Cost Effective Road Accident Prevention System

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Abstract— **In the current scenario one of the major causes of road accidents in the world is the fact that after driving hundreds of kilometers at a stretch, the driver feels drowsy and eventually dozes off while driving or they are not aware of the environment they might just be entering. They might also be unaware of any defect in their cars. There is an alarming increase in hit and run cases caused by drivers driving under the influence of alcohol. So, there is a pressing need of a device which prevents this, so that a lot of lives can be saved every day.**

Safety is the primary concern for humans. When it comes to driving, we need to be extra cautious. So, this project aims at developing an affordable solution to these safety concerns.

The proposed system will be mounted on a car, in front of the driver's seat, which will continuously focus on the person driving the vehicle thereby monitoring the person's actions and give voice messages to the driver, instructing him about the safety procedures every time he comes inside the car. If he found to be drowsy, he is alerted by a voice message telling him that he is drowsy and he should stop the car. If he is found to be under the influence of alcohol or tailgating while driving, the GPS coordinates of the car along with the details of the car, are sent to the nearest control room, so that appropriate action can be taken by the police.

So, this system has the capability of ensuring the driver's safety along with the co-passengers and can easily be integrated with the existing safety systems in the car. This will also enhance overall road safety, by reporting any kind of reckless driving to the nearest control room. In future, it can be enforced by law for every car to have such a safety system installed for driver and passenger protection. Hence the system is a complete solution which prevents accidents, so that a lot of lives can be saved every day.

Keywords—road safety, drowsy driving, reckless driving, following traffic rules, penalty, GPS coordinates.

I. INTRODUCTION

According to the statistics of 2013, more than 443,000 road accidents were reported in India with resulting in 147,423 deaths. India has one of the most dangerous roads in the world, with one person dying every five minutes in an accident. And this might increase to one death every three minutes by 2020 if there is no change in the current driving patterns.

Additional statistics show that it is often India's young and middle-aged who are more prone to deaths on Indian roads. In the year 2014, as many as 35% of those killed were in the age group of 30-44 years. The age group 15-29 years accounted about 31% of the total deaths.

The annual socio-economic cost of these road accidents, as estimated by the Planning Commission of India is about 3% of the gross domestic product. Taking that estimate into account, the cost of road accidents in India would amount to Rs. 3.8 lakh crores ($60 billion).

II. Basic Framework

The overall system block diagram is shown in Figure 1. The Passive Infra Red Proximity sensor checks for the presence of driver in the car and activates the system. The system is designed in such a way that it monitors the state of the driver and checks if he is breaking any rule. The five primary functions of the system are:

- Driver Drowsiness Detection (using Intel Real Sense Camera)
- Tailgating Detection (using proximity Sensor)
- Detecting if the driver is under the influence of alcohol (using MQ3 sensor)
- Detecting if the driver is speaking on the phone while driving (using EMF sensor)
- Ensuring that the driver has fastened his/her seatbelt.

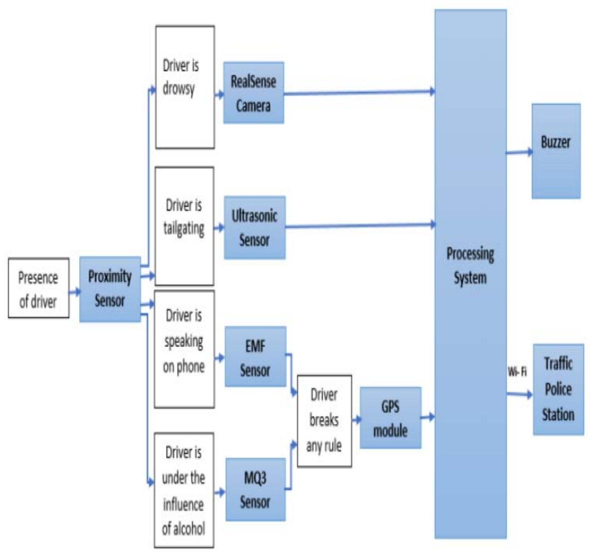

Fig. 1. Block Diagram

III. Overall Architecture

Figure 2 shows all the interfaces used in the prototype of the system.

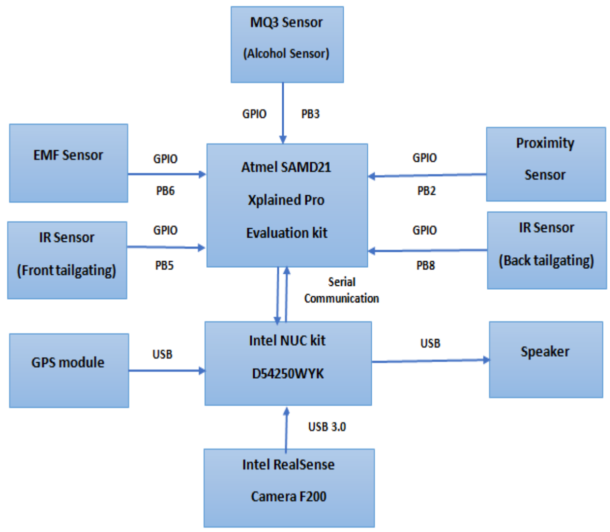

Fig. 2. Interfacing Diagram

The sensors connected to Atmel SAM D21 Xplained Pro will provide the input to it through the GPIO pins. These values will be transmitted to the Intel NUC Kit through serial communication. The Intel NUC Kit also has the Intel Real Sense camera connected to it which will perform drowsiness detection and a GPS module which will obtain the exact coordinates of the car. Based on the sensor and camera input, necessary message will be given to the driver using the speaker and the GPS coordinates can be sent to the nearest control room.

A. Microcontroller

The microcontroller used is Atmel SAM D21 Xplained Pro evaluation board which uses the ATSAMD21J18A microcontroller based on ARM cortex M0+ processor. It is a low power microcontroller operating on a 48MHz clock frequency and contains 52 I/O pins and a 12 bit ADC with 20 channels.

B. Processor

Next Unit of Computing (NUC) is a small-form-factor (SFF) personal computer (PC) designed by Intel. This NUC used in this project is the Intel NUC Kit D54250WYK. It contains an Intel Core i5-4250U processor, memory expandability capability of up to 16 GB, one Display Post, one mini HDMI port, USB 3.0 ports, Intel® Gigabit LAN, consumer infrared sensor and a headphone/microphone jack.

C. Camera

Intel RealSense is a platform for executing gesture-based human-computer interaction techniques. It consists of series of consumer grade 3D cameras supporting an easy to use machine perception library that simplifies supporting the cameras for third-party software developers.

The four primary components of an Intel RealSense camera are: a conventional high definition camera, an infrared laser projector, an infrared camera, and an array of microphone.

The infrared projector projects a grid onto the scene (in infrared light which is invisible to human eye) and the infrared camera records it to compute depth information. The microphone array allows localization of sound sources in space and performs background noise cancellation.

The camera used for this project is the Intel RealSense F200. This is a stand-alone camera that can be attached to a desktop or laptop computer. It is intended to be used for natural gesture-based interaction and face recognition. It has a full VGA depth resolution, 1080p RGB camera,0.2–1.2 meter range and a USB 3.0 interface

D. Sensors

1)Ethanol Sensor

MQ-3 is a semiconductor sensor for detecting the presence of ethanol. It has high sensitivity to ethanol and fast response time, suitable for developing portable alcohol detectors. The sensitive material of MQ-3 gas sensor is SnO2, which possesses lower conductivity in clean air. The sensor's conductivity increases with the increase in the concentration of gas. MQ-3 gas sensor has high sensitivity to ethanol, and has good resistance against gasoline, smoke and vapour. This sensor can be used to detect alcohol with different concentrations of ethanol. The sensor used in this project has a detection range of 10 - 1,000 ppm CO, response time of <150s and needs a supply voltage of 5.0V

2) *Proximity Sensor*

The PIR Sensor HCSR-501 module can be used to sense motion. It is one of the most common methods of detecting the motion of a human body within the range of the sensor. This module consists of an on-board pyro-electric sensor, a signal conditioning circuitry and a dome shaped Fresnel lens. The sensor used in the project has a working voltage range of DC 4.5V- 20V, current drain of <60, detection Range of <140°, voltage Output of High/Low level Signal 3.3V TTL output and detection distance of 3 to 7m which can be adjusted using a potentiometer.

3) Infrared Sensor

The 3mm infrared transceiver module contains an infrared transmitter and a receiver. Transmitter emits infrared light and another receiver (photo-transistor) receives that IR light after reflection. The module has both analog and digital output. Analog output can be used to calculate the distance to the nearest object while digital sensor can be used to trigger an action when the module detects an obstacle. It has on-board LEDs to indicate if the module is connected properly and to indicate if the threshold values are touched. It has a proximity range up to 7 centimeters depending on the obstructing object, surrounding environment and ambient light.

4) EMF Sensor

The EMF sensor has been built by us using discrete components. This is to test if the driver is talking on phone while driving. If that is the case, it will sense the change in the EM Radiation near to him and give him a warning. The circuit is built using the IC NE555, and uses a filter made up of an inductor and capacitor to filter a particular range of frequencies. The LED D2 glows when the driver talks on the phone in the proximity of this EMF sensor.

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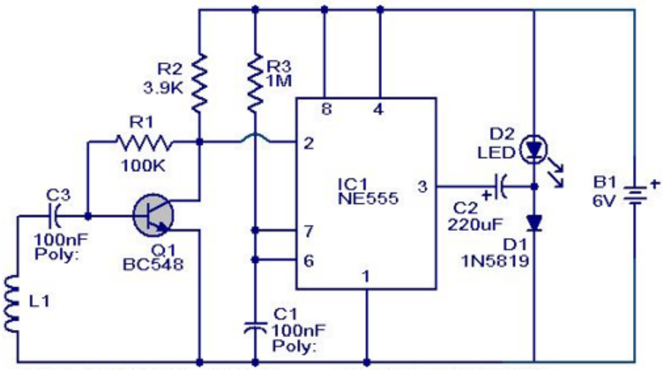

Fig. 3. Circuit for EMF Sensor

E. GPS Module

It is a compact and accurate GPS receiver with low power consumption that plugs into the USB port of a computer. Based on SiRF Star III chipset technology, the GPS receiver provides accurate GPS positioning within 1 to 5 meters. The receiver tracks up to 20 satellites at a time, re-acquires satellite signals in about 100 milliseconds and updates position data every second. Data output by this GPS receiver includes latitude/longitude/altitude, velocity, date/time and satellite and receiver status.

An internal rechargeable Lithium-ion battery sustains the internal clock and memory and is recharged during normal operation.

F. Data Transmission

The GPS coordinates and the details of the driver are transmitted over Wi-Fi using an ESP-8266 NodeMCU. NodeMCU is an open source IoT platform. It uses the Lua scripting language.

IV. DROWSINESS DETECTION

Driver drowsiness detection is performed using the Intel RealSense F200 camera connected to the Intel NUC Kit D54250WYK. It is a 3D camera which uses IR for night vision. It uses the following C# modules of the Intel RealSense SDK.

A. Face Recognition

The general concept of face recognition is to measure similarity between two faces, one from the current image, and the other one from some references in a recognition database. The measurement is performed on all references in the database. A user is considered recognized if the score of the most matched reference passes certain threshold, and the recognition result is simply the user identifier that is associated with the reference.

The face location data includes the following information:

1) *Bounding box*: The bounding box is a rectangular region, in the color pixels, where the detected face is. The bounding box may or may not exactly match the detected face size.
2) *Average depth*: The average depth value indicates how far away the detected face is to the camera.

The algorithm supports the following groups of expressions

- Head Movement
- Eyebrow Movement
- Eye Movement
- Mouth Movement

B. *Gaze Tracking*

The algorithm provides the following parameters:

- *Gaze Point*: The 2D screen point where the gaze lands
- *Gaze Angles*: The horizontal and vertical angles originating from the eye and directed to the screen

C. *Emotion Tracking*

Among the detected emotion parameters the two parameters intensity and evidence determine how likely the face might perform the emotion:
1)Evidence: This value represents the odds in 10-based logarithmic scale of a target expression being present. For instance, the value 2 indicates that an emotion is 100 (=102) times more likely to be categorized as present than not present; while the value -2 indicates that an emotion is 100 times more likely to be categorized as not present than present.

Evidence is more useful when an application needs to know whether a particular emotion is present.

2) Intensity: This value shows the perceived intensity of the emotion as estimated by human experts as follows:

Value Interval	*Description of Emotion Expression*
[0.0, 0.2]	expression is likely absent
[0.2, 0.4]	expression is of low intensity
[0.4, 0.6]	expression is of medium intensity
[0.6, 0.8]	expression is of high intensity
[0.8, 1.0]	expression is of high intensity

Intensity is more useful when an application needs to quantify the strength of the emotions.

Intensity has a non-linear relationship with evidence. As intensity increases, evidence increases. As a subjective scale, intensity is more intuitive than evidence but it is more sensitive to variations. It is recommended that the application uses evidence to determine an outstanding emotion state out of all emotion data.

The module exposes scores for multiple emotion states. It is possible that a person in the picture expresses more than a single emotion state, for example, surprising with joy.

V. DATA PROCESSING

The Intel NUC Kit D54250WYK is the centralized processing unit for the entire system. The sensors are connected to the Atmel SAM D21 Xplained Pro evaluation kit. This in turn sends the data serially to the Intel NUC Kit. The NUC Kit performs the required actions in accordance with the serial values received from the Atmel SAM D21 Xplained Pro board.

The Intel NUC uses a C# script for Voice Synthesis used to give audio messages to the driver. The voice synthesis script uses a Text to Speech conversion algorithm, to convert the written messages into audio messages.

The GPS module is connected to the Intel NUC at the USB 3.0 port. The GPS coordinates are received by the NUC on a serial terminal and are stored in a text file. Whenever it is required to send the data to the control room, this text file is transmitted over Wi-Fi using the ESP-8266 NodeMCU.

VI. RESULTS OBTAINED

1) Sensor values obtained from Atmel SAM D21

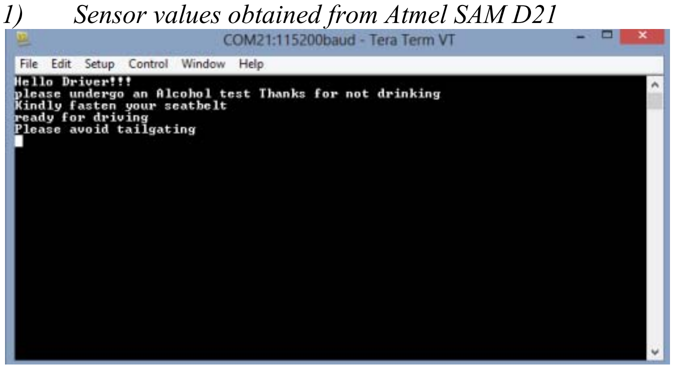

Fig. 4. When the driver starts tailgating

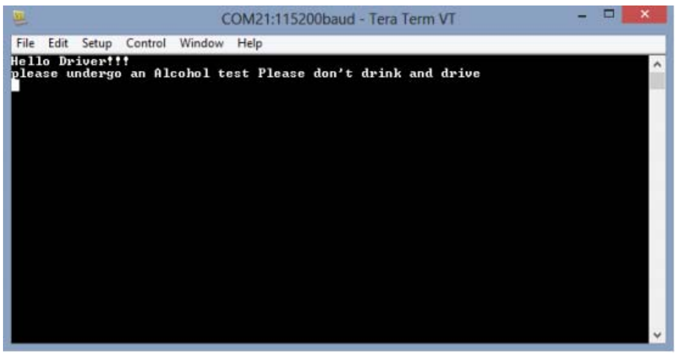

Fig. 5. When the driver is under the influence of alcohol

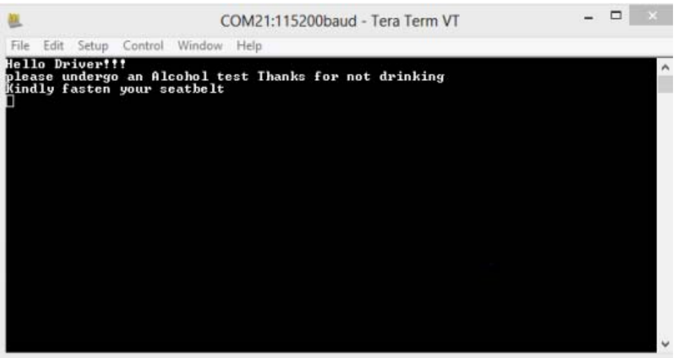

Fig. 6. When the seatbelt is not fastened

2) Output on the Microsoft Visual Studio 2013 GUI when appropriate serial value is received

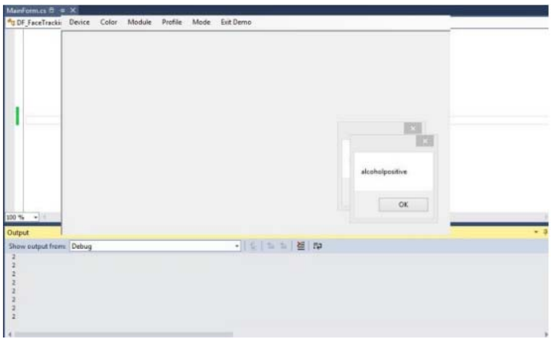

Fig. 7. Message box when the driver is found to be under the influence of alcohol

3) GPS Coordinates

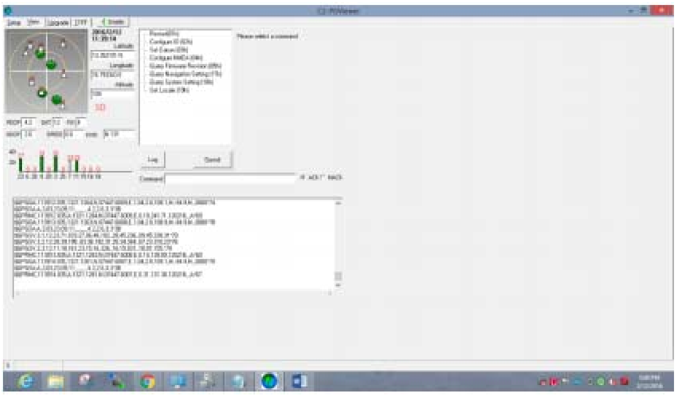

Fig. 8. GPS Coordinates with the relative position of the sattelites tracked

4) Drowsiness Detection

Fig. 9. Voice message to alert the driver when he is drowsy

VII. FURTHER IMPROVEMENT AND SCOPE

1) A driver safety mechanism, which will consist of an emergency switch, which when pressed, will send the GPS coordinates of the car with a "HELP" message to the nearest control room.
2) Using gas sensors to monitor the air quality inside the car, as hazardous gases and suspended particulate matter may cause adverse effects on the driver. This system can be used to alert the driver, in case any hazardous gases are found.
3) Further testing and calibration to make the system suitable for the Indian roads
4) Integration of the system with the existing safety systems present in a car.

VIII. CONCLUSION

With the increase in the number of vehicles on roads, an alarming increase in the number of road accidents has been observed, many of which prove to be fatal for the drivers, co-passengers and pedestrians. Most of the road accidents are caused by the reasons mentioned in this paper.
So, there is a pressing need of implementing such a system in every car, so that road accidents can be prevented, making our roads safer for one and all.

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