Implementation of Blackbox System for gathering safety information in Vehicles

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Abstract

Now-a-days, Road accidents that occur in the world are major problems that people are more worried about. The implementation of safe systems is very much useful to prevent accidents and give information after accidents. The advanced new technologies create good features and services in the vehicles. The evolving technology made our lives easier. The information black box gathering system is useful for analyzing the reason of vehicular accidents and to save the lives of people and also the property of vehicle caused by the vehicular accidents. The major goal of the data collection black box system is to create a prototype model that can be installed in any type of vehicle anywhere in the globe, resulting in an Internet of Things model. This model aims for the safety of vehicle and the driver by collecting all the required information from several sensors in case of an accident that helps in determining the cause of the accident. The system also detects the object that is close to the vehicle by using advanced technology called deep learning.

Keywords: Black box, Road Accident, IoT, information gathering.

1. Introduction

According to the World Health Organization, vehicle accidents claim the lives of more than a billion people worldwide. As a result, it is critical that we follow the government's recommendations and instructions in order to protect ourselves against road accidents. These collisions occur with or without the driver's knowledge. After a vehicle collision, proper analysis should be conducted, including physical evidence, clear evidence from the accident scene, a witness, and a vehicle trace. In majority of the cases, there is inadequate information about the accident which makes it impossible to determine the cause of the disaster and the casualties. It is so important to have recorders that objectively track what goes on in vehicles before, during and after a crash. The information gathering black box system is used to track the vehicle information and monitors the vehicle's and driver's performance in order to ensure the vehicle's and driver's safety and security. The information gathering black box draws the first step to solving the problem in order to react to this circumstance.

Information Gathering Blackbox System is developed to record informational data, such as Speed level, whether driver has drunk or not (alcohol sensor), vehicle details and the position of the car. raspberry pi microprocessor as its main controller that interfaces to take input values from different sensors which collects all the required information from several sensors like alcohol sensor, accident switches sensor and Micro Electro Mechanical System (MEMS) sensor that helps in measuring the condition of the vehicle and driver. This system also includes the object detection by using deep learning technique that uses Single Shot Detectors (SSD). The message can be sent to the respective owners of the vehicle if accident occurs through Global Positioning System (GPS).

The remaining part of the paper is organized as follows: Sections 2 and 3 gives the details about existing system and its limitations. Section 4 and 5 deals with the proposed methodology and its advantages. Section 6 gives the detailed design of the proposed methodology. Section 7 gives the results and discussion.

2. Existing System

The black box already exists in aircraft systems such as airplanes and helicopters. It will be more useful if any accident or crash occurs. In case of a crash, it can record whole data about the accident. So that it will be helpful for determining the reason for accident while investigating. The GPS is used for determining the location of the incident. The camera is used to capture the videos and images. The sensors like alcohol, MEMS etc., are used independently for better safety of the driver and vehicle.

3. Limitations of Existing System

Now a days, though lot of researchers are focusing towards development of black box systems, they are of high cost. They also require high skills to operate and maintain, which focuses on specific kind of applications and are typically developed for the developed countries. In India so far, no such kind of technology is available to sort such a huge amount of waste which is cost effectively and effectively. Even though studies have been conducted in Indian context, there are still no practical implementations. Many existing systems use Wi-Fi to upload the data to the cloud and these systems fail when there is no connectivity to the internet. There is no system which uses object detection along with the information gathering black box system.

4. Proposed Methodology

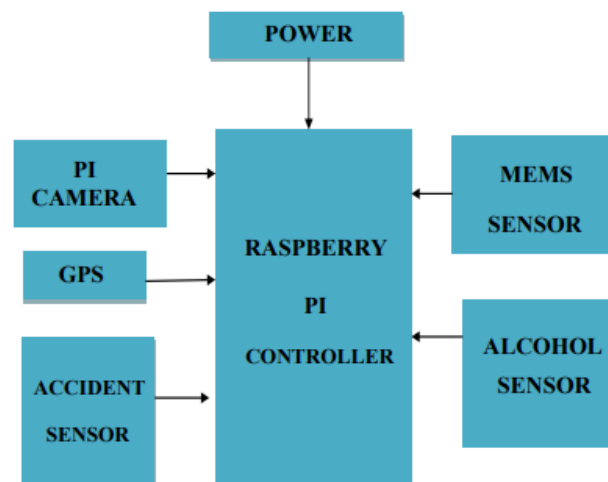Following figure shows the proposed methodology.

Figure 1: Proposed Methodology

The Information Gathering Blackbox system is mainly committed with two sections. The various kinds of sensors that are used to collect information about the driver and state of the vehicle which helps us to decide the safety of vehicle and driver. The other section of system that helps in object detection on the roads which are near to the vehicle so that vehicle can be prevented from any kind of accidents and ensures safety of property on road. The Raspberry Pi is main controller to be used which is connected by various types of sensors to gather data in real time. Sensors like MEMS sensor, switches accident sensor, alcohol sensors are connected to the ports and power supply is given to the Raspberry Pi by using micro-USB power connector.
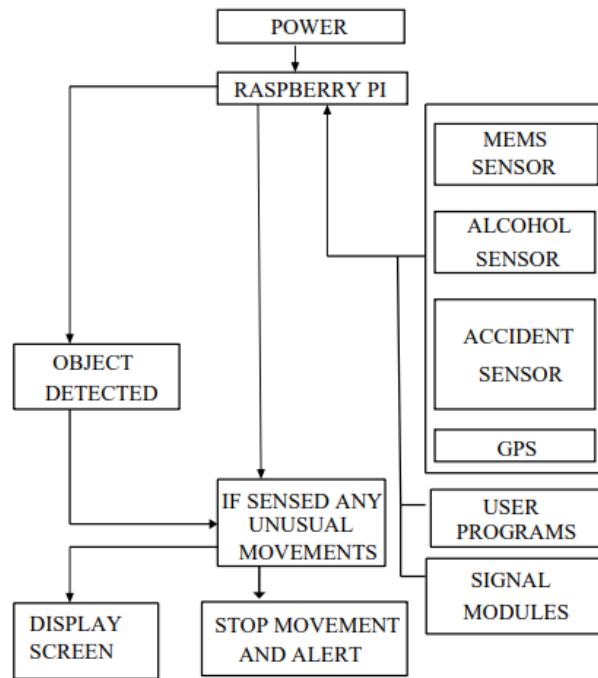Following figure shows the working of the proposed methodology.

Figure 2: working of the proposed methodology

A GPIO is a signal pin on an integrated circuit which is used to execute digital input/output functions that can be performed by hardware or software. The input analog signals from the sensors can be converted to digital in raspberry pi. Each sensor has different threshold values so that when input values cross the threshold values it gives alerting signal driver and stops vehicle. The alerting message can be displayed on the screen.

The second section deals with the objects which are closed to the vehicle can be detected by using deep learning technique. Single Shot Detector (SSD) needs only one shot to detect many items in an image. This method is based on a feed forward convolution network that generates a set of bounding boxes of a defined size. To detect objects, first extract feature maps, then apply a convolution filter. SSD is designed to be independent of the base network and so it can run on top of any base networks such as Yolo, MobileNet etc. To overcome the practical challenges of running high resource and power consuming neural networks on low end devices. MobileNet was integrated into SSD framework. So, when MobileNet is used as the base network in the SSD, it is used as MobileNet SSD.
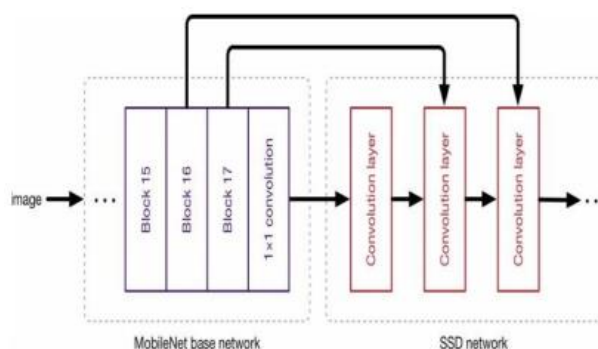

Figure 3: sections of the proposed methodology

5. Advantages of Proposed Methodology

The proposed black box system collects all the necessary information that always ensure safety of person while driving. It also detects whether the driver is drunk and if it is safe if he drives the automobile. It alerts the driver in case the vehicle hits a bump which could have a possible impact on the whole vehicle. Proposed system uses the Raspberry Pi which is a low cost, small sized computer and is more efficient in storing data and processing it.

The system detects any obstacles around the vehicle using the video captured by camera that uses object detection technique. The system will quickly notify the friends or family of the client about the exact location. The notification will be sent to pre-registered contacts and it will provide the location of the accident site. Any number of phone numbers can be given prior and the message along with location will be sent to all of them. The overall system thus, helps the prevention of accidents.

6. Component Design

The Raspberry Pi is a small, low-cost computer that can be controlled using a keyboard and mouse and connected to a computer monitor. It is a competent device that allows individuals to learn how to programme in languages like Python and Scratch and to explore computing. The Raspberry Pi 3 is the latest iteration of the world's most popular single board computer. It's a quad-core 16-bit ARM CPU with a clock speed of 1.2GHz. It comes with a 1.2GHz quad-core 16-bit ARM processor, four USB 2.0 ports, and wired and wireless networking. For physical projects, there are HDMI and composite video outputs as well as a 40pin GPIO connector.

The MQ3 sensor detects ethanol in the air and is referred to as an alcohol sensor. When a drunk individual breathes near this sensor, it detects ethanol and generates an output based on the alcohol concentration. If the alcohol percentage is higher, more LEDs will light up. This device collects the driver's exhaled breath and sends it to a sensor, which measures the levels of alcohol and carbon monoxide. The amount of carbon dioxide in one's breath is used to calculate the amount of alcohol in exhaled air. MEMS is a chip-based technology, called as a Micro Electro Mechanical System. Sensors consist of a suspended mass between the pair of capacitive plates. When the tilt is applied, difference in electric potential will be created by the suspended mass. As a change in capacitance, the difference is measured. This technology combines mechanical elements, sensors, actuators, and electronics present on a silicon substrate level. MEMS sensor is used for accident detection which contains XYZ axis as output. When an accident occurs XYZ axis get exchanged and thus the MEMS sensor sends an information as accident occurred. Accident sensors are activated by push buttons. There are three pins on these buttons: one for the common (C), two for the ordinarily closed (NC), and one for the typically open (NO). Because zero volt was required as an input to the microcontroller in all cases when the push button was pressed, the NO pin was employed. Collisions with the vehicle's chassis are detected using pushbuttons. The logic '0' is applied to the microcontroller's input pin when an accident is detected. The input of the pins attached to the sensors is logic '1' in other conditions due to the pull up resistors. The Global Positioning System (GPS) is used to locate the precise place we are looking for. People will be able to find their geographic location much simpler as a result of this. It is the primary source for determining the vehicle's latitude and longitude in order to determine where the accident happened. Every second, the GPS receives the satellite's latitude and longitude. This GPS can be installed in a vehicle, on a cell phone, or on specialized GPS devices that can be stationary or portable. The GPS system works by supplying location data. This can also be used to track the whereabouts of a vehicle or a person.
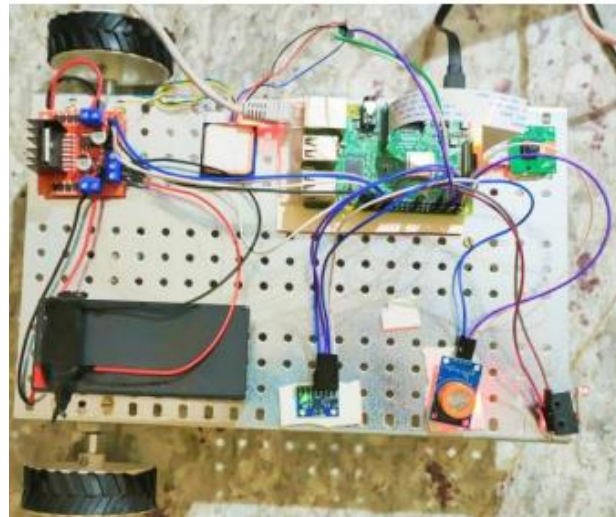
Figure 4: Prototype of the proposed system

7. Results and Analysis

The technology is put to the test in a variety of scenarios, including the driver being given water first, then alcohol, and the vehicle being driven over a minor bump before being driven over a larger bump. Object detection is also a computer vision approach for identifying and locating items in an image or video. Object detection can be used to count things in a scene, determine and trace their exact locations, and precisely label them with this type of identification. The system was tested against common barriers and was able to detect them. The test's results are displayed below.

MEMS SENSOR

ALCOHOL SENSOR

```
1
Forward
1
Detecting.....
< 25PPM : NORMAL AND CAN PROCEED
-1.3814543579101561 -2.1906945190429687
STABLE
-2.039859814453125 -2.31758720703125
STABLE
1
Forward
0
Detecting.....
> 25PPM : ALCOHOL DETECTED !!!!
stop
```

ACCIDENT SWITCH SENSOR

```
STABLE
-0.6248866333007812 -0.44053310546874996
STABLE
1
Forward
1
NORMAL AND CAN PROCEED
-0.16280571289062498 1.3623007446289062
STABLE
-0.9959878906249999 -0.0383072265625
STABLE
0
Bumper Hit Detected
stop
```

OBJECT DETECTION

```
[INFO] loading model...
[INFO] starting video stream...
[INFO] elapsed time: 32.17
[INFO] approx. FPS: 0.28
Alert!! Object detected
```

8. Future Enhancements

The current design focuses on alerting the driver about the possible chances of accidents and alerting the member's kin in case of accidents by sending location with SMS. Enhancements include making the automobile driverless using Artificial Intelligence where there will not be any need for anyone to physically drive or it can be used for transportation purposes as well.

9. Conclusion

This study discussed black boxes, which may be utilized to figure out what caused an automobile accident and the events that led up to it. They are especially useful when there's no proof at the scene of an accident. Accident investigators, police, and an increasing number of insurance companies are using black boxes to reconstruct events prior to accidents in order to assess whether a claim is warranted. Sensors are used by the system to detect the items and alert the driver. These sensors are controlled by the Raspberry Pi controller

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