DRIVE ASSIST-AN IOT AND MACHINE LEARNING BASED DRIVER ASSISTANT FOR A SAFER NIGHT JOURNEY

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Abstract

We live in a world where, as the years go by the count of cars on lane increases exponentially and the workload and stress on each professional raise beyond their threshold. Even though many multinational companies have introduced automated driverless cars it's practically not affordable to the common men. We propose a smart system, "Drive assist" that can be introduced as a portable kit to ensure the reduction in the rate of night road accidents and a safe night journey. The main advantage of the proposed system is that it can be incorporated to any existing car models that most common men of any part of the world can afford. The system consists of four modules, first module is the drowsiness detection system which uses a NOIR camera to accept the live feed of the driver in low light and checks if he's drowsy or not. If he's found to be drowsy the system will alert him. Subsequently the second module of the system is a drunken driver detection system which prevents the driver from driving the car if he's found to be drunk and alert him and his relatives/officials regarding the same. The third module is an accident alert system which alerts the officials and his friends/relatives with the live location of the car if he encounters with a sudden accident. The fourth module is an Anti-theft support system which provides valid evidences to the law and order maintenance officers, if the owner's car is found to be missing. The system can provide the live location of the car and can even take a photo of the thief if needed. All these features can be controlled through the mobile application named drive assist.

Keywords: *Image processing, Machine learning, EAR ratio, IoT.*

1. Introduction

Drunken and drowsy driving are major reasons behind road crashes worldwide. The Metropolitan Region of Mumbai saw a 22 percent increase on New Year's Eve in drunk driving cases, from 2,444 in 2017 to 2,985 in 2018[1]. Critics have often cited the National Crime Records Bureau's report on Accidental Deaths and Suicides in India 2015 from the two-official study of road accidents. The report suggests that approximately 1.5 percent of all 4.64 lakh road accidents were caused by drunken driving or driving under drug or alcohol influence, resulting in injury to 6,295 people. According to the study, however, the crime resulted in 2,988 deaths— more than 8 deaths a day— representing just over 2% of all road accident fatalities [2]. All these studies show us that how drunk driving provides a threat to the people, similarly Drowsy driving is a big issue in many parts of the world. The chance of drowsy driving, danger and often tragic results are troubling. Drowsy driving is the dangerous combination of driving and exhaustion or sleepiness. It usually happens when a driver has not slept enough or due to untreated sleep disorders, drugs, drinking alcohol, or changing jobs, it can also happen [3].A survey shows that on average 1 in 25 adult drivers (aged 18 or older) report having fallen asleep while driving .The National Highway Traffic Safety Administration reports that drowsy driving accounted for 72,000 accidents, 44,000 injuries and 800 deaths in 2013
[3]. All of these studies indicate significant human lapses and preventable causes of death, which can be avoided by adequate monitoring and warning technologies. It is therefore essential to develop a holistic,

non-intrusive system to monitor the physical and facial movements of a person continuously and to alert them at critical moments to prevent road accidents, thereby significantly preventing serious injury and loss of life.
This drive assist system also helps a user when he encounters with an accident or even when his car gets stolen. Motor vehicle crime is the least-resolved offense according to police department in Delhi. In 2018, more than 44,000 cars were stolen but less than 20 percent of those were solved. The number of cars recovered safely in usable condition is probably significantly smaller than this [4]. Also, as a result of a road traffic accident, the lives of nearly 1.35 million people are cut short each year. About 20 to 50 million more people suffer non-fatal injuries as a result of their attack, with many incurring a disability [5]. It is at this point where the relevance of the drive assist technology boosts up.

2. Literature Review

Some efforts have been documented on the advancement of the vision-based non-intrusive monitoring drowsiness systems.

[1] A. Malla, P. Davidson, P. Bones, R. Green and R. Jones, "Automated Videobased Measurement of Eye Closure for Detecting Behavioral Microsleep"[6]

They developed a system which is light insensitive. In OpenCV [9] libraries, they used the Haar algorithm to detect objects [7] and the face classifier implemented by Malla[8]. The eye regions are derived from anthropometric influences in the facial region. Instead, to determine the extent of eye closure, they track the eyelid.

[2] S. Vitabile, A. Paola and F. Sorbello, "Bright Pupil Detection in an Embedded, Real-time Drowsiness Monitoring System"[10]

They implement a system based on an infrared camera for detecting driver drowsiness symptoms. An algorithm for detecting and monitoring driver's eyes has been created by leveraging the phenomenon of bright pupils. The system warns the driver with an alarm message when somnolence is detected.

[3] B. Bhowmick and C. Kumar, "Detection and Classification of Eye State in IR Camera for Driver Drowsiness Identification"[11]

The system use the Otsu threshold [12] to extract area of the face. Eye localization is done by locating facial landmarks such as eyebrow and possible center of the face. Morphological activity and Kmeans are used for precise segmentation of the brain. Then a range of shape features is computed and trained using non-linear SVM to get the eye status.

[4] T. Hong, H. Qin and Q. Sun, "An Improved Real Time Eye State Identification System in Driver Drowsiness Detection"[13]

The system describe a real-time eye tracking system to identify the driver's drowsiness. The facial region is detected using the Jones and Viola optimized method [7]. A horizontal projection is obtained to the eye area. Finally, a new complexity function with a dynamic threshold for the identification of the eye condition.

[5] Z. Tian et H. Qin, "Real-time Driver's Eye State Detection"[14]

The system creates a program that tests the state of the driver's eye. Their device uses the YCbCr color space components Cb and Cr. This system locates the face with a vertical projection function, and the eyes with a horizontal projection function. Once the eyes are located the system calculates the eyes states using a function of complexity.

3. Objective

The main objective is to implement a Driver Assisting System using IoT and Machine Learning that will help in reducing the accidents caused by drowsiness of the driver or even if he is drunk. The system will also detect theft of the vehicle as well as will alert during the accidents. Drowsy driving is a significant, but often unrecognized, issue of traffic safety. It is estimated that drowsiness causes 10-20 per cent of traffic accidents. Apart from the loss of lives, injuries and recovery are expended on a great deal. Drowsy driving is often unrecognized as drivers don't normally admit it, as it would make them responsible. Our goal is to create a safety system that continuously evaluates the driver's operation and measures the time for which the driver's eyes remain closed. If a threshold value reaches the length, the device will generate an alarm to wake the driver up. The main advantage of the system is that it can be built into existing cars, thereby reducing the cost of implementing large scale projects. If the driver is found to be drowsy, an alarm is triggered and the car decelerated. We also add another system to prevent the car from moving when the driver is drunken, and if the car is found to be stolen it will also be made into the notice of the owner. Additionally, message will be sent to friends/ family and officials if the car experienced an accident. The specific objectives of this system is to detect a face from an image accurately, to detect the region of interest (in this case the eyes), to classify the eye condition (closed or open), driver is given an alert using buzzer or alarm, drunken driving along with accident and theft will be detected.

4. Hypothesis

Drive assist is a system that can be implemented in our existing vehicles with very low cost. Only high end and costly vehicles use this technology and are mostly available in developed countries. This system is designed and implemented for developing countries like India, overlooking the traffic conditions and the way of living. Main features of Drive assist are drowsiness detection, drunk driver detection, accident detection and anti-theft. In short, we can say that this is an all in one solution to most of the road accidents in our country. This system is implemented as a hybrid of Computer Vision, Machine Learning, and IoT. All these components work in parallel to make up the system. Currently, there is no similar cost-effective existing system that can be integrated into existing on road vehicles.

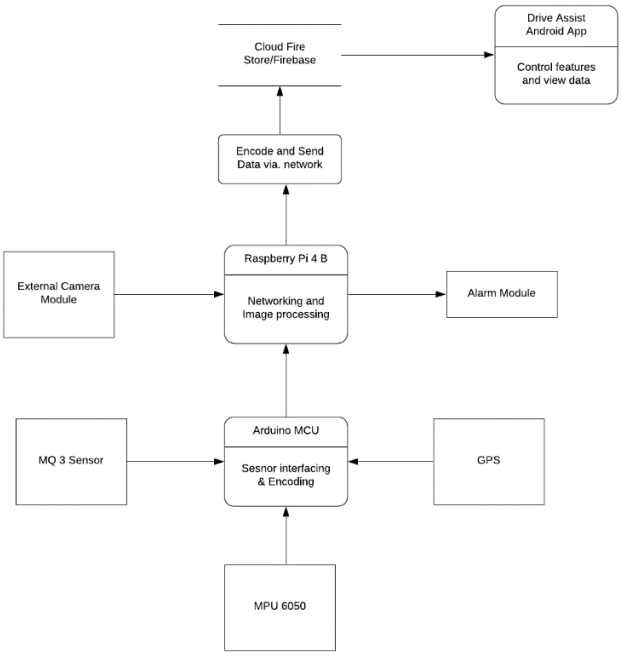

FIGURE. 1. Data flow diagram

5. Methodology

Drive assist is a system which is a hybrid of Computer Vision, Machine Learning and IoT to make our roads a safer place. The four main components of the system are:

- Drowsiness Detection,
- Drunken Driver Detection
- Accident Alert System
- Anti-Theft Support System

Hardware Required:

Raspberry Pi 4 B, Neo 6m GPS Module, No IR Camera for RPi, MPU6050, GSM Module, MQ3 Sensor.

A. Drowsiness Detection:

Drowsiness can be detected using facial movements such as eye lid movements. On an average a human blink the eye at a rate of 15times per minute. If a person closes eye for more than a specific time period (duration of blinking eyes is 100-150ms) then it can be considered as a state of being drowsy, otherwise it's just a blink. This idea is implemented in this system by first finding out a measure which says if the eye lid is closed or open. Then the time for which the eye lid is closed will be found out. In this system, we conclude that the driver is sleeping (if eyes are closed for more than 1000ms it is considered as micro sleep) if his eye is closed for 2 seconds, which is a certain threshold value decided upon experimental results. Machine Learning and Computer Vision is implanted to predict the drowsiness of the driver. The software libraries used for this purpose DLib, OpenCV, NumPy and SciPy. DLib is used to implement Machine learning algorithms. OpenCV is an open source computer vision library. NumPy is used for processing n dimensional arrays in Python and SciPy is used for scientific calculations. Here in this project we use DLibs facial landmarks predictor to detect facial features and thereby predict the state of the driver. This is done in two steps: Localize the ROI (Region of Interest) of the face and then Detect the key facial structures on the ROI of the face.

Seven facial landmarks are detected by the predictor: mouth, right and left eyebrows, right and left eye, nose and the jaw. Each image or a frame of the real time video is loaded and converted into a gray scale image. To detect the number of faces and their (x,y,w,h), which is almost similar to the bounding box of an image, we use the frontal_face_detector of the DLibs library. The detector returns a list containing tuple values of these (x,y,w,h). Now the ROI of the gray scale image can be passed to the predictor. The shape will have all the 68 points that was predicted from the input image. For python to work on it effectively we have to convert that to a numpy array of size 68 x 2. The facial landmarks produced by DLib follow an index able list and therefore determine the starting and ending array slice index values for extracting the (x, y) coordinates for both the left and the right eye.

Then the eyelid closure can be detected with the help of a measure called as the EAR (Eye Aspect Ratio). Every eye is defined by 6 (x, y)-coordinates, starting at the left corner of the eye (as if you looked at the person), and then moving in clockwise direction around the rest of the area. The aspect ratio of the eye is roughly constant while the eye is open, but when a blink happens it will quickly fall to zero.

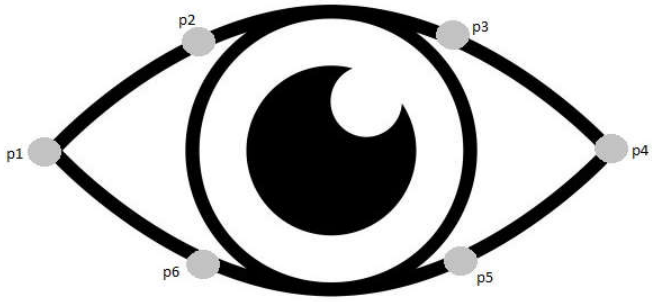

FIGURE. 2. Six points used to locate an eye

A=||p2p6||
B=||p3p5||
C=||p1p4||

The Euclidian distance between the two points p2 and p6 will give the value A, between the two points p3 and p5 will give the value B and between the two points p1 and p4 will give the value C.
The Euclidean distance between points p(x,y) and q(s,t) is calculated using the following formula:

$$||pq|| = \sqrt{(x-s)2 + (y-t)2}$$

These values can be used to find the EAR value as,

$$EAR = (A+B)/2.0*C$$

When EAR falls below a threshold (say EAR <=0.2) we start a timer for 2 sec and when timer expires, we can alert the driver. Both processes will be multithreaded. Alert can be in form of a deep beep or any so.

B. Drunken Driver Detection:

We live in a world where, even with strict rules and regulations people still find it difficult to wear even a simple seatbelt. Therefore, introducing an invasive hardware system to detect if the driver's blood alcohol level is practically impossible. Therefor our proposed system is a hardware module which can be attached to the seatbelt or roof of the car or even the glass or metal part of the driver door or any part of the car where

the driver's breath or the scent from him mouth is available. The idea is when the drunk driver enters the car and turns on the car immediately the system detects his blood alcohol level and will let his dear ones know that he is drunken. If the driver is running a taxi his owner will get an instant notification that the driver is drunken

This module is constructed using MQ3 Alcohol Sensor. It is a low-cost semi-conductor sensor that can detect concentrations of alcohol gases from 0.05 mg / L to 10 mg / L. If the sensor is exposed to alcohol content then the conductivity increases rapidly the conductivity of the sensor is lower in clean air. It is highly sensitive to alcohol and has good resistance to smoke and gas. The sensor volt is calculated in accordance with the conductivity of the sensor.
Primarily the analog output value is read from the sensor by analog read operation and the sensor volt is found.

sensor_volt = (float)sensorValue / 1024 * 5.0

then in order to the find the alcohol concentration in the air to check if he's drunk or not the alcohol content in ppm is found

RS_gas = ((5.0 * R2) / sensor_volt) - R2;

And the next and the final step in the drunk driver detection is finding the blood alcohol concentration value

BAC = pow (x, -1.431) //BAC in mg/L

If the blood concentration is found to be exceeding the permissible limit (in India the permissible limit is 0.03% per 100ml) then an alert message is sent to the friends and relatives of the driver.

C. Accident Alert System:

With several efforts being made by various governmental and non-governmental organizations around the world through various awareness-raising campaigns in careless driving, drowsy driving and drunk driving, accidents occur every now and then. And, if the emergency service could get the details about the accident in time, several lifetimes could have been saved. In our proposed system we have an emergency mode which will be automatically enabled when an accident occurs and will send message to family/friends. The MPU 6050 accelerometer is used in our project to detect accidents. If a sudden acceleration rate greater than 4g is detected system will use the GPS module to obtain GPS coordinates and send the location and an alert to family/friends. For this, an Android Application is designed that shows relevant information about the vehicles such as real-time location and speed. This system proposes to utilize the capability of an accelerometer, which is used to detect change in acceleration, when acceleration becomes greater than 4g, accident might have occurred and the location and time of the accident from the GPS data is processed by a microcontroller and be sent by using the mobile network.

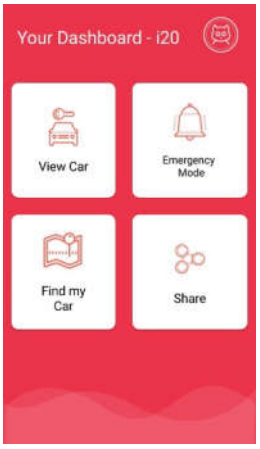

FIGURE. 3. Drive Assist Android App Homepage

D. Anti-Theft Support System:

Theft of automobiles has become a major concern in recent years, and it should be tracked and detected. Even though many high costs vehicles have facilities to let their owners know where the vehicle is at the moment, the common cars that most common men can afford does not hold this facility. Therefore, the antitheft support module of this system ensures that facility, the system mainly consists of a noir camera, a GPS module and an Arduino. If the vehicle is found to be missing or stolen there is an icon in our drive assist mobile app named as emergency mode .If emergency mode is enabled all other modules of the system is stopped temporarily .once the emergency mode is enabled the camera clicks the picture of the thief in the driver seat and is directly send to the mobile app (as in FIGURE 5) this servers as an important evidence in identifying the culprit. Parallelly the live location of the car is also obtained under find my car icon in the android app. If by any chance the live location is not obtained the last seen location is made available to regain the vehicle back to the owner.

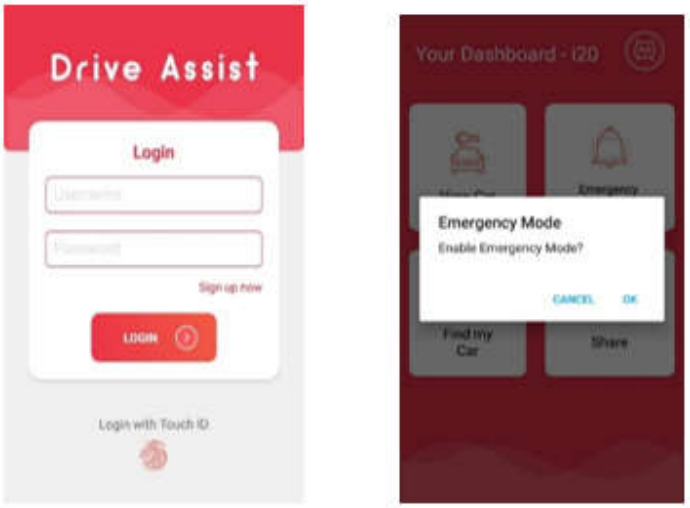

FIGURE 4. Drive Assist Android App (a)Login (b)Manually enabling Emergency mode

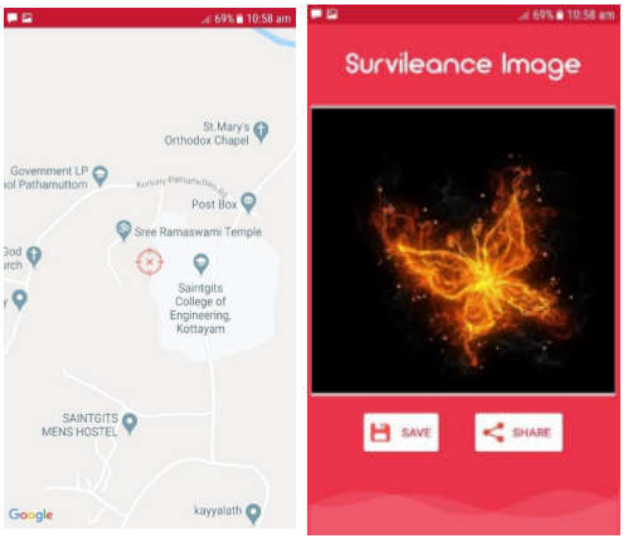

FIGURE 5. Drive Assist Android App (a) live or last known location of car (b)live photo of the thief on driver seat.

6. Circuit Diagram

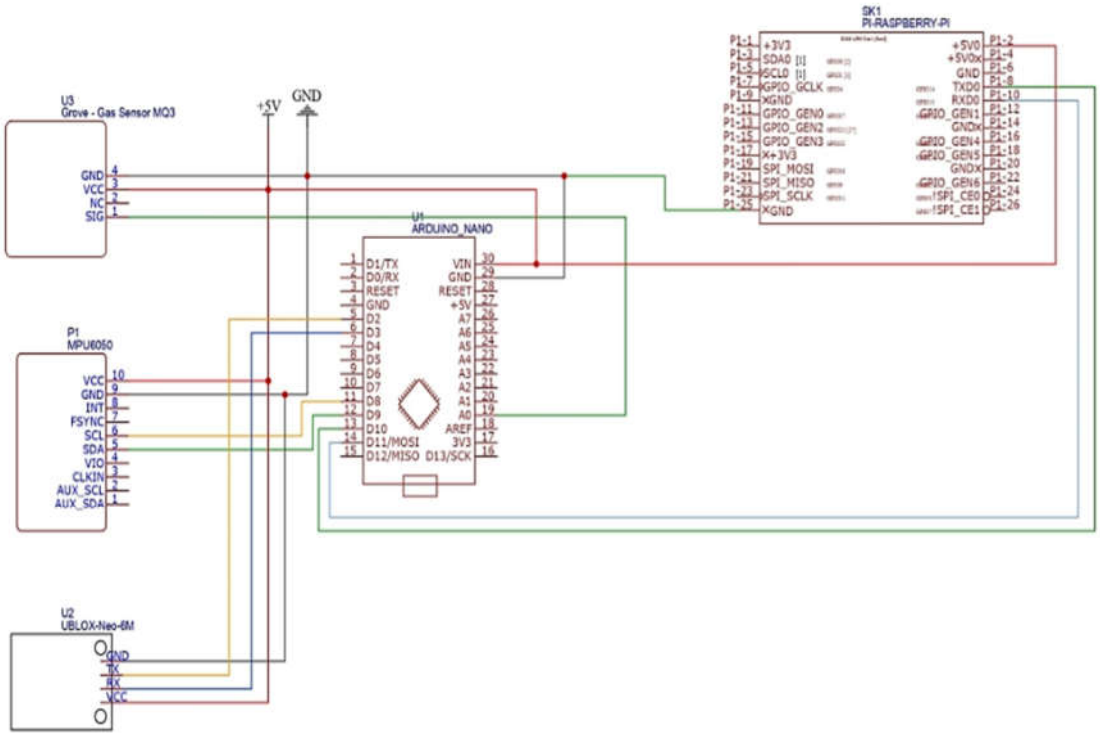

FIGURE 6. Circuit Diagram

The system consists of two control units where the main unit is the Raspberry Pi which is integrated with an Arduino ATmega328p based microcontroller. The Arduino is used to reduce the processing over head of the Raspberry Pi. The power supply required for the system is 5V 3 Amp, the system consists of an accelerometer here we use MPU6050 which consists of a built in gyroscope which measures the mems(microelectronic mechanical systems) inertia the purpose of the component is to measure the sudden acceleration or deceleration of a moving object (that is if a break is applied in an automobile the acceleration decreases by time and the automobile stops but if an accident is encountered there occurs a sudden deceleration) the sensor communicates with Arduino using I^2C interface as serial clock and serial data. GPS module serves the purpose of detecting the location of the vehicle this component is used in two segments of the whole system it is used in accident detection system and also in anti-theft support system it is interfaced by serial communication (Universal Asynchronous Receiver Transmission Module) as UART interface. The next component is the MQ3 gas sensor from which the analog output is obtained this analog output is given as the input to 19^{th} pin (A0) of the Arduino which accepts analog input. Precision is from 2^0 to 2^{16-1}, Arduino is connected to Raspberry Pi by hardware usb serial communication. The Arduino collects the results from the sensors and it's the Raspberry Pi that processes the results and the results are send to the fire base for further processes.

7. Conclusion and Future Work

This paper analysis and design the driver drowsiness detection system using IOT. Purpose of our project is to help solve real life problem in a very cost effective way. Whenever the driver feels drowsy and closes his eyes for more than a second, the buzzer/alarm is blown. Drunk and careless driving accidents are one of the major problems now-a –days. This paper provides a lot of advanced facilities in today's life as it can be easily applied in cars with multi-stage testing so that we can avoid accidents caused by driving drunk. Thus, by this we can reduce road accidents and hence these detectors have great importance in the future which we are going to implement with IOT. Vehicle theft, although not as intrusive as violent crimes, causes the victims greater damages. Proposed system provides vehicle safety and efficiently detects theft at very low cost. The future scope of the system is never ending. In the future this system could be modified to a way that the vehicle parks itself automatically if the driver is found to be drowsy and another alteration that could be done is that the system can prohibit the vehicle to move a step forward or backward if the driver is found to be drunken.
This system stands out from the other existing systems in that it is very efficient, economical and fit-able in the existing vehicles.

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