ADVANCED DRIVER ASSISTANCE SYSTEM

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Abstract: 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 behaviour of the vehicle.

***Index Terms* - Pedestrian detection; Headlight detection & beam change indication; Front camera with drowsy detection using image processing; sonar to detect obstacle; Gas detection**

I. INTRODUCTION

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 thresholding, 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 thresholding 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 neighbour data association are used.

Sensing vehicles ahead and traffic situations during driving are important aspects in safe driving, accident avoidance, and automatic driving and pursuit. We designed a system that is capable of identifying vehicles ahead, moving in the same direction as our car, by tracking them continuously with an in-car ultra-sonic. The fundamental problem here is to identify vehicles in changing environment and illumination. Although there have been numerous publications on general object recognition and tracking, or a combination of them, not many of these techniques could successfully be applied in real time for in-car video, which has to process the input on-the fly during vehicle movement. This paper introduces an effort to design and implement such real-time oriented algorithms and systems that are highly adaptive to the road and traffic scenes based on domain-specific knowledge on road, vehicle, and control.

The major challenge of pedestrian protections systems (PPSs) is the development of reliable on-board pedestrian detection systems. Due to the varying appearance of pedestrians e.g., different clothes, changing size, aspect ratio, and dynamic shape and the unstructured environment, it is very difficult to cope with the demanded robustness of this kind of system. Two problems arising in this research area are the lack of public benchmarks and the difficulty in reproducing many of the proposed methods, which makes it difficult to compare the approaches. As a result, surveying the literature by enumerating the proposals one-after-another is not the most useful way to provide a comparative point of view.

II. OBJECTIVE

Below of the objective of the work:

1. To design a prototype to ADAS using CAN.
2. To develop an HMI interface for generating alerts using Nextion display.
3. Enabling communication between master & salve using CAN protocol.
4. To integrate sonar to detect obstacle.
5. To integrate Gas detection & alert using MQ7 in slave.
6. To integrate temperature & fuel sensor to slave for continuous monitoring.
7. Pedestrian detection & alert generation using image processing.
8. Headlight detection & beam change indication using image processing.
9. Front camera with drowsy detection using image processing.

III. DESIGN CONCEPT

The design involves combination of both hardware and software. The hardware part includes building the electro-mechanical model for the vehicle, developing circuits for implementing the individual nodes, interfacing the various sensors associated with the tasks of the slave nodes, a display system to show the status of the vehicle as user-friendly data and an alarms to indicate any violation of the user specified constraints for the vehicle operation. The software part includes programming the CAN nodes to carry out specific tasks like temperature monitoring, obstacle sensing, movement of the vehicle, adaptive lighting system, pedestrian, fuel monitoring, gas detection displaying the digital values of various parameters being monitored by the slave nodes, raising alarms for any violation of the user constraints for operation of the vehicle, remote control of the vehicle etc. The software part also includes defining the digital driving behaviour followed by the vehicle during operation. The digital driving behaviour includes prescribed temperature limits, optimum fuel level, and obstacle detection mechanism. In the design of the vehicle system, a CAN network is implemented between one slave nodes and a master node where the slave nodes are responsible for various tasks that are encountered in operating a normal vehicle and the master node is responsible for processing the information obtained from the slave nodes and overall control of the vehicle with Mat lab image processing. The whole design can be grouped into three modules.

The first module consists of the design related to the master node & slave node. Master node & slave node is responsible for temperature monitoring and fuel monitoring & Co2 detection. Analog-to-digital converter is used to convert the analog temperature to digital data and the digital data is sent to the master node for display.

The second module consists of the design related to the master node & slave node. Master node & slave node is responsible for obstacle sensing and implementing the adaptive light control and communicating with Mat lab for detecting pedestrian & drowsy. Obstacle sensing is achieved by using a sonar combination. The transmitter keeps sending an ultrasonic signal continuously and if there is an obstacle, the transmitted signal is reflected back which is sensed by the receiver. The receiver is continuously monitored for any signal so that when an obstacle is present, a signal is sent to the master node to indicate the presence of an obstacle

Finally, slave node is integrated into the CAN network and the node are additionally programmed to work as a CAN communication based single control system to achieve overall control of the digital driving system for the vehicle through a single master node.

IV. 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. This 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.

Jadhav Snehal Dnyandeo[4] explained about vehicle control system using CAN protocol. In his paper he has 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 are 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.

V. HARDWARE DESCRIPTION

The brief description about the hardware components used in this project are

1. CCD and CMOS Cameras
2. STM32F103C8PROCESSOR
3. Nextion Dash Board HMI Display
4. Ultrasonic Sensor
5. LM35
6. MQ7 Sensor

5.1 CCD and CMOS Camera

Vision development can be divided into the two main classes of image acquisition and image processing. Image acquisition is a system that employs a camera to capture different types of image in terms of resolution, using different lenses. Currently, there are two types of digital camera technologies: charged coupled device (CCD), and complementary metal oxide semiconductor (CMOS). The CCD camera is the most basic type used in robotic vision systems nowadays. The CCD chip is designed from a group of light sensitive picture elements called pixels and normally includes between 20,000 and several million pixels. These pixels are considered to be discharging capacitors that can be as small as 5 to 25 μm. The problem with this type of cameras is that their capacitors of all pixels need to be fully charged before the process of reading can occur. The reading process is performed at one corner of the CCD chip. This means that each charge should be sustainably transferred across the chip in a row and a column to reach one specific corner. This procedure requires a precise technique to ensure the stability of the transported charge.

5.2 STM32F103C8PROCESSOR

The STM32F103xx medium-density performance line family incorporates the high-performance ARMCortex-M3 32-bit RISC core operating at a 72 MHz frequency, high-speed embedded memories (Flash memory up to 128 Kbytes and SRAM up to 20 Kbytes), and an extensive range of enhanced I/Os and peripherals connected to two APB buses. All devices offer two 12-bit ADCs, three general purpose 16-bit timers plus one PWM timer, as well as standard and advanced communication interfaces: up to two I2Cs and SPIs, three USARTs, an USB and a CAN.

Fig.1. STM32F103C8 Processor

5.3 Nextion Dash Board HMI Display

Nextion is a Seamless Human Machine Interface (HMI) solution that provides a control and visualization interface between a human and a process, machine, application or appliance. Nextion is mainly applied to IoT or consumer electronics field. It is the best solution to replace the traditional LCD and LED Nixie tube.

Nextion includes hardware part (a series of TFT boards) and software part (the Nextion editor). The Nextion TFT board uses only one serial port to communicate. It lets you avoid the hassle of wiring. We notice that most engineers spend much time in application development but get unsatisfactory results. In this situation, Nextion editor has mass components such as button, text, progress bar, slider, instrument panel etc. to enrich your interface design. And the drag-and-drop function ensures that you spend less time in programming, which will reduce 99% of your development workloads. With the help of this WYSIWYG editor, designing a GUI is a piece of cake.

5.4 Ultrasonic Sensor

An Ultrasonic Sensor consists of three wires. One for Vcc, second for Gnd and the third for pulse signal. The ultrasonic sensor is mounted on the front side both of them further connected to the STM board. The ultrasonic sensor uses the reflection principle for its working. When connected to the STM, the STM provides the pulse signal to the ultrasonic sensor which then sends the ultrasonic wave in forward direction. Hence, whenever there is any obstacle detected or present in front, it reflects the waves which are received by the ultrasonic sensor. If detected, the signal is sent to the STM and hence to the Nextion to the display that shows the presence of the obstacle in front of the vehicle

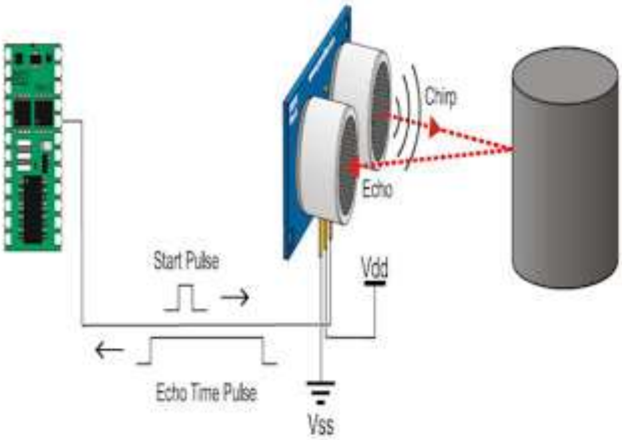

Fig.2. Ultrasonic Sensor

5.5 LM35

LM35 is temperature sensor as shown in Fig.3 incorporate with multiple yield output voltage in analog format it's a low impedance type direct output interfacing to particular control with ADC input and consumes broadly 60µA from supply. In this project these sensors are used to monitor the temperature of the engine

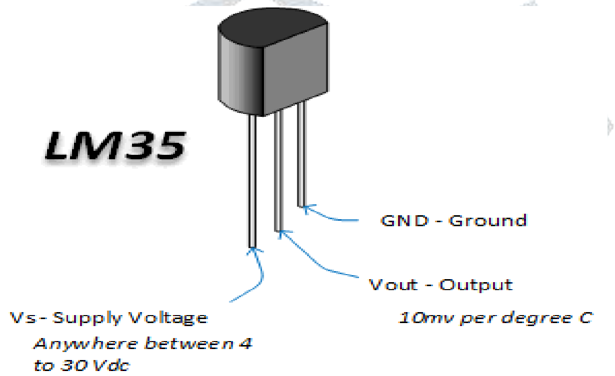

Fig.3. LM35 Temperature Sensor

5.6 MQ7 Sensor

The basic components of two electrode gas sensors are a working (sensing) electrode, a counter electrode, and an ion conductor in between them. When toxic gas such as carbon monoxide (CO) comes in contact with the working electrode, oxidation of CO gas will occur on the working electrode through chemical reaction with water molecules in the air

$$CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^- \ldots \ (1)$$

Connecting the working electrode and the counter electrode through a short circuit will allow protons (H^+) generated on the working electrode to flow toward the counter electrode through the ion conductor. In addition, generated electrons move to the counter electrode through the external wiring. A reaction with oxygen in the air will occur on the counter electrode (see Equation 2).

$$(1/2)\ O_2 + 2H^+ + 2e^- \rightarrow H_2O \ldots \ (2)$$

The overall reaction is shown in Equation 3. Figure Electrochemical-type gas sensor operates like a battery with gas being the active material for this overall battery reaction.

$$CO + \ (1/2)\ O_2 \rightarrow CO_2 \ldots \ (3)$$

By measuring the current between the working electrode and the counter electrode, this electrochemical cell can be utilized as a gas sensor.

VI. Software Description

6.1 Methodology for Image Processing

6.1.1 Computer Vision

Computer vision is one of the most interesting subjects for scientists, since it plays an important role in many applications such as video surveillance, robot navigation, road traffic analysis, etc. Machine vision has six parameters, as follows

1. Sensing: which deals with the visual image
2. Pre-processing: which is used for noise reduction, image enhancement, etc
3. Segmentation: which is concerned with image partitioning into the desired object

4. Description: This is the computation of the object features.
5. Recognition: Used to identify the object.

Interpretation: Used for assigning meaning to the recognized object

While driving at night, vehicles on the road are primarily visible by red colored rear facing lamps and clear colored headlamps. While all vehicle lamps will differ in appearance, they must adhere to automotive regulations which provide a set of characteristic features that can be utilized by image processing systems for identification.

6.1.2 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. Behavioural measures

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

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

Vehicle headlight detection using blob analysis

There are 7 steps in the Headlight Detection Algorithm.

They are:

1. Image Acquisition
2. Image Gray scaling
3. Noise Filtering
4. Image Binarization
5. Morphological operations to the image
6. Light Blob area calculation
1. Conversion of High Beam to Low Beam

VII. METHODOLOGY AND IMPLEMENTATION

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.

7.1 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 MATLAB 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 pre-processing & 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.

7.2 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.

VIII. Block Diagram

8.1 Master Node:

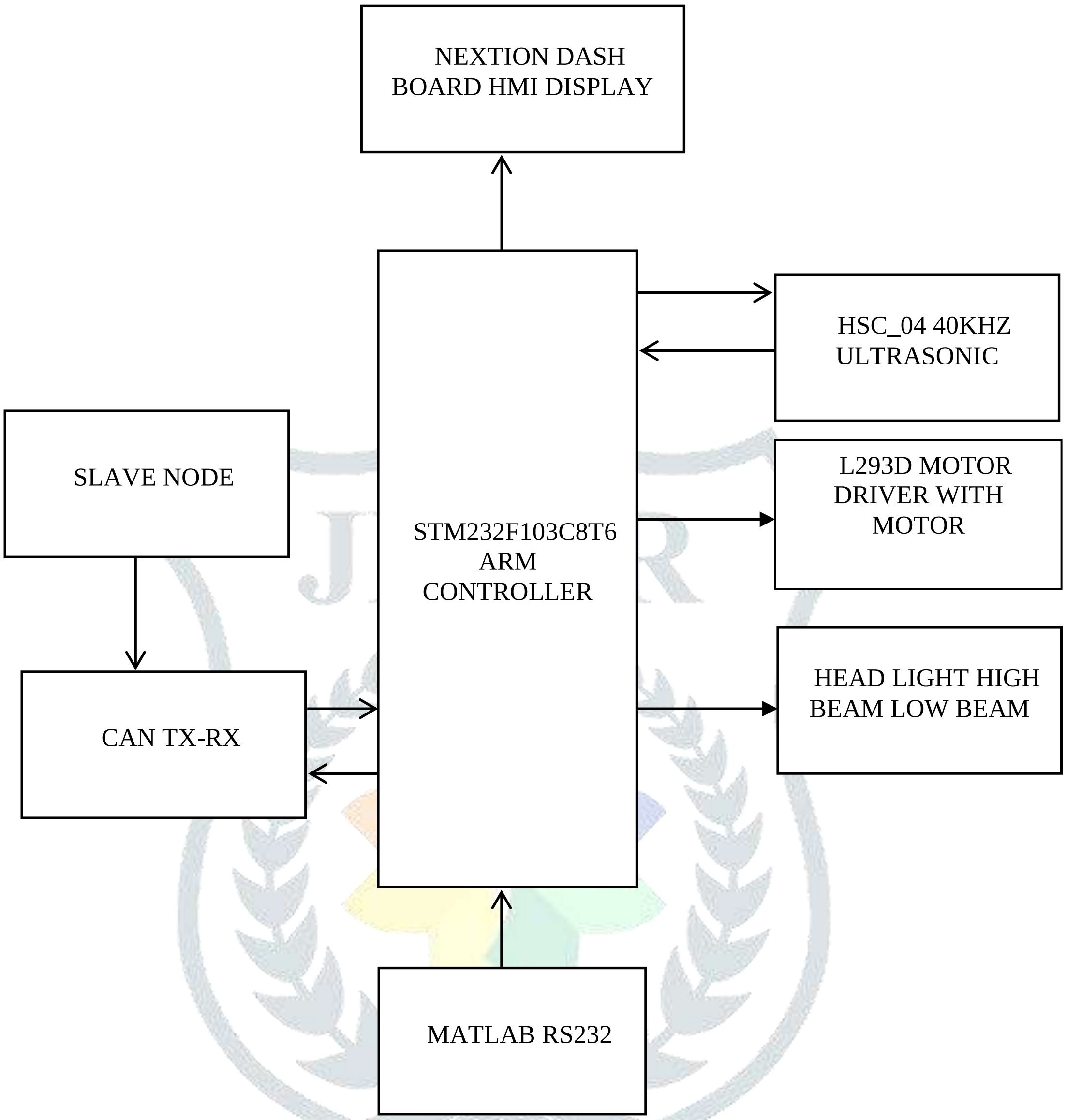

Fig.5. Master Node Block diagram

8.2 Slave Node:

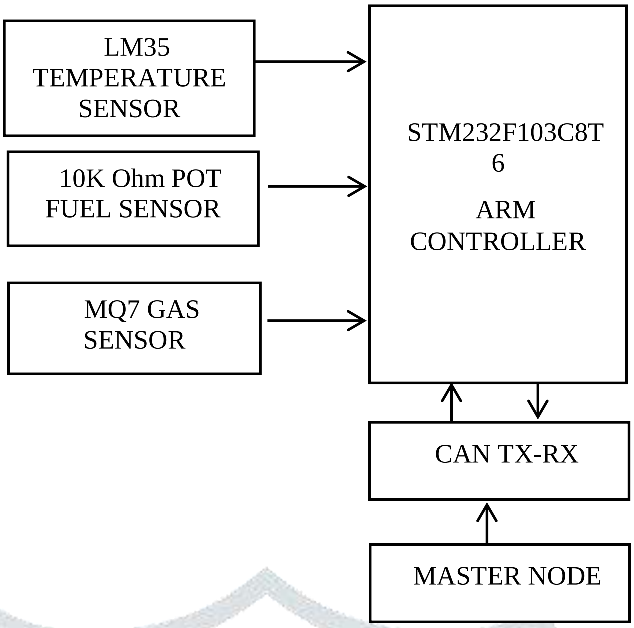

Fig.6. Slave Node Block diagram

- 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 degree. 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.
- Master node receives other information like temperature, fuel & sensor status from slave node using CAN. Over all process is handled by ARM parallelly 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:
    - Temperature, fuel level& co2 detection
    - Temperature alarm is set 70*c
    - Fuel alarm is set to 5liters
    - Gas alarm is set to 200ppm

Slave node which does multiple operations and makes the decision as according to the input provided by master node and sensors.

- 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.

IX. Conclusion

- 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.

X. FUTURE IMPLEMENTATION

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.

The following improvement can be done:

Lane monitoring, emergency vehicle alert, navigation using Nextion HMI display, dash cam implementation.

XI. REFERENCES

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