



Car Post Crash Analysis & Emergency Rescue Alert System

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Abstract: *The Black Box concept is derived from the aviation industry, a flight recorder, colloquially known as a black box; although it is now orange-colored for easy search, is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of aviation accidents and incidents. With the advancement in technology and cost coming down, in our project we attempt to build similar device for our cars, not only this device will help us in post-crash analysis but also it will help us in quicker emergency rescue operation. Our research has been targeted towards building an integrated system for emergency rescue services in the event of a road accident. The project focuses on building an infrastructure in which vehicle safety authorities can be implemented to enhance their reporting of vehicle crashes, provide post-crash analysis using motion sensors, record of the event in images and reduce the time it takes for emergency rescue to arrive at the crash location.*

Index Terms: *Black Box, Car Crash Analysis, Rescue Alert System*

I. INTRODUCTION

According to the World Health Organization, more than a million people in the world die each year because of transportation-related accidents. The risk of accident or crash on road has become an unavoidable issue globally and of everyone's concern. According to WHO Road Traffic Injuries Fact Sheet about 1.24 million people die each year as a result of road traffic crashes. They have predicted the figure would reach 1.9 million casualties by the year 2020 if no action is taken. Those who live, has a high chance of incurring a disability as a result of the impact. 91% of the fatalities on the roads occur in middle and low income countries. The issue is of such concern that vehicle safety has been improved from the factory to a reasonable amount with airbags becoming standard vehicles and improved crumple zone. With vehicle productions ranging in wide variety of make and model several assessment programs have been initiated such as Euro NCAP to crash test vehicles and provide a standard rating system for safety. Along with protection by ensuring safer vehicles other initiatives such as The International Road Assessment Programmed is making roads safer by design. The vehicle accident is a major public problem in many countries, particularly India. Despite awareness campaign, this problem is still increasing due to rider's poor behaviors such as speed driving, drunk driving, riding without sufficient sleep, etc. The numbers of death and disability are very high because of late assistance to people who got the accident. These cause huge social and economic burdens to people involved. In order to react to this situation, the black box system draws the first step to solve problem. Like flight data recorders in aircraft, "Black Box" technology can now play a key role in motor vehicle crash investigations. A significant number of vehicles currently on the roads contain electronic systems that record in the event of a crash. That is why it is so important to have recorders that objectively track what goes on in vehicles before, during and after a crash as a complement to the was used.

Our research has been targeted towards building an integrated system for emergency rescue services in the event of a road accident. The project focuses on building an infrastructure which vehicle safety authorities can implement to enhance the reporting of vehicle crashes, provide post-crash analysis using motion sensors, record of the event in images and reduce the time it takes for emergency rescue to arrive at the crash location. We can achieved this using existing cellular network infrastructure already in place and also using GPS to pinpoint the exact location of the crash and send that data to an emergency rescue authority (such as Hospital, Fire Department, Police) using GSM text service. To allow crash investigators find out how the vehicle was being driven and what road surface conditions it was being driven over we have accelerometers in our project. Temperature for both cabin and engine bay is also recorded in a file to figure out events such as a blown engine that resulted in fire is actually an instant occurrence or did it gradually came to that condition. Another trigger comes from the Electro Conductivity sensor if vehicles plunges into water or has entered in water. Logging of the complete data with time via RTC chip can be done on I2C EEPROM or SD card. Our target was to build a low cost device that everyone can afford and use in their vehicles. The focus of our research is to reduce the time it takes for an ambulance to arrive at the crash location in the event of an accident and build a rescue infrastructure for emergency services. And future help the investigation team to analyze the crash by providing them critical vehicle related data.

II. RELATED WORK

Several Accidents alert system has been designed to provide rescue operation in case of crash, even system were built to track the vehicle. Some work has been done to record the events of the car crash in memory, full fledged system still will

take time and still research and development is going on. Our project is also towards the same R&D domain and this project will clear major milestone of these kinds of systems. Some related are as follows

1. Automatic Vehicle Accident Detection and Messaging System Using GSM and GPS Modem by C.Prabha,R.Sunitha, R.Anitha. IJAREEIE July 2014.

They have designed an alert system in case of accident. Just one piezoelectric sensor is used as accident detection sensor. As soon as sensor trigger, position information GPS is sent to fixed mobile number via GSM.

2. Automatic Vehicle Accident Detection And Messaging System Using GPS and GSM Modems by Sri Krishna Chaitanya Varma, Poornesh, Tarun Varma, Harsha. International Journal of Scientific & Engineering Research, Volume 4, Issue 8 August 2013.

Above project is also similar to previous project, they have used IR sensor to detect collision but this can give fall trigger if IR sensor comes very near but not collide. And their paper is more about GPS and GSM and less about accident alert system.

There were several papers on Accident alert system and all are almost same. Now we shifted our literature review towards system for assisting crash investigation.

3. Mueller, C., Daily, J., and Papa, M., "Assessing the Accuracy of Vehicle Event Data Based on CAN Messages," SAE Technical Paper 2012-01-1000, 2012.

Vehicles using controller area networks (CANs) for on-board device communications may have event data recorders (EDRs) that either capture or reflect network feeds from an array of sensors and other electronic control units. Using the data recorded in an EDR for investigative purposes requires external verification of accuracy. This paper describes the method to verify the stored data based on CAN interface and messages

4. Bing-Fei Wu; Ying-Han Chen; Chung-Hsuan Yeh, "Driving behavior-based event data recorder," in Intelligent Transport Systems, IET , vol.8, no.4, pp.361-367, June 2014

For crash investigation driver behavior is very important and from the stored data it can analyzed too. This paper is towards this research which is very important part for crash investigations. The authors approach is to recognize the seven behaviors: normal driving, acceleration, deceleration, changing to the left lane or right lane, zigzag driving and approaching the car in front by the hidden Markov models. All data were collected from a real vehicle and evaluated in a real road environment. The experimental results show that the proposed method achieved an average detection ratio of 95% for behavior recognition.

5. Lokhande, Rajashri R., and Sachin P. Gawate. "Design & Implementation of Vehicle Black Box for Driver Assistance and Alert." IOSR Journal of Computer Science, pp. 39-42, 2014.

This paper is only about car accident alert but not on post-crash analysis.

6. Patil, Ramchandra, and Shivaraj Hublikar. "Design and Implementation of Car Black Box with Collision Avoidance System using ARM." International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075.

This system has two main principle components namely Vehicle to Vehicle Collision Avoidance Unit (VVCAU) is used to avoid crashing between vehicles and Black Box (BB) records the relevant details about a vehicle such as Engine Temperature, Distance from obstacle, Speed of vehicle, Brake status, CO2 Content, Alcohol content, Accident Direction, trip Time and Date. Although this project has some sort of storage of parameter but it's not with the time stamp and data volume is too low for post-crash analysis. And some sensors are good for small robotic experiments but not in real scenario. This paper was purely student implementation lacks professionalism and real time implementation.

7. Sekhar Reddy, M. Chandra, P. Ajay Kumar Reddy, et al. "BLACK BOX FOR VEHICLES", International Journal of Engineering Inventions, Volume 1, Issue 7(October 2012) PP: 06-12.

The main purpose of the paper is to develop a prototype of Black Box For vehicle diagnosis that can be installed into any vehicle. This prototype can be designed with minimum number of circuits. This can contribute to construct safer vehicles, improving the treatment for crash victims, helping insurance companies with their vehicle crash investigations, and enhancing road status in order to decrease the death rate.

Project lacks the storage of systematic data with multitude of parameters and display for post-crash analysis is on 16x2 LCD and shown only last stored data which is not enough for investigation.

III. OBJECTIVE OF PROJECT AND PROBLEM STATEMENT

To create a model of this system our objectives include

- (1) Build a device (Black Box) that can collect GPS Data and Send them via GSM instantly on the event of a crash.
- (2) Allow trigger for several types of crash such as vehicle getting plunged in to water, high cabin, engine temperature and different road collision types such as rear-end collision, angle or side impacts.
- (3) Log data such as GPS, temperature, frame by frame image of the event, Motion Data for preliminary post-crash analysis.

IV. SYSTEM THEORY

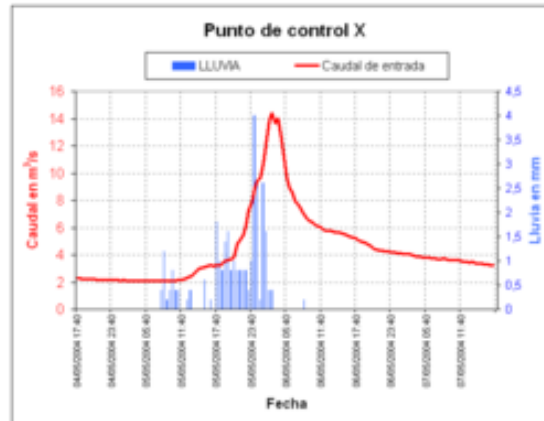
The open system theory is the foundation of black box theory. Both have focus on input and output flows, representing exchanges with the surroundings.

The black box is an abstraction representing a class of concrete open system which can be viewed solely in terms of its stimuli inputs and output reactions:

The constitution and structure of the box are altogether irrelevant to the approach under consideration, which is purely external or phenomenological. In other words, only the behavior of the system will be accounted for.

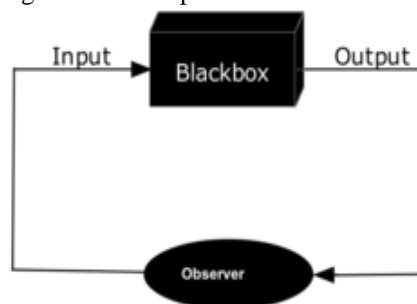
The understanding of a black box is based on the "explanatory principle", the hypothesis of a causal relation between the input and the output, and:

- input and output being believed to be distinct,
- having observable (and relatable) inputs and outputs,
- Being black to the observer (non-openable).
- Recording of observed states



The observed hydrograph is a graphic of the response of a watershed (a blackbox) with its runoff (red) to an input of rainfall (blue).

An observer makes observations over time. All observations of inputs and outputs of a black box in which, at each of a sequence of times, the states of the box's various parts, input and output, are recorded. Thus, using the Ashby's example, the box that fell from the Flying saucer might lead to the protocol



When the observer can also do some stimulus (input), the relation with the black box is not only an observation, but an experiment.

Thus every system, fundamentally, is investigated by the collection of a long protocol, drawn out in time, showing the sequence of input and output states. From this there follows the fundamental deduction that all knowledge obtainable from a Black Box (of given input and output) is such as can be obtained by re-coding the protocol (the observation table); all that, and nothing more.

If the observer also controls input, the investigation turns into an experiment (illustration), and hypotheses about cause-and-effect can be tested directly.

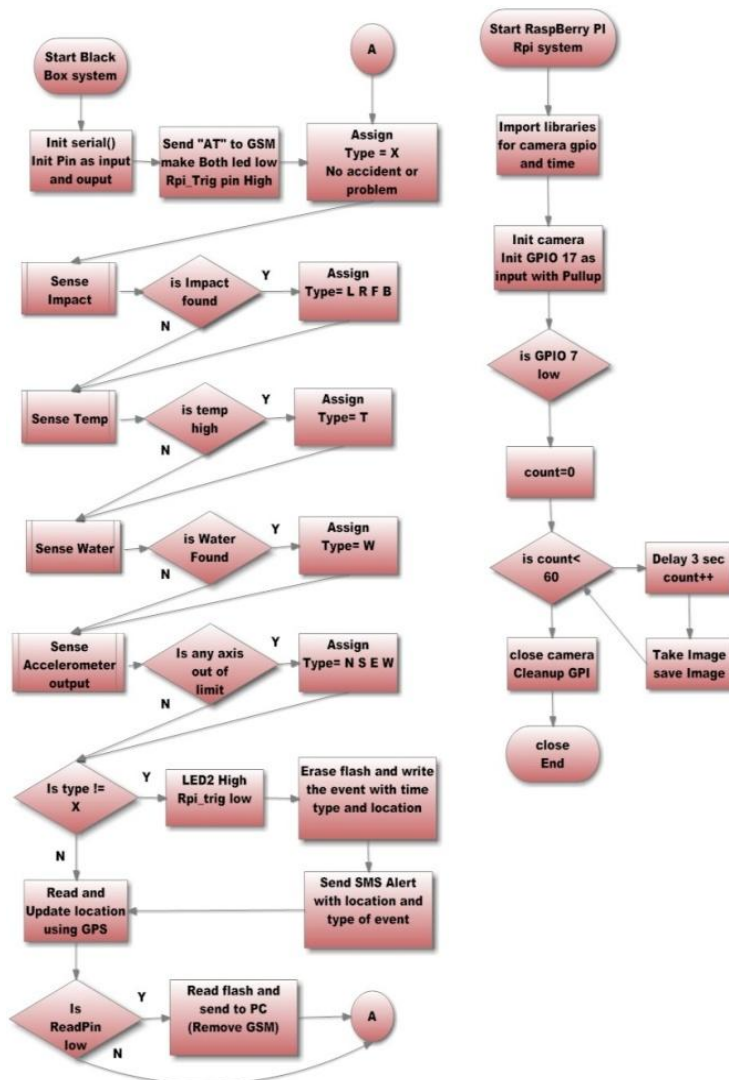
When the "experimenter" is also motivated to "control the box", there is an active feedback in the box/observer relation, promoting what in control theory is a feed forward architecture.

1) Modeling

The modeling process is the construction of a predictive mathematical model, using existing historic data (observation table).

2) Testing black box model

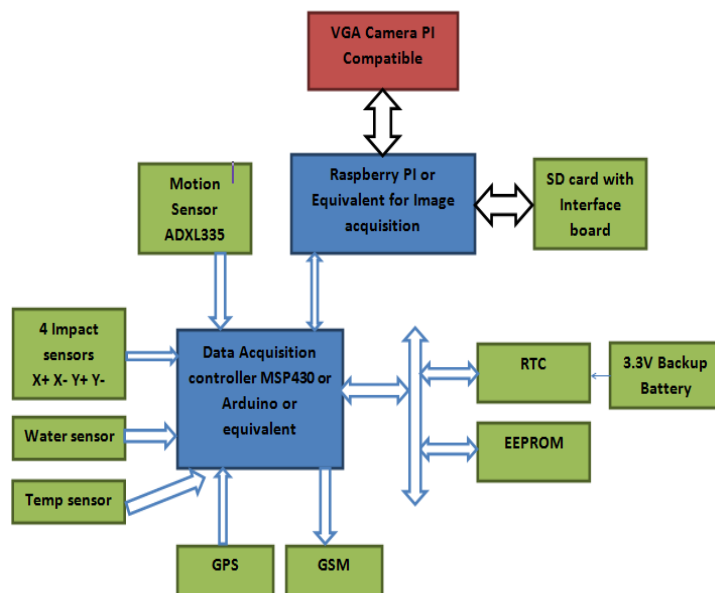
A developed black box model is a validated model when black-box testing methods ensures that, based solely on observable elements. See also back testing: inputs for past events (not used in the "modeling effort") are entered into the model to see how well the output matches the known results.



V. SUMMARY FOR LITERATURE REVIEW AND RELATED WORK

After going to various papers and literature R&D for black box is happening all over world and many papers have been publish, but most lack systematic storage of data and display of data properly to make it presentable for analysis purpose. Some projects are only storage of parameters and some are only accident alert, but we are merging both and shaping the system towards more practical and real time implementation. And for accident alert our system will search the nearest hospital and send SMS to it directly no call center is required for that.

VI. BLOCK DIAGRAM AND WORKING DESCRIPTION



A. Description

Two embedded boards are used one exclusively for camera data acquisition in SD card and other for storing critical parameters for crash analysis and detection purpose. One more task of sending sms in case of accident for emergency medical services is also required to be done by this embedded board. All the sensor data either digital or analog will be stored in memory with time stamp and can be retrieved with serial interface to any serial terminal software with proper format so it can be really help full in crash investigation. GPS and GSM uses UART interface whereas motion sensor output is analog so we will use MCU internal ADC to convert the data in digital for processing and storage purpose. Impact sensor and water sensor o/p is digital any digital I/O can be used. And finally temperature sensor data is analog too.

B. Hardware Requirements'

- Raspberry PI,
- Pi compatible VGA camera
- SD card 4GB or more and SD card adaptor
- Arduino Board or MSP430 or similar board
- Temperature sensor LM35
- Water/Moisture Sensor
- GPS module TTL
- GSM Module TTL
- Switches for impact sensor
- I2C RTC chip DS1307
- I2C EEPROM AT24c64
- ADXL335 Motion Sensor
- 3.3V battery
- LEDs 5mm or 3mm
- Jumper wires
- Power supply and other accessories

C. Software requirements

- Arduino ide
- Tera term or similar for serial communication
- Raspberry PI IDE for Python or C (Adafruit Web IDE)
- Telnet software for interface.

VII. CONCLUSION

This system will be use full in all types of vehicles like cars trucks buses etc. and very much useful in post crash analysis and accident investigation. Help to alert emergency medical service team to reach at required location in shortest time. As system is using GPS and GSM it can use for tracking also. With multitude of sensor many physical parameters can be monitored and stored for future analysis. Impact sensor being installed in all sides and along motion sensor accident trigger is ensured with high accuracy. Accident alert is an advantage as we use KNN algorithm to find nearest hospital and no need of call center. As any systems have some limitations so in our system also one time installation cost is required, it is not fire proof and shock proof and if GPS signal is not coming or no of satellites in view are less then position will not be available and alert SMS will not sent. In future enhancement, latest before crash 2 minute of video can be retained, SD card can be used to store other parameters too, Alternative to GPS and GSM for accident alert to be found and implemented and the system can be made fireproof and shock proof.

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