ADVANCED DRIVER ASSISTANCE SYSTEM USING HYBRID MODEL

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Abstract- Demands for Advanced Driver Assistance Systems is expected to increases consumers grow increasingly safety conscious and insurance companies and regulators begin to recognize the positive impact such systems can have on accident rates. Concurrently, vision systems are becoming increasingly feasible in road vehicles due to advances in technology and lower costs. The proposed paper is divided in to two segments of sectors. One will be embedded system and other will be image processing using mat lab. In embedded sector we are using HMI. In embedded using two arm controller using CAN protocol communication between master & slave node done multiple sensor integrated to master & slave node. Processed information is displayed on NEXTION display in graphical format. Master node communicates with MATLAB to light beam change, pedestrian alert, and drowsy alert and Slave node processes the temperature, fuel and gas and data is send to master node for processing.

Keywords— Advanced Driver Assistance Systems (ADAS), Controller Area Network (CAN)

I. INTRODUCTION

Automotive Electronics has been witnessing a major change from the analog world to the digital world to accommodate the rapidly growing technology so that the driving experience is made better, safer and at the same time, the end-user is provided with a variety of features that he can utilize in the vehicle. This change in the automotive industry is driven by a driving mechanism called the digital driving behavior of the vehicle.

Due to the rise in automobile use over the last century, and its continued rise today, road accidents have become a prominent cause of injury and death. The knowledge in the field of computer vision continues to grow, so too does the realization of its potential benefits in the area of driver safety. Over the past few years, many recognition algorithms have been proposed to assist in the area of driver safety, but very few of them are both accurate and fast enough for real-time processing. This major qualifying project aims to further develop one of these algorithms for high accuracy and real-time performance in the area of pedestrian detection, beam control, drowsy driver, fuel monitoring, temperature monitoring, and obstacle & gas detection from an automobile.

Detecting pedestrians in an image has proven to be a challenging task for many researchers due to the wide variability in possibilities. Posture, clothing, size, background, and weather all can be impactful on the appearance of an image. Real time pedestrian detection and tracking is considered as a critical application. Night time driving is riskier as compared to day time driving because of poor visibility especially in the case of senior citizens. While traditional methods of segmentation using threshold, background subtraction and background estimation provide satisfactory results to detect single objects, noise is produced in case of multiple objects and in poor lighting conditions. To overcome these difficulties, a new method is proposed for detecting and tracking multiple moving objects on night-time lighting conditions. The method is performed by integrating both the wavelet-based contrast change detector and locally adaptive threshold scheme. In the initial stage, to detect the potential moving objects contrast in local change over time is used. To suppress false alarms motion prediction and spatial nearest neighbor data association are used.

Pedestrian recognition is one of the most challenging problems in the field of computer vision. There have been many recognition algorithms proposed for purposes such as prevention of traffic accidents by using vehicle cameras. For embedded systems, however, a recognition algorithm that achieves not only high accuracy but also real-time processing in an environment with limited resources is required. Pedestrian detection is also an essential and significant task in any intelligent video surveillance system, as it provides the fundamental information for semantic understanding of the video footages.

Consequently, engineers and planners have started to implement new road treatment and intersection designs with the aim of reducing the risk of vehicle-pedestrian crashes. Accordingly, there is a growing need to conduct observational studies to understand underlying factors of roadway treatments that may reduce risk of pedestrian crashes. Roundabouts are one such treatment that has gained considerable attention among planners and engineers. The objective of this study was to test a computer vision-based tool to extract and quantify pedestrian events that occur at such intersections, to aid planners and engineers who wish to monitor and characterize their effectiveness and safety for pedestrians.

II. LITERATURE SURVEY

Mohammed Ismail[1],describes about Design and Development of a Vehicle Monitoring System Using CAN Protocol, Nowadays economical automobiles are developed by more of electro mechanical parts with analog interface for efficient & cost effective operation. Generally, a vehicle is built with an analog driver-vehicle interface for indicating various vehicle statuses like speed, fuel level, engine temperature etc. This paper presents a design &development of cost effective solution for digital driving interface with a semi-autonomous vehicle improving the driver-vehicle interaction with increase in safety. Our designed system uses a PIC Microcontroller based data acquisition system that uses in built ADC to gather data from analog sensors to digital format and visualize them to the vehicle driver through a LCD display. The communication module used here is an embedded network bus CAN, which has efficient data transfer. Experimental data with a prototype is obtained for various vehicle parameters like vehicle speed, engine temperature and fuel level in the tank which are compatible with a real time system.

HazimHamza[2],describes about the Night Time Car Recognition Using MATLAB. In his paper presents a car recognition system by locating and segmenting tail lights in the night-time road environment. Numerous approaches towards car recognition during day time have been implemented in the past. However, the features of cars during day time are seldom available when it's dark due to lack of lighting and other conditions. Unlike previous work in the area, this system employs HSV color thresholding for segmenting the red regions (brake lights) and capturing certain object features of the segmented parts. These features are used to train and classify the different classes of lights for different car models. For this, the machine learning based approach – Support Vector Machines (SVMs) is incorporated. Satisfactory results were obtained and they show that the SVM technique is effective for classification.

Roy-ErlendBerg[3],studied about the Real-time people counting system using video camera His paper experiments will be tried out on a people counting system in an effort to enhance the accuracy when separating counting groups of people, and non-human objects. This system features automatic color equalization, adaptive background subtraction, shadow detection algorithm and Kalman tracking. The aim is to develop a reliable and accurate computer vision alternative to sensor or contact based mechanisms. The problem for many computer vision based systems are making good separation between the background and foreground, and teaching the computers what parts make up a scene. We also want to find features to classify the foreground moving objects, an easy task for a human, but a complex task for a computer. Video has been captured with a bird's eye view close to one of the entrances at the school about ten meters above the floor. From this video troublesome parts have been selected to test the changes done to the algorithms and program code.

JadhavSnehalDnyandeo[4] explained about vehicle control system using CAN protocol .In his paper he have given an effective way by which we can increase the car safety. This paper presents the development and implementation of a digital driving system. The ARM based data acquisition system that uses ADC to bring all control data from analog to digital format. The communication module used in this paper is embedded networking by CAN which has efficient data transfer. The CAN Protocol it was necessary for the different control systems (and their sensors) to exchange information. This was usually done by discrete interconnection of the different systems (i.e. point to point wiring). The requirement for information exchange has then grown to such an extent that a cable network with a length of up to several miles and many connectors was required. The benefits of CAN is effectively implemented in vehicle it is used for achieving automation, over other tradition schemes it will offer increase flexibility and expandability for future technology. Generally, a vehicle was built with an analog driver-vehicle interface for indicating various vehicle statuses like speed, fuel level, Engine temperature etc.

Sina[5] describes about Vehicle Counting and Speed Measurement Using Headlight Detection. CCTV is one of the tools that can be used to extract the needed traffic Information. Extracted information from image sequences of CCTV can give us real information about the number of passing vehicles and vehicles speed. In this paper we propose a new method in detecting the number of vehicles and vehicle speed measurement in low light conditions. Headlight detection is used in order to identify the existing vehicle. There are few steps in order to extract the information from CCTV. First for vehicle headlight detection, the vehicles are detected with normalized cross-correlation method and centroid-area-difference. The second step is vehicle tracking. Headlight is used to track the movements of the vehicle. The third step is vehicle counting and vehicle speed measurement; pin-hole and Euclidean distance methods are used to estimate the vehicle speed. We have compared the vehicle detection algorithm and vehicle counting-speed measurement. The result shows that the normalized cross correlation method has a higher accuracy than area-centroid difference. The pinhole model also is better in estimating vehicle speed compared to Euclidean distance.

Douglas W. Gage (1995) discusses the history of developments made in control of unmanned ground vehicles. The basic idea of a digital driving system and how to formulate digital driving system architecture have been discussed by Wuhong Wang (2002), C. Little (1999), GerdKrämer (2001), Fei-Yue Wang et al (2002), JulianKolodko et al (2003). Luis Manuel et al (2002) and Richard Bishop (2000) have dealt with the various features that can be included to improve the driving experience in a digital driving system. Tatsuya Yoshida et al (2004) discusses the concept of adaptive driving systems. U. Franke et al (1999) discusses various approaches to develop autonomous vehicles. The issues in developing a CAN based embedded network system have been dealt by Robert Boys (2004), Steve Corrigan (2002) and John Rinaldi et al (2003). The website of Microchip Inc. USA gives information about how to develop a CAN system using their microcontroller PIC 18F4685. The website of CAN in Automation (CiA) provides information about the basics of CAN protocol.

III. SYSTEM DESIGN

The whole design can be divided into two stages. First stage is the development of the three individual nodes with necessary hardware interface and software to implement the various tasks performed by them. Second stage is to implement CAN network between the master node and the slave nodes and develop additional software to achieve CAN based communication among the three individual nodes.

A. MASTER NODE DESIGN

The master node of the system and is implemented using a STM32F103C8T6 32bit ARM Controller. The hardware modules in MASTER Node circuit includes the Nextion TFT display unit, alarms for each of the system parameters in case of violation of user specified constraints. Serial port communication is also implemented between the master node and the host PC for Mat lab to update the pedestrian & headlight. The software part includes the Mat lab on the host PC for the serial port communication based HD camera acquisition preprocessing & decision making feature is developed using image processing and microcontroller programs for displaying the current status of the vehicle, and for monitoring the current status of the vehicle by processing various control information received from the slave nodes in the system.

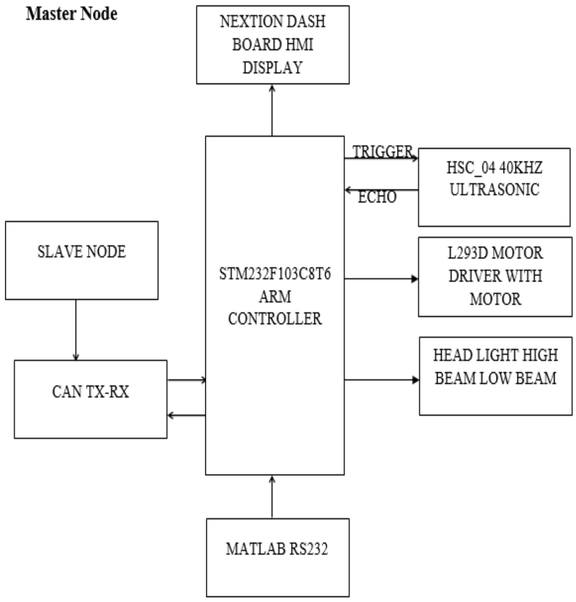

Figure 1: Block diagram of peripheral interface of master node

- Figure 1 shows the Peripheral Interface of Master Node. Master node which does multiple operations and makes the decision as according to the input provided by slave node and MATLAB. Master node is designed using STM32 series Arm controller operating at 72 MHz with the execution speed 1.2dmips.
- To provide visual information to this module 3.2 inch TFT Nextion display is with various field is used which gives various alerts in graphical part.
- 40KHZ Ultrasonic transducer is used to detect obstacle and generate the alerts. This sensor can scan the range of 400cm with scan angle of 32 degrees. Electrical burst signal of 10microsecond is sent through transmitter in the form of sound. This procedure is called trigger. Once the trigger is issued echo will be received from another transducer which converts sound in to electrical signal. Depending on the echo high time distance will be calculated with respect to sound equation.
- Four white led is used to simulate the headlight. In this LED’s two LED’s will be lit all the times and another two is controlled by STM. Beam changes information to the STM is received by MATLAB which checks the high intensity light through camera and process the information to the hardware.
- L293D h-bridge motor driver with a 5V dc motor is used to simulate the speed variation with respect to pedestrian & obstacle detection.
- Master node receives other information like temperature, fuel & sensor status from slave node using CAN. Over all process is handled by ARM parallel with the help of RTOs with various task and priority.
- Communication between master & slave node is done with the help of CAN at 100Kbs.

Master node receives information from slave node are as follows:

1. Temperature, fuel level& co2 detection.
2. Temperature alarm is set 70*c.
3. Fuel alarm is set to 5liters.
4. Gas alarm is set to 200ppm.

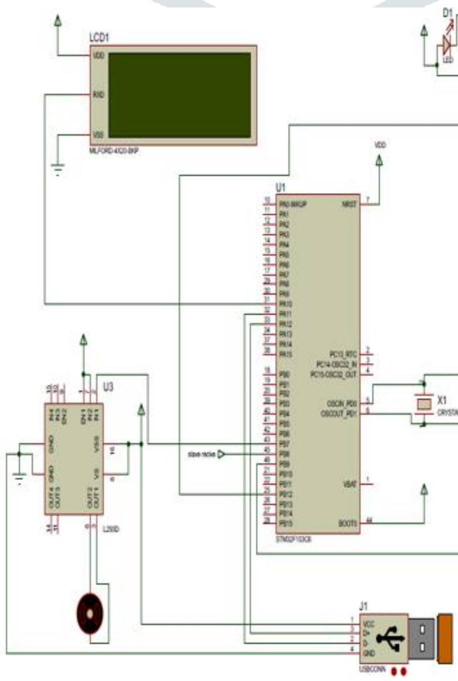

Figure 2: Design Diagram of Master Node using STM32F103C6

Figure 2 shows the design diagram of Master Node using STM32F103C6

- PA10 pin is configured with UART transmission port connected to RxD of Nextion display.
- PA11 pin is configured as an input to USBCONN data minus (D-).
- PA12 pin is configured as an input to USBCONN data plus (D+).
- PB7 pin is configured with L293D H-bridge motor of IN1 (U3).out1 & out2 pint is connected with motor.
- PB8 pin is a slave receiver from CAN reception pin.
- PB9 is configured as an input to output of SIG pin (send input to output pin).
- PB12 is configured as an input to output of LED.

B. SLAVE NODE DESIGN

Slave node is the system and is implemented using the same STM32F103C8T6 ARM controller used for master node implementation. The hardware modules in slave node circuit include the fuel level, temperature unit and gas detection unit. The software part includes microcontroller sub-routines to set up the current status of the vehicle, sensing any obstacle by using an ultrasonic combination and sending the current status signal to the display.

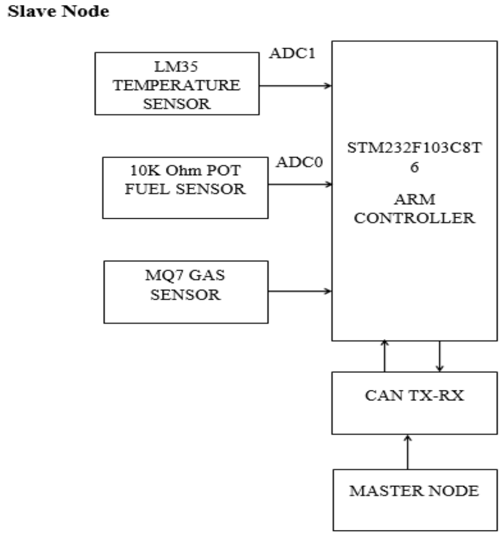

Figure 3: Block diagram of peripheral interface to slave node

- Figure 3 shows the Peripheral Interface to Slave Node. Slave node which does multiple operations and makes the decision as according to the input provided by master node and sensors. Slave node is designed using STM32 series Arm controller operating at 72 MHz with the execution speed 1.2dmips.
- Temperature measurement is done using LM35 analog sensor which provides voltage has according to variation to temperature.12-bit inbuilt ADC is used to convert voltage into digital values and convert in to degree centigrade.
- Fuel measurement is simulated using 10kohm pot configured as voltage divider. As according to voltage variation from 0 to 3.33volts is mapped as 0-100value by using 12-bit ADC channel 1.
- MQ7 carbon monoxide sensor with a platinum wire coated with SN02 on ceramic tube with equipped with heater electrodes is helpful in detecting co2.
- All the processed information from sensors is sent to master node using CAN.

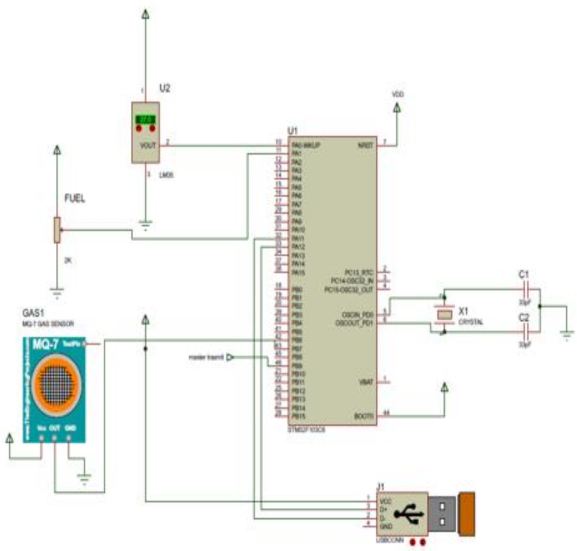

Figure 4: Design diagram of slave node using stm32f103c6

Figure 4 shows the design diagram of Slaver Node using STM32F103C6

- PA0 pin is an Analog channel as an input connected from LM35 (temperature sensor).
- PA1 pin is an input connected from Fuel Sensor (10K Ohm POT).

- PA11 pin is configured as an input to USBCONN data minus (D-).
- PA12 pin is configured as an input to USBCONN data plus (D+).
- PB7 pin is configured as an input to MQ-7 Gas sensor of output pin.

C. EMBEDDED NETWORKING PROTOCOL

Embedded networking based on CAN (Controller Area Network) protocol is used in the realizing the prototype. Accordingly, the microcontroller chosen namely STM32F103C8T6 from ST-semiconductors is a CAN enabled ARM controller.

Pedestrian and Drowsiness Detection Using Viola Jones Algorithm:

Driver drowsiness is one of the major reasons which lead to these mishaps. We are discussing a Real Time Drowsiness Detection System which could determine the level of drowsiness of the driver. This system considers both the closing of eyes as the constraints for determining the drowsiness. Viola Jones Algorithm is used for facial features detection. Primary attention is given to faster detection and processing of data. Driver drowsiness will be detected by checking whether the eyes are closed over some particular consecutive frames.

Measures for Detection of Drowsiness:

The study states that the reason for a mishap can be categorized as one of the accompanying primary classes:
(1) Human,
(2) Vehicular, and
(3) Surrounding factor.
The driver's error represented 91% of the accidents. The other two classes of causative elements were referred to as 4% for the type of vehicle used and 5% for surrounding factors.
Several measures are available for the measurement of drowsiness which includes the following:

1. Vehicle based measures.
2. Physiological measures.
3. Behavioral measures.

VEHICLE BASED MEASURES:

Vehicle-based measures survey path position, which monitors the vehicle's position as it identifies with path markings, to determine driver weakness, and accumulate steering wheel movement information to characterize the fatigue from low level to high level. In many research projects, researchers have used this method to detect fatigue, highlighting the continuous nature of this non-intrusive and cost-effective monitoring technique. This is done by:

- Sudden deviation of vehicle from lane position.
- Sudden movement of steering wheels.
- Pressure on acceleration paddles.

For each measures threshold values are decided which when crossed indicated that driver is drowsy.

Physiological Measures

Physiological measures are the objective measures of the physical changes that occur in our body because of fatigue. These physiological changes can be simply measure by their respective instruments as follows:

1. ECG (electro cardiogram).
2. EMG (electromyogram).
3. EOG (electro occulogram).
4. EEG (electroencephalogram).

Behavioral Measures

Certain behavioral changes take place during drowsing like

1. Yawning
2. Amount of eye closure
3. Eye blinking
4. Head position

VIOLA JONES ALGORITHM:

In videos of moving objects, one need not apply object detection to each frame. Instead, one can use tracking algorithms to detect salient features within the detection bounding boxes and track their movement between frames. Not only does this improve tracking speed by removing the need to re-detect objects in each frame, but it improves the robustness as well, as the salient features are more resilient than the Viola-Jones detection framework to rotation and photometric changes.

The problem to be solved is detection of faces in an image. A human can do this easily, but a computer needs precise instructions and constraints. To make the task more manageable, Viola–Jones requires full view frontal upright faces. Thus in order to be detected, the entire face must point towards the camera and should not be tilted to either side. While it seems these constraints could diminish the algorithm's utility somewhat, because the detection step is most often followed by a recognition step, in practice these limits on pose are quite acceptable.

Feature types and evaluation:

The characteristics of Viola–Jones algorithm which make it a good detection algorithm are:

- Robust – very high detection rate (true-positive rate) & very low false-positive rate always.
- Real time – For practical applications at least 2 frames per second must be processed.
- Face detection only (not recognition) - The goal is to distinguish faces from non-faces (detection is the first step in the recognition process).

The algorithm has four stages:

- Haar Feature Selection
- Creating an Integral Image
- Adaboost Training
- Cascading Classifiers

The features sought by the detection framework universally involve the sums of image pixels within rectangular areas. As such, they bear some resemblance to Haar basis functions, which have been used previously in the realm of image-based object detection. However, since the features used by Viola and Jones all rely on more than one rectangular area, they are generally more complex. The value of any given feature is the sum of the pixels within clear rectangles subtracted from the sum of the pixels within shaded rectangles. Rectangular features of this sort are primitive when compared to alternatives such as steerable filters. Although they are sensitive to vertical and horizontal features, their feedback is considerably coarser.

Haar Features:

All human faces share some similar properties. These regularities may be matched using Haar Features.

A few properties common to human faces:

- The eye region is darker than the upper-cheeks.
- The nose bridge region is brighter than the eyes. Composition of properties forming match able facial features
- Location and size: eyes, mouth, bridge of nose
- Value: oriented gradients of pixel intensities. The four features matched by this algorithm are then sought in the image of a face.

VEHICLE HEADLIGHT DETECTION USING BLOB ANALYSIS:

There are 7 steps in the Headlight Detection Algorithm.

They are:

- Image Acquisition
- Image Gray scaling
- Noise Filtering
- Image Binarization
- Morphological operations to the image
- Light Blob area calculation
- Conversion of High Beam to Low Beam

The above steps have been discussed in detail as follows.

1. Image Acquisition: The video sequence is acquired from a camera (CMOS Camera). A video sequence needs to be sampled in to multiple frames before applying the image processing techniques and those set of frames are the inputs to the subsequent stages of the system. The function called win video (), which is a built-in function in MATLAB is used in this step.

2. Image Grayscaling: Converting color images into grayscale images is the first step of the pre-processing. Gray scaling removes the color values of an image and simplifies computational time significantly compared to a color RGB image. The function called rgb2gray (), which is a built-in function in MATLAB is one such method.

3. Noise Filtering: After gray scaling the image, it had to go through the filtering process to filter out any noise in the image. The filter used in this work is a median filter which is used to reduce the "salt and pepper" noise. Median filter is more effective because it reduces noise as well as preserve the edges. The function medfilt2 () is a built-in function in MATLAB, which performs the median filtering operation.

4. Image Binarization: After the filtering process, we have to determine the threshold to convert the grayscale image to binary image. The function im2bw () is a built-in function in MATLAB, which performs the thresholding operation and converts the image from grayscale to binary.

5. Morphological Operations: To The Image: To enhance the binary image, we apply different morphological operations, in the binary image, some areas of the headlight have black pixels which need to be filled to get more accurate results. The function infill () is a built-in function in MATLAB, which performs the filling operation on the binary image.

6. Light Blob Area Calculation: After the morphological operations, we then calculate the number of white pixels present in the binary image.

7. Conversion of High Beam to Low Beam: After calculating the area of the number white pixels we then compare it to our threshold value. This threshold value is calculated from a binary image in which the vehicle is at a distance of certain distance for headlight detection

IV. CONCLUSION AND FUTURE SCOPE

CAN is ideally suited in applications requiring a high number of continuous messages with high reliability in automobiles. Since CAN is message based and not address based, it is especially suited when data is needed by more than one location and system-wide data consistency is mandatory. Fault detection is also a major benefit of CAN. The safety measures include temperature & fuel monitoring, gas detection, pedestrian detection, headlight detection & drowsy driver detection and accident alert system are provided in this safety system.

As research and development is an endless process, there is always a chance to improve any system. This system has no exception to this phenomenon and the following improvement can be done: Lane monitoring, emergency vehicle alert, navigation using nextion HMI display, dash cam implementation.

V. RESULTS AND DISCUSSION

Figure 5 shows the detection of multiple pedestrian at various ranges using viola jones algorithm that uses cascade object detector including the features of human upper body like eyes, face and shoulder. The model can detect multiple pedestrians for about 40 to 50 feet.

Figure 5: Pedestrian Detection

Viola jones algorithm uses facial features like eyes to detect if the eyes are closed or not. If the eyes seem to be closed like in figure 6, an image through the camera will be detected and sent to MATLAB and an alert will be generated informing the driver to slow down and take rest. If the driver does not acknowledge the motor automatically slows down the vehicle and stops.

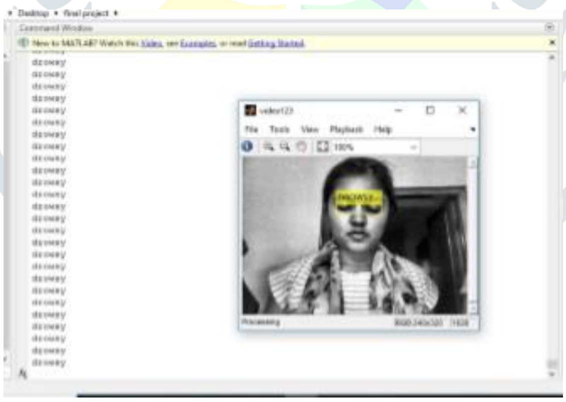

Figure 6: Drowsy detection

As we have discussed earlier about the problems faced by drivers while traveling at night due to the lights in opposite direction, this model will help in reducing it but detecting the light through the camera based on blobs and switching to low beam to reduce the strain on eyes. The figure 8.5 shows the light detected.

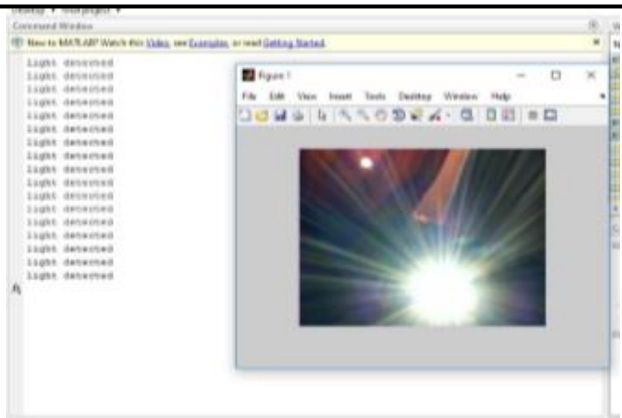

Figure 7: headlight detection

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