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Smart Transportation System using IOT and Computer Vision

[1] Vidushi Bhadola; [2] Dr. (Mrs.) Neha Agrawal

[1] IT, B. Tech Student, Maharaja Agrasen Institute Of Technology, Rohini
New Delhi, Delhi, India

[2] IT, Assistant Professor, Maharaja Agrasen Institute Of Technology, Rohini
New Delhi, Delhi, India

Abstract - Logistics is a process which ensures efficient and cost-effective flow of goods and. In India, the logistics sector is highly unorganized due to a lack of proper infrastructure and inclusion of technology which results in a lack of seamless movement of goods and people from one place to another. Also, with a surge in the number of taxis and trucks in the country due to increase in demand of the logistics sector, the accidents related to drunk driving and late alert of accident to the concerned authorities have drastically increased. In India, more than 60% of annual accidents are caused due to the menace of driving under the influence of alcohol. It is practically untenable for owners of these cab and trucks to keep an account of the activities of drivers and any accidents of these vehicles. The purpose of this research is outlining some of the key challenges faced by the logistics industry and providing a cost-effective and feasible solution for the same. This paper provides a solution called as SMART TRANSPORTATION SYSTEM and makes use of sensors and the IOT technology to track the activities of the drivers and notify the owners to take the right action and uses Computer Vision technology to detect a drowsy driver and alert him.

***Keywords* –**Accident alert, Drunk Driver, IOT, Drowsy Driver, Computer Vision, Arduino Uno, Shock Sensor, MQ-3 Sensor

1. Introduction

Logistics can be defined as a process which includes planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. It is basically the time-related positioning of resource, or the strategic management of the total supply chain. The supply chain is a sequence of events intended to satisfy a customer. It can include procurement, manufacture and distribution, together with associated transport, storage and information technology.

1.1 Logistics Scenario in India

According to the Economic Survey 2017-18, the Indian logistics sector provides livelihood to around 22 million people and improving the sector would facilitate a 10% decrease in indirect logistics cost. Also, the net worth of Indian logistics market would increase from USD 160 billion to around USD 215 billion in the next two years due to the execution of GST.

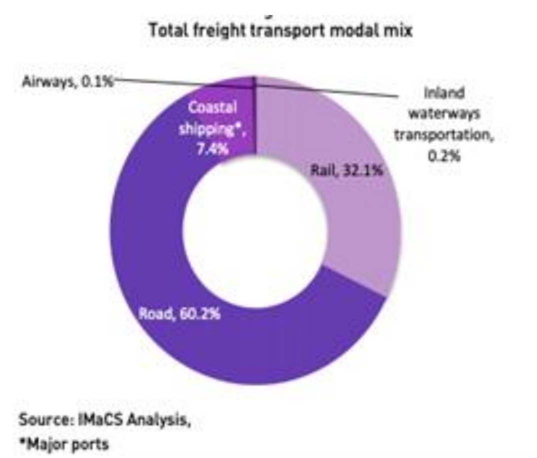

Figure 1

Due to various recent policies and programs of Government of India, eg. the Make in India program and improvements in infrastructure along with the emergence of skilled professionals, the country was ranked 35th in The World Bank LPI Index (Logistic Performance Index) that ranks countries based on Logistics Performance, moving up from 54th position in 2014.

In India, road is the dominant mode of transport which accounts for 60% of freight movement. The most widely used mode of transportation is trucks. At present, around 1.5 million trucks operate on the Indian roads and their number increases around 10% annually. Rail and coastal shipping account for about 32% and 7%, respectively, while the share of inland waterways transportation and air is less than 1% each. Railways are a relatively cheaper mode of transport and are mainly used for transporting bulk materials over long distances.

1.2 Challenges faced by Logistics Sector in India

There is an immense scope for further increase in India's rankings in The World Bank LPI Index if the existing infrastructural inefficiencies are addressed. The biggest challenge that currently beset the Indian logistics industry is its unorganized nature. The other challenges hindering this sector's growth include poor integration of transport networks, integration with modern information technology and warehouse & distribution facilities, absence of multiple regulatory and policy making entities. These challenges severely affect India's performance in international trade, resulting into around 70% of the delays.

2. Proposed System

The proposed system provides a solution to the inefficient transportation of goods from point of origin to point of consumption. There is no way for the companies to track the activities of the drivers who are transporting the goods and materials. The drivers may get into an accident or the driver may be driving above the allowed limit of drinking, the company would not be notified of these activities of the drivers which leads to inefficient transportation and delays in transportation and all leads to loss of life and good and all this incurs extra cost to the company. For this purpose, the proposed system has the following hardware and software requirements enlisted in Table 1.

Table 1

Hardware Requirements	Arduino Uno Shock Detector Sensor MQ-3 Sensor Jumper Wires ESP8266 module
Software Requirements	Arduino IDE Open CV

2.1 Hardware Requirements

Hardware Requirements consists of the various hardware tools which are necessary for the completion of this project. These include various sensor, Raspberry Pi etc.

2.1.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button

.

Figure 2

2.1.2 Shock Detector Sensor

The shock sensor is an electronic switch which induces shock force and transfers the result to a circuit device thus triggering it to work. It contains the following parts: conductive vibration spring, switch body, trigger pin, and packaging agent.

Figure 3

The shock switch works like this: the conductive vibration spring and trigger pin are precisely placed in the switch and fixed by adhesive. Normally, the spring and the trigger pin are separated. Once the sensor detects shock, the spring will vibrate and contact with the trigger pin, thus conducting and generating trigger signals.

2.1.3. MQ-3 Sensor

Alcohol sensor (MQ 3) as shown in figure 4 is suitable for detecting alcohol concentration just like in a common breath analyzer.

Figure 4

Figure 4 represents the structure and configuration of the MQ-3 Sensor.

It detects the alcohol and send the output in form of analog signals to the Raspberry Pi. Its sensitivity towards benzene, gasoline, smoke and vapor is less while that toward the alcohol is very high. It contains Sno2 as gas sensitive material to sense alcohol. It is also a low-cost material, has a long life, and require minimal or no maintenance.

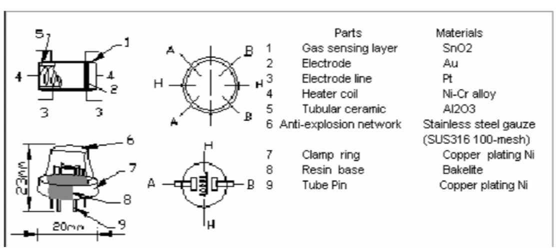

Figure 5

2.1.4 ESP8266 Wifi Module

The Arduino Uno does not have the feature to be connected to the Internet directly.

Figure 6

For this purpose, we require the ESP8266 module The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Espress if Systems in Shanghai, China. It takes the analog values generated by the MQ-3 sensor and convert it to digital signals in order to test the alcohol level.

3. Working of Proposed System

The proposed system works using two technologies -IOT Architecture and Computer Vision. The system makes use of two different types of sensors-

Shock Detector Sensor Module which detects a vibration and generates an alert to authorities in order to inform them on time, thereby decreasing the number of deaths due to late alert to authorities.

MQ-3 Sensor Module which senses the alcohol content in the breath of driver to check whether the driver is driving above the permissible limit of alcohol, and thereby avoiding accidents due to drunk driving.

3.1 Module 1: Car accident detection Module

In this project, I used a shock sensor to detect a car accident. The shock detector can be installed anywhere in the car.

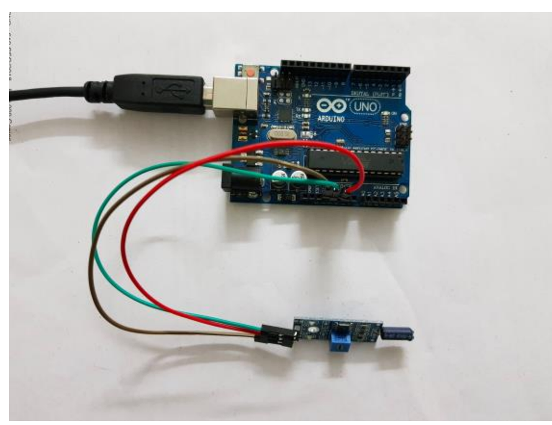

Figure 7

The shock switch works like this: the conductive vibration spring and trigger pin are precisely placed in the switch and fixed by adhesive. Normally, the spring and the trigger pin are separated. Once the sensor detects shock, the spring will vibrate and contact with the trigger pin, thus conducting and generating trigger signals.

When the shock is detected, a message is sent using Twilio service to the mobile number of the concerned authorities. This projects also makes use of Twilio -

The Twilio service provides a service of - Programmable SMS which lets you send and receive text messages globally with the API that over a million developers depend on. Figure 8 shows the alert sent using twilio service to any mobile number.

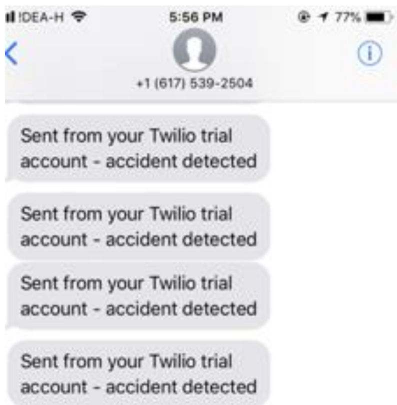

Figure 8

3.2 Module 2: Drunk Driver Detection Module

In this module I have installed the MQ-3 sensor with the Arduino Uno. The module detects the alcohol in breath and checks if the value is less that the permitted value. In India, the permissible blood alcohol content (BAC) is set at 0.03% per 100ml blood. The microcontroller accepts analog signals and provides a digital value for the same without the need of any external chip or ADC.

The MQ-3 Sensor detects the alcohol level in the driver's breath and the generated value is compared with the permissible blood content value and if found greater, an alarm is raised to the concerned authorities. Also, if the car is not moving, then the ignition will turn off simultaneously. Figure 8 shows the connections of the MQ-3 sensor to the Arduino Uno.

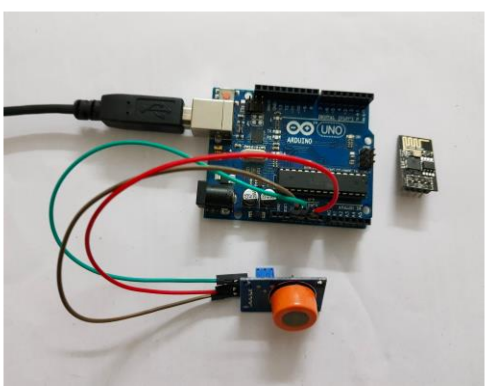

Figure 9

Since, the MQ-3 alcohol sensor is expected to detect alcohol level of the driver alone and not that of the fellow passengers in the motor-vehicle, it is important to embed the device at such a position i.e. at the top of the steering wheel (see figure 10). This will ensure that the device works efficiently and effectively and the readings of the device are not hampered by presence of fellow passengers.

Figure 10
(Source: https://techxplore.com/news/2015-06-car-driver-blood-alcohol.html)

3.3 Module 3: Real-time Drowsy Driver Detection Module

In this project, I have used Computer Vision technology to a detect a drowsy driver in real-time by analyzing two facial features i.e. eye closing for a period of time and yawning. Using these 2 features we can determine the driver's drowsy state with around 80% accuracy. This algorithm also works if the driver is wearing spectacles, hence, increasing the efficiency and feasibility of the solution.

3.3.1 Eye Closing detection

In this module we use Computer Vision technology to detect whether the driver is asleep. Each eye is represented by 6 (x, y)-coordinates, starting at the left-corner of the eye and then working clockwise around the eye.

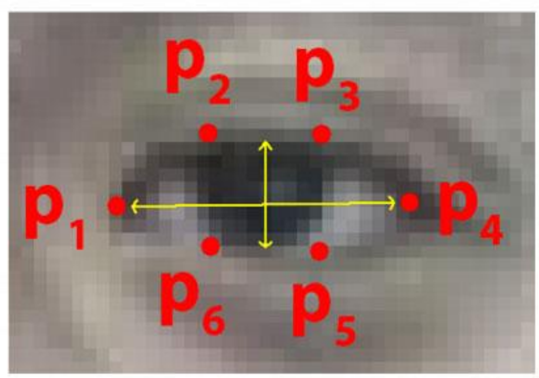

Figure 11
(Source:http://vision.fe.unilj.si/cvww2016/proceedings/papers/05.pdf)

The Eye Aspect Ratio is given by the formula -

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|} \quad (1)$$

The EAR value remains almost constant when the eye is fully open but it drops to almost zero when an eye blink occurs as shown in Figure below.

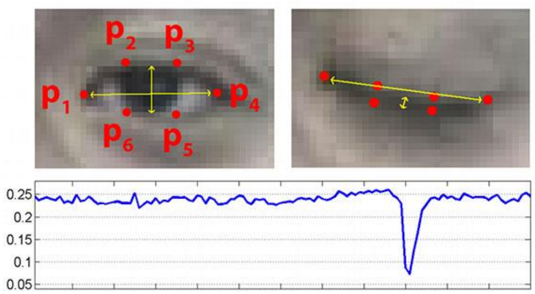

Figure 12
(Source: http://vision.fe.uni-lj.si/cvww2016/proceedings/papers/05.pdf)

In this module we first identify the facial landmarks for the eyes and then apply the EAR ratio for a fixed number of consecutive frames to check for drowsiness since a blink only lasts for approximately 5 frames, hence whenever the value of EAR is less than threshold for more than 5 frames, a drowsy driver will be detected.

3.3.2 Yawn detection

In this module, we detect a drowsy driver by detecting the yawning activity of the driver. For this we first identify the mouth of the driver using the facial landmarks i.e. we separately identify the upper lip and the lower lip of the image in frame.

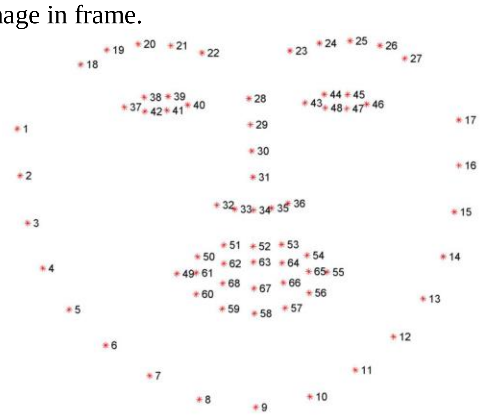

Figure 13
(Source: https://ibug.doc.ic.ac.uk/resources/facial-point-annotations/)

Then after identifying these, we set a threshold for the mouth opening and if the value remains equal to or is above the threshold for a certain number of frames, we identify that the driver is yawning. Here, the mean upper lip and the mean lower lip point is calculated for finding the distance between the two as yawning. The threshold distance is set at 20, if the distance is equal to or greater than 20, yawn alert is generated.

4. Conclusion

The system is an accident alert system along with a drunk and drowsy driver detection system that detects the intoxicated level of the drunk driver with high level of certainty and detects any accident to the car and generates a corresponding alert. The system is also capable of detecting a drowsy and sleepy driver using the latest Computer Vision technology. The system detects drunk driver situation initially or during driving and activates the alternate mechanisms for local persons i.e. turning off the ignition if car is not moving along with remote indication to the authorized persons i.e. generating alert to the required authorities. The main aim of the project is to decrease the chances of loss of lives in accident, occurring due to the intoxicated or drowsy state of driver and late alert to the required authorities, hence improving public safety and also making a better system for the logistics companies to track their drivers. Based upon the latest Computer Vision technology and semiconductor gas sensing as well as a sensitive shock detector, the system is cost-effective and reliable. The development cost of the device would be less than INR 3000.

Apart from this, vehicle location tracking and alter system of this kind can be helpful both in case of personal as well as business purpose, thereby improving safety and security of each person on the road.

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