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Simple Black Box for Vehicle

Shreya Ramrao Deshmukh
Dept. of Electronics and Telecommunication,Nanded, Maharashtra, India.

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Abstract: *Automobile technology has created a new level of data services in vehicles. One best example is the black box. The aim is to achieve accident analysis by objectively tracking what happened at the time of the incident. The system also involves the enhancement of security by preventing tampering with the recorder data. It is used to analyze the cause of vehicular accidents and to prevent the loss of life and property arising from vehicle accidents. So to overcome these problems, the black-box system came into existence. This is not a new technique, just getting updated day by day with different hardware combinations. This project proposes a prototype of the black box System that can be installed into any vehicle. The main objective of the paper is to make a system that can monitor images and video in real-time continuously on an SD card. It can be easy for accessing. The data recorded is used for investigation purposes as it is needful. The data is stored in the SD card that is externally connected to the Raspberry pi which plays a unique role. The information is collected by Raspberry Pi processors using a camera and RTC which is connected to the processor gives all the collected data information to the monitoring system. The monitoring system will display the data (if needed and wanted) in real-time which helps the investigation to find out the scenario of the accident that occurred.*

Keywords *– black box, camera, RPi, RTC.*

I. INTRODUCTION

The black box is one of the most secure solutions for public safety. The black box is nothing but a data recorder that can records video, images, sound, time, and many more parameters if included. The Black Box concept is adapted from the aviation industry and is an electronic recording device placed in an aircraft to facilitate the investigation of aviation accidents and incidents. With the advancement in technology and cost coming down, attempted to build a similar device for any vehicle. Fig.1 1 shows the flight data recorder.

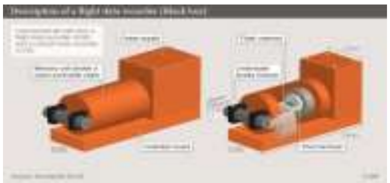

Fig. 1 Flight data recorder

A. Background

According to the World Health Organization, people in the world die because of transportation-related accidents. Most of the time the accident happens due to the rash driving of human beings and through any vehicle. To react to this situation, the black box system draws the first step to solve the 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 [1]. That is why it is so important to have recorders that will show what happened during, and after a crash. Initial investigation is done usually from victims, eyewitnesses, and police reports. But it will take time to prove whether the information is right or wrong. So, to overcome this problem, we have implemented a system that will keep a record of the accident. This system is mainly committed to two sections. The first one is how to detect and collect the information from the vehicle. The second is how to present the data to the user in a simplified way. The basic functions of a black box should include continuous audio/visual recording for both the front and rear of the vehicle. To implement this, various types of sensors and python language can be used. While the next section was implemented by using the software like a putty shell, VNC server, etc. This programming helps in not only recording the data but also retrieving the data from memory to any GUI display like monitor, mobile, laptop, tablet, or directly to LCD connected to the raspberry pi. Here to make it simple and easy to access, we used a Camera sensor and RTC.

B. Problem Statement

Whenever an accident happens, most of the time people nearby call the ambulance. The problem associated with this is sometimes you get help, and sometimes you do not. There are chances where no people nearby the accident spot or people who are around neglect the accident. This is the biggest flaw in any accident analysis. There are many solutions proposed for the concerned problem and each one has some advantage over the others. Presently tracking system and adding multiple sensors is introduced in vehicles to avoid accidents and save people's life. They have used different microcontrollers for this purpose. But the existing systems are available only in high-end vehicles because the monitoring system and cost of the overall system are expensive. The Black Box will give us an easy solution. The Black Box will be used by any vehicle. Several potential benefits of this project include Vehicle monitoring (on the spot too if anyone can) and Evidence collection. Factors that are likely to drive the economics of development are Safety and accident prevention, Vehicle maintenance, Cost of black-box maintenance, and Hardware and software costs.

II. LITERATURE REVIEW

"Evidence Collecting System from Car Black Boxes" [2], by Kangsuk Chae, Daihoon Kim, Seohyun Jung, Jaeduck Choi, and Souhwan Jung. They have proposed a demonstration about how to effectively collect and manage information obtained from car black boxes in vehicular networks. The car black box is a vehicle-based CCTV that records video images, sound, GPS position, speed, and time. These data can be used for accurate car accident investigations and some public crime prevention.

The author proposed "BLACK BOX FOR VEHICLES" [1] to develop a prototype of Black Box For vehicle diagnosis that can be installed into any vehicle. This prototype can be designed with a minimum number of circuits. This can contribute to constructing safer vehicles, improving the treatment for crash victims, helping insurance companies with their vehicle crash investigations, and enhancing road status to decrease the death rate.

"Design and Implementation of Novel Video Compression Technique Using Raspberry Pi" [4], by Shiva Kumar NR, Venkatesh Murthy N K. in this paper, new novel video compression techniques are proposed since it effectively compresses the video data by saving the bandwidth of the wireless sensor networks (WSN). The proposed video compression algorithms are implemented on the raspberry pi platform using the python language and communicated wirelessly to the base stations (laptop) using low-power Zigbee radio trans-receivers. The performance of the implemented video compression technique is studied by considering performance matrices such as compression ratio, space-saving ratio, mean square error, and peak signal to noise ratio.

III. BLACK BOX SYSTEM

Fig. 2 shows the block diagram of the system. The proposed paper consists of the Raspberry pi as the main processing unit for the entire system and all devices are connected to it. The components are connected to the RPi through GPIO and CSI.

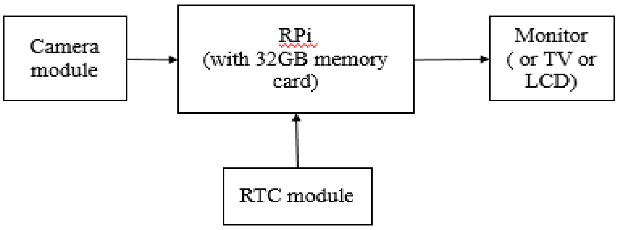

Fig. 2 Block diagram

The Camera module repeatedly sends the data to the RPi and simultaneously RTC too. So, the implemented design consists of Raspberry Pi, a camera module, and RTC (real-time clock) to get the real timing and date of the evidence (in case of offline mode). Whenever the user wanted or in this case whenever the vehicle gets a start, the camera module will take down the pictures and will record the video as per the programming done. RTC will record the time and date of images and videos captured. The system is time-consuming. Basically, for the first time, all the sensors have to get the setup done manually. Then only on the 2nd time on boot, the modules will work properly. Initially, raspberry pi OS is installed into the SD card and all the required hardware and sensors are connected to the RPi. Switch on the power supply and connect the raspberry pi to the internet. Enable the sensors and write code for overall sensors. After that run the code in python. Finally check the output. Here, the system hardware and software are discussed as:

A. Raspberry pi: The Raspberry Pi is a credit-card-sized computer based on the BCM2835 system-on-chip (SoC), which includes an ARM11 processor and a powerful GPU. The Raspberry Pi supports various distributions of Linux including Debian, Fedora, and Arch Linux. Here, for demo purposes used the Raspberry Pi Model B+.

Fig. 3 Raspberry Pi

The Raspberry Pi was designed by the Raspberry Pi Foundation to provide an affordable platform for experimentation and education in computer programming. The Raspberry Pi can be used for many of the things that a normal desktop PC does, including word-processing, spreadsheets, high-definition video, games, and programming. Features of RPi are 700 MHz ARM11 processor, 512 MB of RAM, Ethernet port, Four USB ports, Full-size HDMI output, Four-pole 3.5 mm jack with audio output and composite video output, 40-pin GPIO header with 0.1″-spaced male pins that are compatible with our 2×20 stackable female headers and the female ends of our premium jumper wires, Camera serial interface (CSI), Display serial interface (DSI), Micro SD card slot. The RPi takes a long time to boot when powered on for the first time, so need to be patient.

B. Camera module: The Raspberry Pi Camera used here is the 5-megapixel OmniVision OV5647 sensor of the original camera. The original model was released in 2013. This is the plug-and-play compatible version of the raspbian operating system, making it perfect for time-lapse photography, recording video, motion detection, and security applications. Connect the included ribbon cable to the CSI (camera serial interface) port on raspberry pi, and you are good to go. This module is only capable of taking pictures and videos, not sound.

Fig. 4 Camera module

Fig. 5 Camera with RPi

The Camera Module can be used to take high-definition video, as well as stills photographs. It's easy to use. You can also use the libraries we bundle with the camera to create effects. There are two versions of the Camera Module one is The standard version, which is designed to take pictures in normal light and the other is The NoIR version doesn't have an infrared filter, so you can use it together with an infrared light source to take pictures in the dark.

C. DS3231 High Accuracy RTC (Real Time Clock): While your Pi is connected to a network it will be able to set its clock correctly using NTP. Without a network connection, the system time and date will almost certainly be wrong. For this project, this is a problem especially because we are logging time and images and performing other time-sensitive operations. This can be solved using a Real-Time Clock (RTC) module. This will use a small coin cell battery to keep the time for the Pi even if it is turned off. When the Pi reboots it can set its internal clock using the time held in by the RTC. The easiest way of implementing an RTC is to buy a pre-made module. Luckily RTC modules are relatively cheap and easy to obtain.

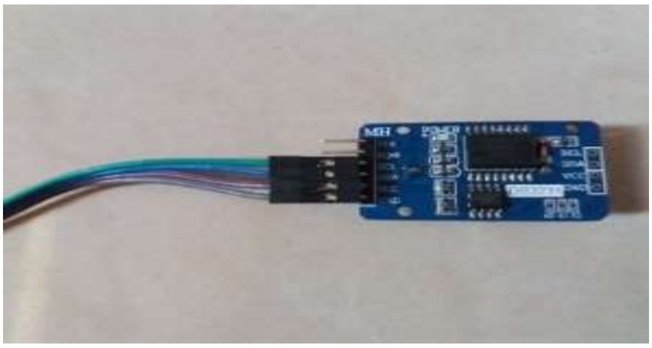

Fig. 6 RTC module

Fig. 7 RTC with RPi

The High Accuracy Pi RTC is based on the clock chip DS3231. The DS3231 is a low-cost, extremely accurate I2C real-time clock (RTC). It provides an RTC for Raspberry Pi via the I2C interface. With the clock source from the TCXO(temperature compensated crystal oscillator), the RTC maintains seconds, minutes, hours, day, date, month, and year information. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap years. The clock operates in either the 24-hour or 12-hour format with an AM/PM indicator. The clock provides two programmable time-of-day alarms and programmable square-wave output. The INT/SQW pin either generates an interrupt due to alarm conditions or outputs a square-wave signal and the selection is controlled by the bit INTCN. If you want to retain the time information even when the Raspberry Pi is powered off, you need to insert a 3V CR1225 lithium cell into the battery holder.

D. Raspberry Pi OS: Raspberry Pi needs an operating system to work. Raspberry Pi OS (previously called Raspbian) is the official supported operating system. Raspberry Pi recommends the use of Raspberry Pi Imager to install an operating system on your SD card. You will need another computer with an SD card reader to install the image. So, Install Raspberry Pi OS using Raspberry Pi Imager. Raspberry Pi Imager is the quick and easy way to install Raspberry Pi OS and other operating systems to a micro SD card. Installing the Operating System as:

Fig. 8 Raspberry Pi Imager

Download and install Raspberry Pi Imager to a computer with an SD card reader. Put the SD card you'll use with your Raspberry Pi into the reader and run Raspberry Pi Imager.

E. Python: Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language.

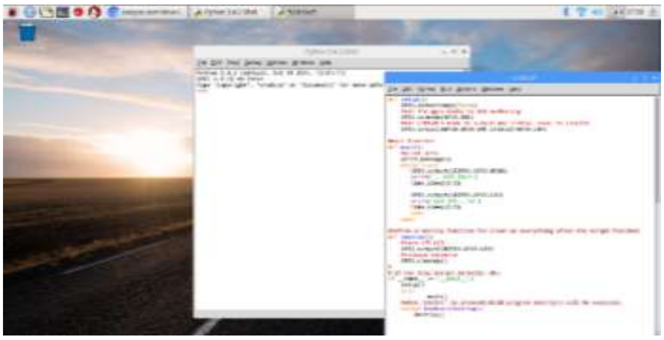

Fig. 9 Python on RPi

IV. RESULT AND CONCLUSION

Connect computer monitor with display with HDMI input to RPi, and Connect the Camera module and RTC module to raspberry pi with cable and wires to CSI and GPIO pins respectively, and keyboard and mouse for initial start. Now, power on RPi, and run the program will show:

Fig. 10 output

So, successfully implemented the simple black box which has less number of components but the most important one as evidence and gave good results. The data can be retrieved as required. The initial testing is done with a connection to a monitor instead of an LCD. Also, the trials are done on mobile for simplicity and laptops through USB and Ethernet cables (RJ45). Due to the loss of data haven't added images.

V. FUTURE SCOPE

One can use a quad-camera setup through the USB port. Also, can use voice activation, fingerprint, or facial recognition to make the system and data security. We can add various sensors for more data collection.

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