sold on the market, for which the highest accuracy is 90%.

As for the Beagle board, most of our requirements are satisfied. The Average time of a main loop is less than 0.33 second, which give us an image capturing frequency of 3Hz. GPIO pins are able to output a signal of 1.788V to 1.835V. Button press is able to send a ground signal through GPIO pin to start the process of image taking.

4. Conclusion

4.1. Accomplishments

As for the software part, we fulfilled our goal successfully. The detection algorithm could not only work effectively and accurately at daytime, but also at night. The Eye portion extraction is smooth and in real time with no delays on the computer. In addition, there is a bonus function in the software part – detection with glasses.

For the Beagleboard, we achieved two major difficulties. First, we were not able to power up the board with any commercial chargers initially, including the ones for Iphone, for Samsung, or the USB charger on car. But later we added DXPOWER battery to power our board and used the power supply we designed to charge the battery to solve the problem. Second, we experienced a few difficulties while installing the OpenCV library on Beagleboard, but were able to solve it by changing flags in makefiles to the one corresponding to ARM board architecture. The power supply unit basically completes all its design requirements. By adding the extra USB battery stage, the problem of powering the entire microcontroller and alarming system has been solved. Moreover, the alarming system works as we supposed. The voltage ripple of the power supply unit can be mitigated by applying more resilient capacitor components.

It is apparent that the overall project success is not derived from one team member's mind but the keen coloration within our group. Each part is indispensable and every team member made the great dedication on the completion of this design project. The pace is intense, the learning, immense.

By using our Driver Sleep Detection and Alarming System, customers would be warned when his/her physical condition is not good enough for driving and thus

prevents dangerous behaviors from happening. It is consistent with the safety and welfare of the public.

We design our product using qualified components and follow proper safety rules, avoid wrong actions happening to other people.

5.3. Future work

1. Use OpenGL to control the frame rate more accurately
2. To achieve a higher accuracy at night
3. Use parallel programming such as CUDA to make code faster and more efficient
4. Use bash script to enable our program to auto start after booting.
5. Use parallel programming and multi thread to handle image capturing, sending control signal, and running algorithm separately.
6. Design hardware enclosure for PCB , microcontroller and USB battery
7. Use more advanced components in out/in capacitors to reduce the voltage

ripple of the output voltage

5.4. Uncertainty

The precision of night vision detection has some spaces to improve due to the algorithm and hardware ability limitation. The accuracy of the algorithm needs further optimization for the night condition.

6. References

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PROTOTYPE

