License Detection and Accident Prevention System

P.D.R. Dewmin
Department of Computer Systems and Network Engineering
Sri Lanka Institute of Information Technology
Malabe, Sri Lanka

P.S.H Yapa
Department of Information Technology
Sri Lanka Institute of Information Technology
Malabe, Sri Lanka

S.D. Lokuge
Department of Information Technology
Sri Lanka Institute of Information Technology
Malabe, Sri Lanka

ABSTRACT
From 2013 to 2019, more than 30,000 accidents happened in Sri Lanka, according to the department of census and statistics. In this time frame, more than 2000 people die [1]. Road accidents are ranked 10th out of the top 10 causes of death in Sri Lanka [2]. The main contributing factors to these accidents are drunk driving, weariness, drowsiness, distracted driving, and driving without a valid license [3]. Drivers without a legal license are to blame for 20% of collisions [4]. There is currently no automatic mechanism for IoT-built driver's license verification. The society also lacks a means to detect drunk driving, distracted driving, and sleepy driving.A smart license detection and accident prevention system was suggested after data analysis to use RFID to identify and validate driver's licenses. The suggested system also enables sub-systems that use a Raspberry Pi camera module and computer vision software called TensorFlow Lite to monitor a driver's alertness, weariness, alcohol level, and whether or not they are distracted. Using a pressure sensor, a sub-system that has been initiated determines the intensity of the brake pedal's engagement. The technology evaluates the pressure and uses the brightness of the brake light to signal the intensity level appropriately.Airbag detection subsystems, which use GSM modules and SMS Gateway API, reduce the fatality rate of accidents by detecting the deployment of airbags and notifying the closest police station and hospital of the incident. While these subsystems decrease the likelihood of an accident occurring, they also reduce the likelihood of it occurring fatally. The suggested system will lower the number of accidents that happen all year long.

General Terms
IoT, Computer Vision, Accident Prevention

Keywords
Vehicle Accident, IoT, GPS, GSM, Raspberry Pi, Computer Vision, TensorFlow Lite, Pressure Sensor, RFID, Accident Prevention

1. INTRODUCTION
Transportation safety is getting increasing attention as a result of the significant increase in fatalities around the world over the past several years. Traffic hazards are among the most crucial issues that need to be addressed in the transportation sector. According to World Health Organization assessments, road accidents are the leading cause of death for the majority of people globally.

According to motor traffic (amendment) act, no. 8 of 2009, “Where a driver of a motor vehicle does not possess a valid learner’s permit and a regular driving license a police officer may detain such driver of the motor vehicle until such driver produces a valid learner’s permit and regular driving license. Where it is found that such driver does not hold a valid learner’s permit and regular driving license, such driver and owner of the motor vehicle shall be guilty of an offence and shall be liable to a fine not less than three thousand rupees and not exceeding six thousand rupees and to imprisonment of either description for a term of six months.Provided however that the owner of such motor vehicle shall not be deemed to be guilty of an offence if he proves to the satisfaction of the court that the vehicle was removed by such driver without his knowledge” [5].A driving license is a necessary document that certifies the license holder's eligibility to operate a certain type of vehicle. A person who operates a vehicle without a valid license is more likely to cause an accident.

The National Highway Traffic Safety Administration (NHTSA) reported that between 2016 and 2018, on average, 29% of fatal accidents were caused by drunk driving[6], 2.5% by drowsy driving[7], and 16% by distracted driving[8].

At the moment, the majority of nations employ manual techniques to identify drunk driving and inattentive driving by sending out police personnel. The growing frequency of fatal accidents shows that the society cannot benefit from the following ad hoc strategy.

The two most frequent causes of traffic accidents are driver inattention and close proximity of vehicles. The most frequent category of accidents has been recognized as rear-end collisions [9]. The main means of warning oncoming vehicles to slow down or brake are the rear-mounted stop lamps that illuminate when applying the brakes. Rear-end crashes can be prevented by being aware of how the front vehicle is decelerating. Regardless of the brake intensity, the current brake system always displays the brake light with the same brightness.

The highest number of deaths occurs within the first hour following an accident. 75% of fatalities from traffic accidents were reported in the first hour. The primary factor in these deaths was the absence of immediate health care support. The lives of accident victims can be saved if they are given access to adequate medical care within this time frame. The first hour following an accident is referred to as the "Golden hour"[10] since it is the critical period.

The emergency units' slow reaction time is accountable for the deaths that occurred in the first hour. With the procedures that were being used in the current society, the amount of time it needed to alert these emergency units was comparatively high. The aforementioned deaths can be avoided if the emergency services are notified shortly after an accident.

The proposed system forbids a driver from driving a vehicle without a valid driver's license. One of the subsystems keeps track of the driver's tiredness, intoxication, and distracted driving patterns and notifies them if there is a risk to their safety. Another subsystem monitors the intensity of the brake pedal being applied, and the brake light adjusts its brightness dynamically to match that intensity. The aforementionedauxiliary systems will lessen the likelihood of an accident happening. The airbag sensor will keep track of airbag deployment and notify emergency services to lower the likelihood of fatalities in an accident.

2. LITERATURE REVIEW

There were few license verification systems were proposed to the society in previous years. Prema.S, Praveen.S, Murali Krishna V.P. and Mohamed Riyas Deen V.S.[11] has proposed a system to verify driving license using a fingerprint sensor. In this proposed system vehicle registration number, registered name, policy number of the insurance and RC book details will be stored in government database. For each vehicle detail, a specific serial number will be assigned. Then the RFID tag writer will be used to program the serial numbers into the RFID tags. These RFID tags will be given to the respective vehicle. Authorities can use the RFID reader to scan each vehicle's RFID tag and get the respective vehicle details through the cloud database.

R.Manoharan and S.Chandrakala[12] has proposed a system to monitor driver's drowsiness and fatigue. Face detection, eye rub detection, drowsy eye blink detection and yawn detection were mainly considered when developing this system. Haar Cascade classifier was used to develop face detection model. Drowsy eye blink detection study was conducted by providing a custom threshold value (driver eyes experiences closure time > 400ms , considered as a drowsy situation). The fatigue detection system evaluates the number of yawns, and if the total number of yawns exceeds three, then the driver will be notified with a recorded voice.

A system was proposed by Md. Syedul Amin, Jubayer Jalil, and M. B. I. Reaz[13] to detect accidents and send distress alerts. This paper proposes to use a GPS receiver to monitor vehicle's speed, detect an accident based on the monitored speed, and report the location of the accident to an Alert Service Center. Through a Microcontroller Unit, the GPS will monitor vehicle's speed and compare it to the prior speed every second. It will be assumed that an accident has occurred by analyzing the results. The system will then use the GSM network to relay the accident location, as determined by the GPS, as well as the time and speed.

3. METHODOLOGY

The system prioritizes on extinguishing the potential causes of an emerging road accidents by identifying and neutralizing them beforehand and responding to arisen scenarios of road accidents.

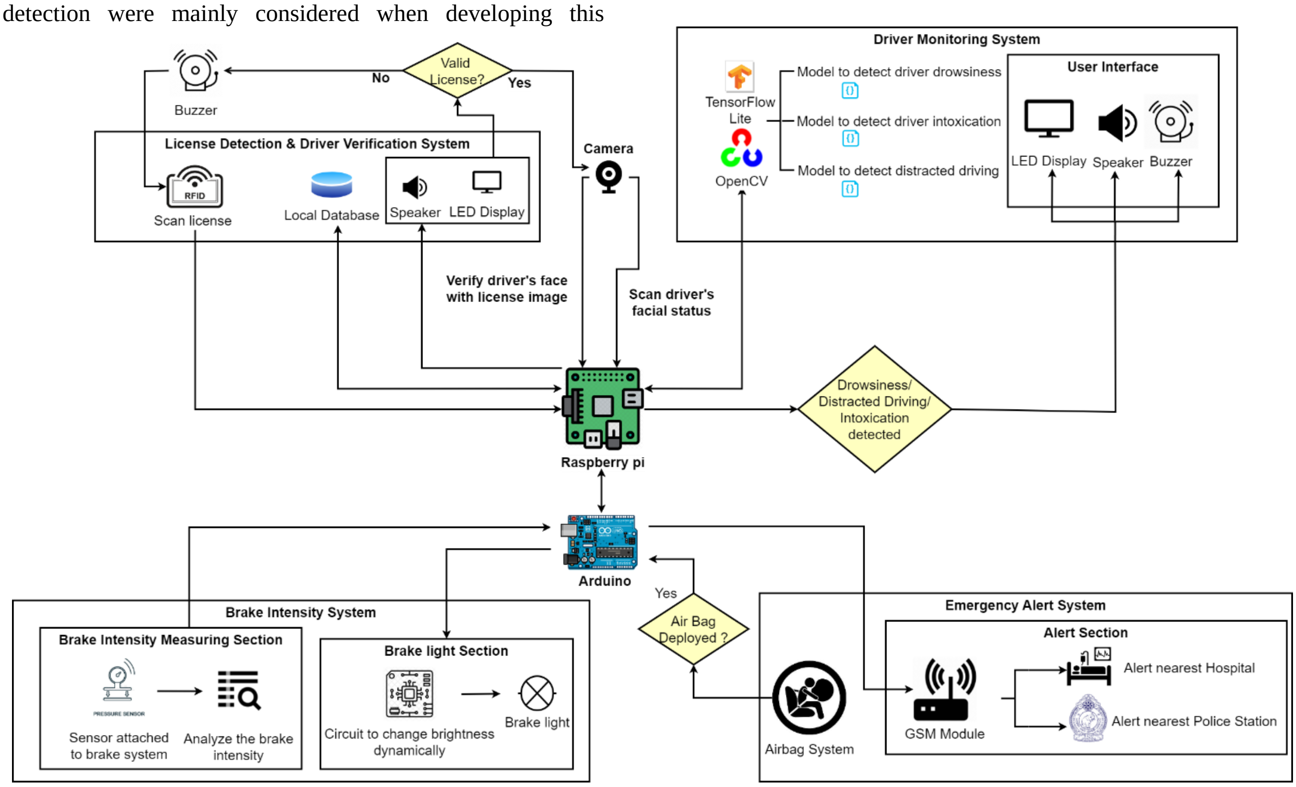

Figure 1. System Overview Diagram

3.1 License Verification

The initial step of the system is filtering the unlicensed and Invalid license holders from driving a vehicle. When the user power on the vehicle the system initiates an ignition lock and request the license of the driver prior to starting the vehicle engine.

When the driver holds the license before the RFID reader, the system retrieves the license number using the RFID technology and send it to the Raspberry Pi board. Then the system compares the given license number with the cloud database that consists of license details of all the registered drivers.

If the license number exist on the cloud database, all the related details will be temporarily loaded into the local database to increase the response time for future analysis. The system then validates if the license is expired by comparing the expiry date and the current date.

3.2 Driver Face Verification

Once the license is verified as valid and not expired, the system sends the verified license number to face verification section. Then the system switch to the camera module and scan for a face within the frame using Haar Cascade library. System stores the live image when a face is identified within the frame.

Then the system loads the face image of the verified license holder from database using the license number and compare it with the live image. System conducts a feature comparison in Raspberry Pi and find similarity of the features using facepp library.

If the confidence score is above the implemented threshold value, the system will decide the driver and the license owner are the same individual.

3.3 Ignition Locking

If both the license verification and driver face verification processes become successful, the ignition locking will lift off. Failure of either one the verification will result in locking the ignition of the engine. To start an engine of a vehicle, the starter motor requires a spark of electricity. Initiation of ignition locking will block the electric flow from vehicle battery to starter motor.

3.4 Drowsiness Detection

The drowsiness detection algorithm consists of two key areas namely eye state predictions and yawn state prediction. Two separate CNN models were implemented to detect those behaviors.

Implemented CNN model structure consists of 3 convolutional layers each with 32 layers, a flatten layer, two hidden dense layers, and an output layer. In this project extraction of the face and eye regions are captured by using the ‘media pipe’ library.

The real-time video is captured frame by frame using a WHILE loop which is always on TRUE status unless manually interrupt by the flow process occurs. After capturing the region of interest area, the algorithm will perform necessary modifications and feed it to the trained CNN model.

The driver notification system is supposed to activate if a driver is in a closed-eye state/yawning state for a custom continuous frame period. The custom threshold value can be adjustable according to the optimal scenario.

3.5 Intoxication Detection

The intoxication detection algorithm involves red-eye detection and gesture tracking algorithm.

For the red-eye detection model, the data gathering(images of red eyes) was performed using the volunteers who consist of intoxication conditions along with the red-eye effect. The deep learning CNN network architecture follows the same structure applied in the drowsiness detection model.

Driver’s stability status is able to track using the developed gesture tracking algorithm. The algorithm works in the following manner.

- Calculate the distance between nose and Left/Right Shoulders
- Based on a threshold value, decide the stability status for a particular frame
- If the maximum unstable frame is limit exceeded, the system will notify the driver

3.6 Distracted Driving Detection

CNN model was trained by using custom images related to distracted driving activities(texting, calling, etc.…) and the sample relevant images gathered from the web. Initially the model is trained to predict the distracted activity related category(safe state + class1 + class2 + class3 ……+class10). This kind of approach is heavily biased to overfitting issues because of the complexity of dependent classes. A class compression method was proposed to solve that problem. All the distracted driving behaviors were classified into one class and safe driving behaviors into another class(safe state + class1). Advanced image augmentation methods are applied aiming to increase the accuracy of the CNN model. For the live video feed capturing, the side camera embedded to the system(RH side) will activate instead of the front camera, because only a side camera is able to properly capture the distracted driving related activities.

Initially the models were developed in the local environment. The models were migrated to TensorFlow Lite to optimize theperformance prior to implement them in raspberry pi environment. Threading techniques were used to increase and stabilize the fps count.

3.7 Brake Intensity Detection

An analog pressure sensor is connected to the brake pedal. When the driver engages the brake, the intensity of the brake pedal being engaged will capture by the pressure sensor. Then the sensor will send the value as an analog signal to the Raspberry Pi. Raspberry pi analyze value and select the predefined category the value relevant to. According to that category, the resistance level of the electricity will be set. By changing the resistance, the brightness of the brake light will be changed(Low brightness level for low brake intensity and high brightness level for high brake intensity).

3.8 Emergency Alert System

If the air bags were deployed in an accident, the air bag sensor capture it and initiate the alert system. The GSM module retrieves the current location of the vehicle via google API. Then the system scans the nearest hospital and police station within a certain radius from the point of accident. Using the SMS Gateway API, a distress alert will be sent to the selected hospital and police station informing the co-ordinates of the accident.

4. RESULTS AND DISCUSSIONS

As the cloud database for storing original license data, firebase was used. To represent the starter motor of a vehicle, a red LED bulb was used. When the system detects a driving license, the license number and the expiry date of the license is checked with the database. If the license number is present in the database and if the license is not expired, the system will display the license as a valid license.

Face identification in driver verification was implemented using “Haar Cascade frontal face default”. When a face is detected by the camera, the system saves the frame as an image file. Comparing the images using facepp, 70 was assigned as the threshold value for confidence level. The assigned threshold value has been validated with people and their images that has been taken before 10 years.

Table 1. Similarity Score Test Results

Scenario	1st Image Set	2nd Image Set	3rd Image Set	4th Image Set	5th Image Set
Images 1 and 2 are same person's	100	100	99.89	100	99.93
Images 1 and 2 are two different persons	68.33	52.05	37.57	14.23	51.07
Same person's images with 10-year gap	93.03	72.77	88.62	81.02	94.92

To get the optimal similarity threshold value, 4 image sets consists of 2 images were taken. In first 2 image sets, image 1 was taken 10 years before image 2 was taken and image 1 and 2 is face of same person. 3rd and 4th image sets contained faces of two different persons. These 5 image sets were tested while changing the threshold value.

Table 2. Similarity Threshold Value Testing

Similarity Threshold Value	Image Set 1 Result (Same)	Image Set 2 Result (Same)	Image Set 3 Result (Same)	Image Set 4 Result (Same)
80	Same person	Different persons	Different persons	Different persons
75	Same person	Different persons	Different persons	Different persons
70	Same person	Same person	Different persons	Different persons
65	Same person	Same person	Different persons	Same person
60	Same person	Same person	Same person	Same person

With the successful completion of the verification processes, the ignition locking system will lift off by enabling the electricity from the power source to starter motor.

CNN models to monitor drowsiness, distracted driving and intoxication had following accuracy scores. The drowsiness monitoring model accuracy is based individual accuracy of eye status detection model and yawn detection model. Accuracy of the intoxication detection model is based on red eye detection model accuracy and gesture recognition model accuracy.

Table 3. Accuracy Scores of CNN Models

	Drowsiness Detection		Intoxication Detection	Distracted Driving Detection
CNN Model	Eye Status	Yawn Status	Red Eye Status	Distracted Driving
Accuracy	0.969	0.989	0.824	0.857

Built CNN model to monitor drowsiness of the driver can detect "eye status" and "yawn status" of the drivers. System detects closed eyes and yawns individually. If either one of the features were detected, the system will classify the driver as drowsy.

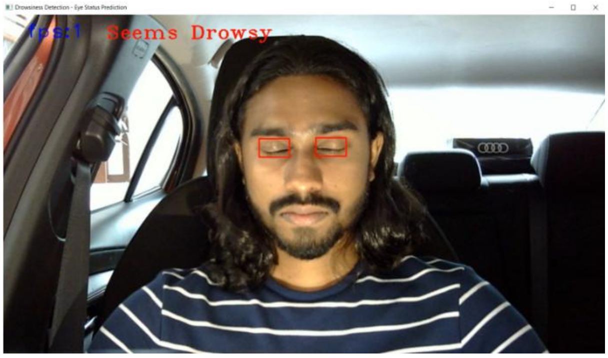

Figure 2. Eye Status

Figure 3. Yawn Status

If the system does not detect any yawns or closed eyes, then the system will decide that the driver is good to drive the vehicle.System will state that the driver is able to drive a vehicle until closed eyes or yawns or both were detected.

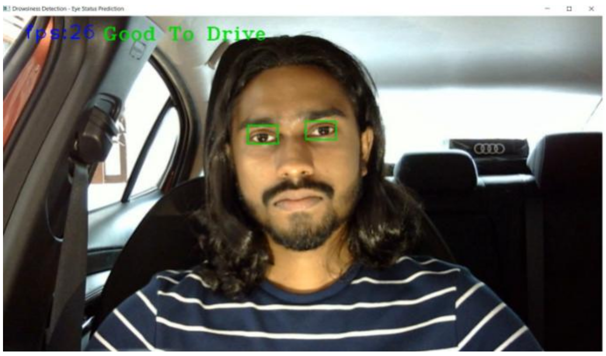

Figure 4. Safe to Drive State

Intoxication detection model monitors the distances between nose and shoulders. Using the gesture recognition if the distance is less than the threshold value for certain time-period, the system detects the driver as an intoxicated driver.

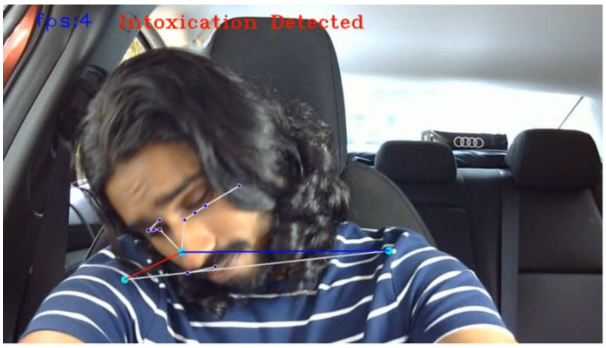

Figure 5. Intoxicated Driver Detection

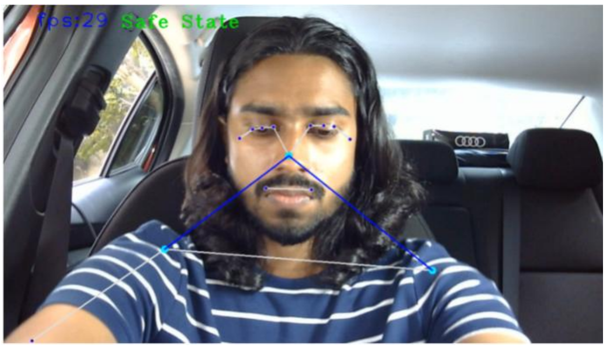

Figure 6. Not Intoxicated Driver Detection

The CNN model built to monitor the distracted driving captures the image of the driver and classify the image into one of the two classes. According to the class, the system outputs the driver is distracted or not.

Figure 7. Distracted Driver Detection-Mobile Phone

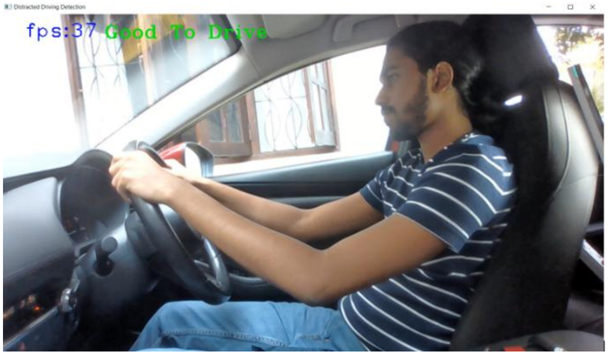

Figure 8. Not Distracted Driver Detection

The emergency alert system detects the deployment of vehicle's airbags and send a distress signal to emergency units. The distress message contains a brief description and a hyperlink. The hyperlink contains the live location of the vehicle. The distress message and receiving number is customizable.

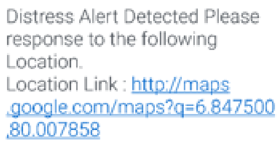

Figure 9. Emergency Alert

The SKU237545 pressure transducer measure the air pressure injected from the syringe. The measurement converts to an analog signal from the transducer and send it to the Arduino mega board. Using the implemented algorithm, the Arduino board changes the brightness of the lights respective to the pressure group the input belongs. The Arduino board interconnects to the raspberry pi.

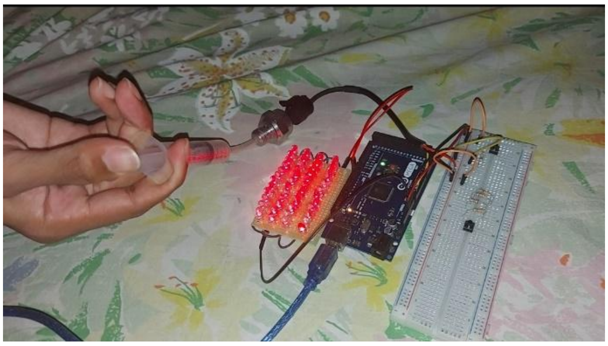

Figure 10. Brake Intensity System

The overall process of the system as follows.

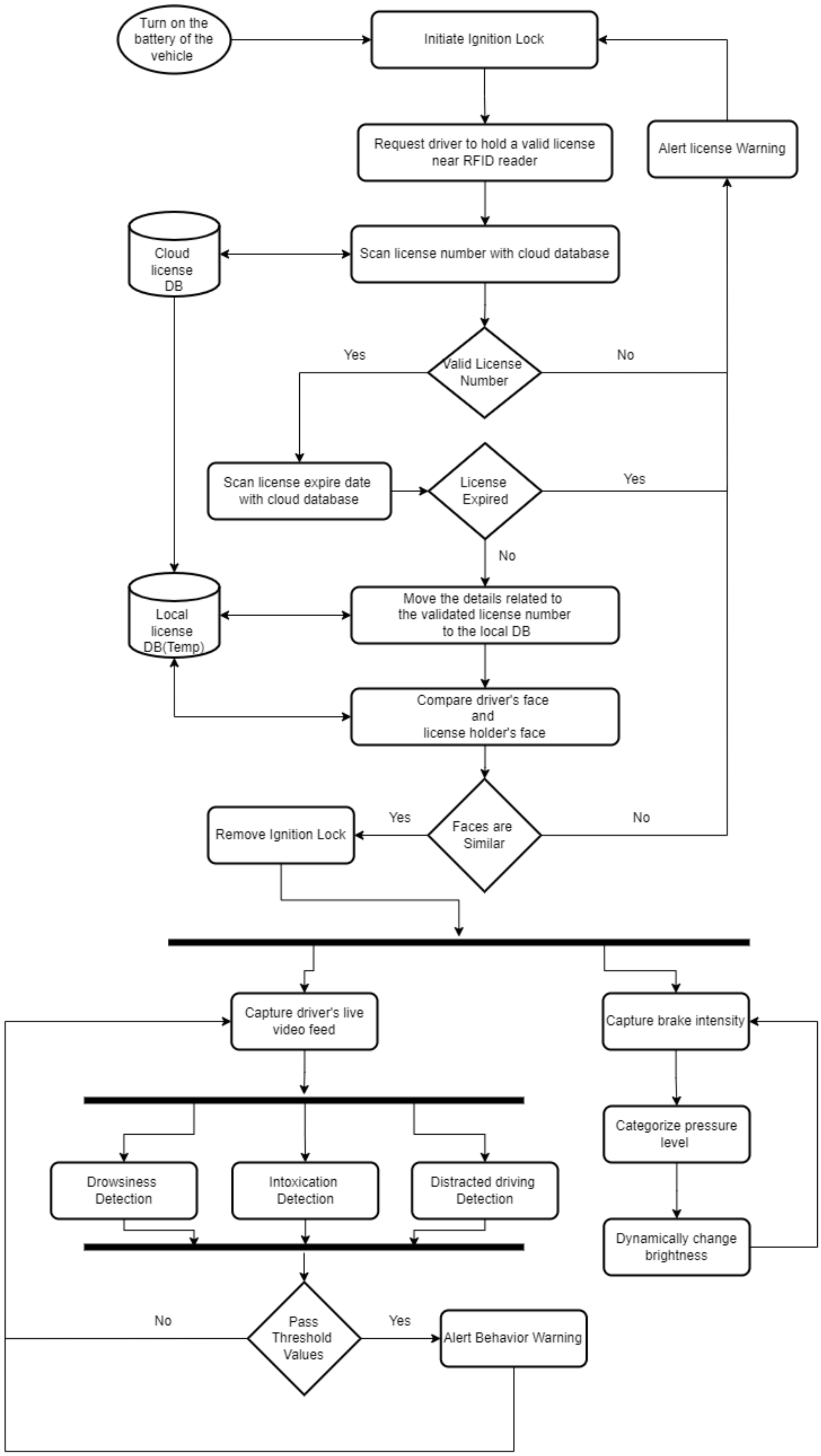

Figure 11. Process Flow-Accident Prevention

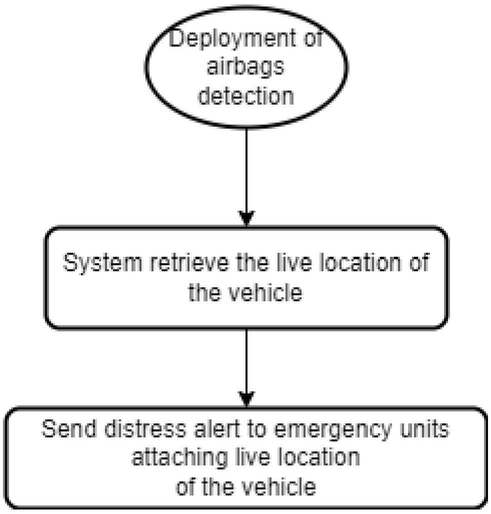

Figure 12. Process Flow-Emergency Alert

5. CONCLUSION

In this study, an innovative method for detecting, preventing, and reporting vehicle accidents has been tested utilizing a Raspberry Pi. The license detection system ensures that the driver and license owner are the same person and verifies to ensure that the driver has a valid driver's license. Drowsy driving, drunk driving, and distracted driving are conditions that driver monitoring system detects and report. The brake light is adjusted in accordance with the intensity of the brake pedal being engaged by the braking intensity section. The emergency alert system recognizes when an airbag deploys and alerts the emergency services.

As a result, even in remote places, this technology can deliver crucial information about the accidents. As a result, the staff at the emergency care facility can assist the accident victims more effectively. To help the injured, they should bring first aid equipment with them to the scene of the accident.

6. REFERENCES

[1] "Department of Census and Statistics," [Online]. Available: http://www.statistics.gov.lk/abstract2020/CHAP7/7.4-7.5-7.6.

[2] "World Life Expectancy," [Online]. Available: https://www.worldlifeexpectancy.com/country-health-profile/sri-lanka. [Accessed 19 12 2021].

[3] A. p. o. t. E. Unit, "Epidemiology Unit," [Online]. Available: https://www.epid.gov.lk/web/images/pdf/wer/2021/vol_48_no_07-english_1.pdf. [Accessed 19 12 2021].

[4] "Non-licensed drivers responsible for 20 percent of allauto accidents," Litigation Funding Simplified, [Online]. Available:https://usclaims.com/educational-resources/non-licensed-drivers-responsible-for-20-percent-of-all-auto-accidents/.

[5] "Motor Traffic (Amendment) ACT, NO. 8 OF 2009,"2009.[Online].Available: https://www.lawnet.gov.lk/act-no-8-of-2009/.

[6] Bankrate, "2022 drunk driving statistics," Bankrate, 2021. [Online]. Available: https://www.bankrate.com/insurance/car/drunk-driving/. [Accessed 08 01 2022].

[7] Bankrate, "2022 drowsy driving statistics," Bankrate, 2021. [Online]. Available: https://www.bankrate.com/insurance/car/drowsy-driving-statistics/. [Accessed 08 01 2022].

[8] Bankrate, "Distracted driving statistics 2022," Bankrate, 2021. [Online]. Available: https://www.bankrate.com/insurance/car/distracted-driving-statistics/. [Accessed 08 01 2022].

[9] S.Razzaq, A. R.Dar, M. A.Shah, H. A.Khattak, E.Ahmed, A. M.El-Sherbeeny,H. T.Rauf (n.d.). Retrieved 2022, from Researchgate:https://www.researchgate.net/publication/358001835_Multi-Factor_Rear-End_Collision_Avoidance_in_Connected_Autonomous_Vehicles.

[10] J. J. Md. Syedul Amin and M. B. I. Reaz, "Accident Detection and Reporting System using GPS, GPRS and GSM Technology," IEEE, 2012.

[11] Prema.S,Praveen.S,Mohamed Riyas Deen V.S. and Murali Krishna V.P., "Vehicle and License Authentication Using Fingerprint," 5th International Conference on Advanced Computing & Communication Systems (ICACCS 2019), IEEE, 2019.

[12] R.Manoharan, & S.Chandrakala. (2015). Android OpenCV Based Effective Driver Fatigue and Distraction Monitoring System. IEEE, (p. 5).Retrievedfrom https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7292757.

[13] J. J. Md. Syedul Amin and M. B. I. Reaz, "Accident Detection and Reporting System using GPS, GPRS and GSM Technology," IEEE, 2012.