Car Black Box

Anoop Mathew, Joseph Kuncheria, Yadukrishnan S, Gifty Raju, Haritha Chandrasekhar

Abstract*—Black box refers to collection of several different recording devices used in transportation: the flight recorders (flight data recorder and cockpit voice recorder) in aircraft, the event recorder in railway diesel locomotives, the event data recorder in automobiles and the voyage data recorder in ships. Car black box is an Event Data Recorder. When two cars collide, the sensor detects an accident and stores information regarding the car's speed, whether the seatbelts are fastened, the status of indicators and headlights and whether the driver hit the brakes before a collision. The number plate of the nearby vehicle is extracted from the captured images when accident was detected and the data is stored.

Keywords: - Black box, devices, Data Recorder, collide, collision.

I. INTRODUCTION

Car black boxes seem quite logical feature in vehicles considering that more people die in car accidents than in airplane crashes investigation of which primarily base on the black boxes. The causes of car accidents are not that difficult to investigate as plane crashes but there are cases that are very difficult to solve due to contradictory stories of the drivers or/and absence of witnesses of the accident. And in these cases, a car black box can be crucial piece of evidence for the investigators as well as the insurance companies. Just like black boxes in aircrafts help determine the cause of an airplane accident, car black boxes help determine what has caused a car accident and the events that led to collision. They are particularly valuable when no witnesses are present at the scene of the accident and when each driver has his/her own version of the events. The benefits of car black boxes for reconstruction of the events before accident are also emphasized by accident investigators, the police and increasing number of insurance companies which now have a powerful tool to determine whether the claim is justified or not. The benefits of a car black box outweigh the drawbacks in virtually all aspects. In addition to insurance companies and car accident investigators, car black boxes are also very useful for car rentals because any disputes about car damage can be easily resolved by reviewing the data from the device. These are typically stored on a secure digital (DS) card, while all accidents are stored automatically. However, this is good news for the customers as well because they will no longer be charged for car damage they have not done.

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Car black boxes are also ideal solution for young drivers below the age of 25 who are at increased risk of getting involved into an accident. This small device that is installed in the vehicle records several key actions that have been made by the driver before the collision including the speed of engine, accelerating, braking, turning, etc. which typically reveals enough information. Also, with a car black box that includes a camera there will be no longer any word against the police while insurance claims will be approved a lot faster.

II. SYSTEM OVERVIEW

A. Block Level Description

The car black box as a whole is a combination of several modules each provides some necessary information to be stored. The modules are constructed using suitable sensors and the sensor readings are interfaced with the processor so as to perform the necessary action depending on the sensor readings. It also has a camera section to capture images and extract data from the images. A brief block diagram representing the system is shown in Figure 1.

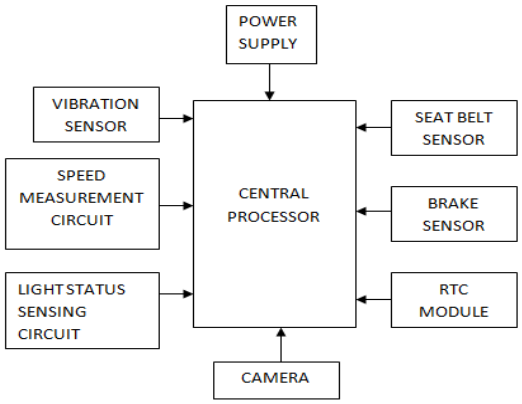

Figure 1: Block Diagram

- Central Processor

In the proposed system Beagle Bone is the heart of the system. It works on an installed operating system. It is the central controlling unit and co-ordinates the activities of all other units in the system. With highly advanced features available and ease of interfacing peripherals, this board is the most important unit in the system and generates the necessary controls to manage the working of the user interface as well as the flow control and database management mechanisms.

- Vibration Sensor

It is used to detect accidents by measuring the output of the vibration sensor, whose threshold value can be fixed. They give out a measurable voltage output when at the event of crash.

- Speed Measurement Circuit

The speed measurement is done using IR transmitter receiver pair. When there is no obstacle in between IR Tx and Rx , a 0v is detected. Once an obstacle comes in between them, the output goes to a high value less than supply voltage. The output is displayed in revolutions per minute.

- Light Status Sensing Circuit

The status of indicators can be checked using LDR placed in front of the indicator light. In a similar way, the status of head light as well as reverse light can be checked.

- Seat Belt Sensor

It indicates whether seat belts are fastened. This is ensured by checking if the button connected is pressed or not.

- Brake Sensor

Brake sensor, which is basically a switch, is used to detect the application of brake. When the brake is applied, switch turns on and when released, it turns off.

- RTC Module

When there is no network connection low cost battery-backed RTC module is used to keep track of time in BBB when the power goes out.

- Camera

Cameras are used to capture pictures from front, rear as well as sides of the car. When collision occurs previous images are processed to localize the number plate and the value is stored in memory along with the time of capture.

- Power Supply

The BeagleBone is powered by 5 V, 2 A adapters. The camera needs no external power supply when connected to the central processor. The various sensing circuits are also powered from the Beagle Bone using its analog output pins providing constant voltages of 1.8V and 3.3V.

B. *System Working Algorithm*

The device operates in two modes depending on whether accident is detected (accident mode) or not (normal mode).

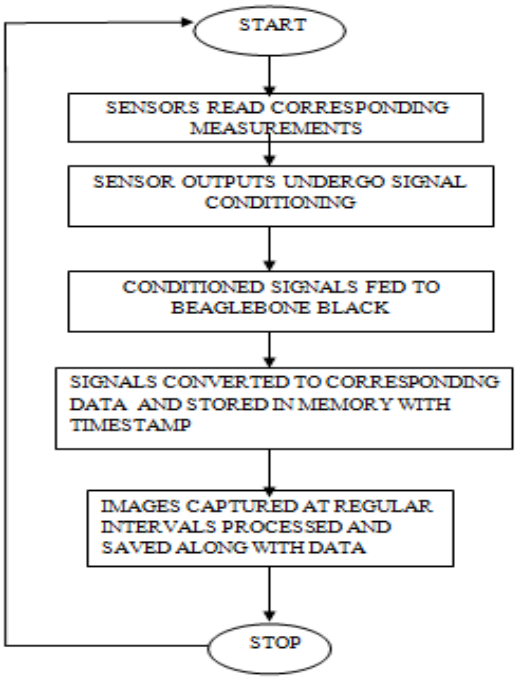

Figure 2: System Flow- Normal Mode

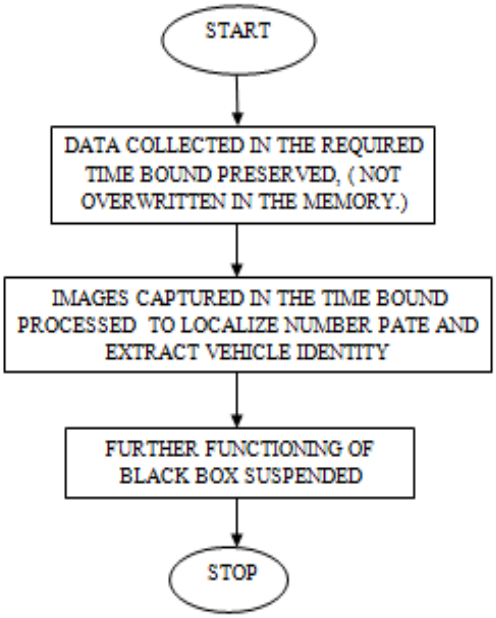

Figure 3: System Flow- Accident Mode

In normal mode, the sensor readings are taken and are given to the BBB after necessary processing. These are then converted into corresponding data and are stored with a timestamp. The images captured by the camera are also saved simultaneously. The accident mode is activated once the vibration sensor reading indicates accident occurrence. In this case the recorded data is preserved without overlapping and the captured image is processed to extract the number plate. The work flow in the system is depicted in Figures 2 and 3.

III. HARDWARE DETAILS

The hardware associated with the system are primarily the processor and the sensors to read data on to the processor and the camera.

A. BeagleBone Black

Stand-alone microcontrollers like the PIC were found to be a poor choice since they do not support graphical applications and networking. This led to the decision to opt for a single board computer like the Beagle Bone Black. Compared to Raspberry Pi, Beagle offers features like UART, ADC and PWM. It also provides more GPIO pins, with a lower power. The BeagleBone Black is a low-cost, high-expansion, focused Beagle Board using a low cost Sitara XAM3359AZCZ100 Cortex A8 ARM processor from Texas Instruments. It has 65 GPIO pins, with a lower power consumption of 220mA from 5V supply The attractive features of BeagleBone Black include a 1GHz ARM Cortex-A8 processor with 512 MB DDR3 on-board RAM along with USB, mini-HDMI interface connectors and 2 x 46 expansion headers.

B. Camera

The camera used is high resolution Logitech C270 camera.

It is made to capture the image of nearby vehicles and the images are stored for some time and overwritten at a later point of time when new images are captured. On occurrence of an accident, the images captured just before are processed for number plate extraction. The Software Support (at release) is Logitech Webcam Software 2.0 (LWS) and OS Support (at release): Windows XP, Windows XP x64, Windows Vista, Windows Vista x64, Windows 7, Windows 7 x64 . It has fixed focus type and Focal Length of 4.0 mm. The Field of View (FOV) is 60° and Optical Resolution (True): 1280 x 960 1.2MP.

C. RTC Module

RTC Module consist of IC DS1307, with a coin cell battery backup. In DC1307 serial RTC , address and data are transferred serially through an I^2C bidirectional bus and clock provides seconds, minutes, hours, day, date , month and year information and it operates in either the 24 hour or 12 hour format with AM/PM indicator. The month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The DS1307 has a built in power sense circuit that detects power failures and automatically switches to the backup supply.

IV. IMAGE PROCESSING SECTION

The various phases for extracting number plate is shown in figure 3.

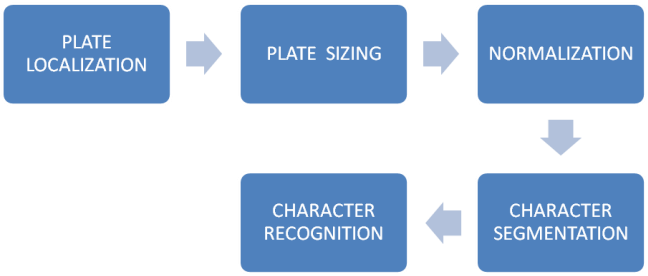

Figure 4:Image Processing Algorithm

The image be processed is captured by the camera. The origal image is a high resolution colour image. An example is shown in Figure 4.

Figure 5: Original Image to be Processed

- Plate Localization

At first the image is converted into corresponding binary image, using suitable threshold. The co ordinates of all non-zero elements of this image is found. The detail is used to compute the first and last row containing non-zero element. The same procedure repeated for column. Based on the obtained co ordinates the image is cropped.

- Plate Sizing

It is done to enlarge the image as required so as to maintain uniformity in dimension of all the localized number plate images. The localized and resized image is shown in Figure 5.

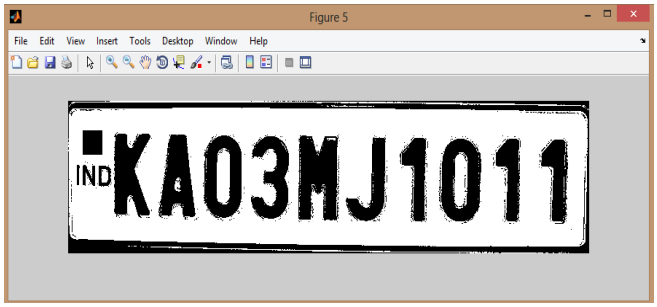

Figure 6: Localized and Resized Number Plate

- Normalization

The image brightness and contrast is adjusted so that the image processing can yield better results.

- Character Segmentation

The background of the plate is identified and the region between adjacent characters is replaced by a black separation line, to separate the characters. The images are segmented at these regions, and hence individual characters are obtained. The segmented characters are further cropped to exactly obtain the character portion. The number palte after character segmentation is shown in Figure 6.

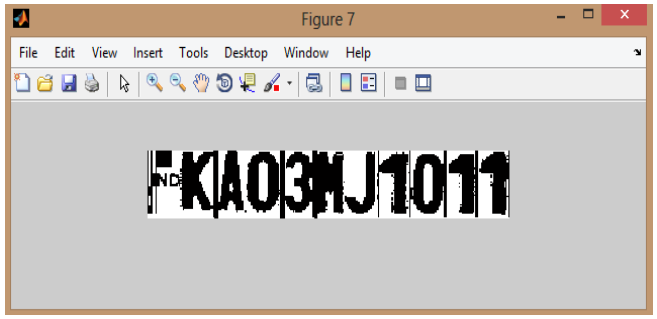

Figure 7 : Output for character segmentation

- Character Recognition

All the expecting characters in the specified font and size are stored in the form of a template, corresponding to their text .The individual segmented characters are adjusted in size to match with the template dimensions. and are compared, by correlating with all the characters in the template. The character with maximum value of correlation is the one which matches perfectly and is hence the text equivalent of the character. The final output is made to display as a text “KA03MJ1011”.

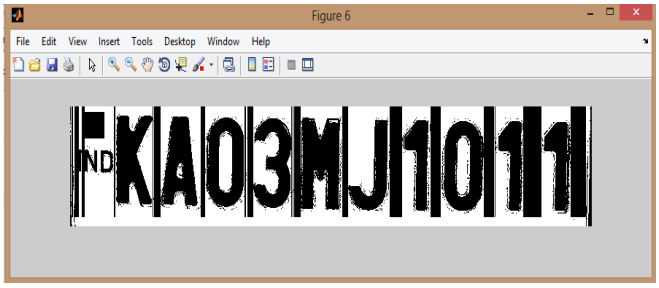

Figure 8: Image Resized to the Dimensions of Template

B. Sensor Section

V. IMPLEMENTATION DETAILS

The system uses several softwares for correct implementation. A brief description of these is included below.

A. Python Programming Language

Python was found to be the optimum choice for programming among the various other languages considered. as it is a widely used general-purpose, high-level programming language. It is easy to use in GUI applications, database management and networking. Moreover, BeagleBone libraries for executing ADC functions are easily available in Python. It has comparatively simpler syntax, allowing programmers to express concepts in fewer lines of code than would be possible in languages.

B. Open CV

OpenCV was chosen for its computational efficiency ,with a strong focus on real-time applications. Written in optimized C/C++, the library can take advantage of multi-core processing. OpenCV (*Open Source Computer Vision Library*) is a library of programming functions mainly aimed at real-time computer vision. It is free for use under the open source BSD license. The library is cross-platform. It focuses mainly on real-time image processing. If the library finds Intel's Integrated Performance Primitives on the system, it will use these proprietary optimized routines to accelerate itself.

C. *Database Management System - DBMS*

DBMS stands for Database Management System and it refers to a program or programs used to store data, manipulate data, and return data from the database to the user. SQL is a special-purpose programming language designed for managing data held in a relational database management system (RDBMS). SQL consists of a data definition language and a data manipulation language. The scope of SQL includes data insert, query, update and delete, schema creation and modification, and data access control. DBMS SQL sends the specified statement to the database engine for execution after colon expansion is performed.

VI. CONCLUSION

The proposed system would serve as an effective source of information at the event of an accident. When any type of accident occurs due to any reason car black box provides necessary data to generate the report of accident and about its causes. The recorded data of parameters are easily transferred to laptop computer with real date and time. Thus it provides help to monitor the status of several parameters of car which are responsible for proper movement of car. The system proposed can be further expanded in future to accommodate more number of functionalities. By incorporating GPS module, the location of the vehicle can be traced and using Google map, they path traversed can be routed. Using GSM module, the black box can be designed so as to send a message to the authority in case of an accident and with the help for GPS location of vehicle can also be provided with the alert message. With the help of internet, the number plate extracted can be used to know the details of the vehicle owner along with the other data.

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