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AN IMPLEMENTATION OF CRASH-DATA AUTOMATIC MONITORING SYSTEM (CDAMS) IN AUTOMOBILES

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ABSTRACT

The paper addresses the problem of investigating the situations of near crash and at the time of impact, in the event of head-on collisions and rear end collision as well, by locating the latitude and longitude of the position of the vehicle using GPS function. The Crash Data Automatic Monitoring System (CDAMS) is analogous to the Black Box technology that underwent dramatic changes through its reconciliation with the embedded system and camera technology. The data, so generated may give a fillip to understand the mechanics of accidents and serves a beacon light to planners, Crime Investigative Agencies and the researchers as well.

KEYWORDS: Black Box, Communication Satellite, Embedded System, GPS & GPS Tracker, Sensors, Serial Communication and Wireless Transmission (See Foot-Notes)

INTRODUCTION

With the advent of modern era the car becomes necessary good, be it small or large light vehicle to all segments of population in all developing and developed societies. The statistics on Road Accidents in India (1) paraphrases that during the calendar year in 2010, there were close to 5 lakh road accidents in India, which results in more than 1.3 lakh deaths and inflicted injuries on 5.2 lakh persons. These numbers were adduced to substantiate the statement that one road accident every minute, and one road accident death every five minutes. Unfortunately, more than half the victims are in the economically active age group of 25-65 years. The loss of the main breadwinner can be catastrophic. The statistics explains eloquently the gravity of the problem demanding the attention of the planners and researchers as well. In this context, Auto manufacturers are bent upon implementing GPS technologies in various formats to minimize the risk of deaths on roads. As an adjunct to the problem of finding a solution, the researcher is attempting to build an automatic data recording system at the dying minutes of an impending crash videoing the proceedings that may give supportive information for the planners to plug in with the safety devices.

Genesis of Black Box Technology

For years, Airplane crash investigators have had the benefit of retrieving data from the flight-data recorder or Black-Box. The data have proven invaluable help determine what happened in seconds before a crash. For the first time in the Car industry, General Motors was using similar technology in about 40 percent of its 1999 model vehicles. The Black Box technology has been evolving over years in Automotive Art. In the 1970s, the industry moved to electronically controlled fuel injected engines. Engine control module (ECM) which engaged sensors typically gather information about throttle position, engine RPM and airflow. As the vehicles become more sophisticated, new electronic system found their way into automobiles. Acceleration Sensors (for Airbag module), Wheel speed Sensors (for Traction control), Vehicle Yaw rate Sensors (for Stability control) etc., are used specific to each system. Each module has the ability to store faults that are discovered in that particular system. For example, the Airbag could not only store a fault, but also it could count

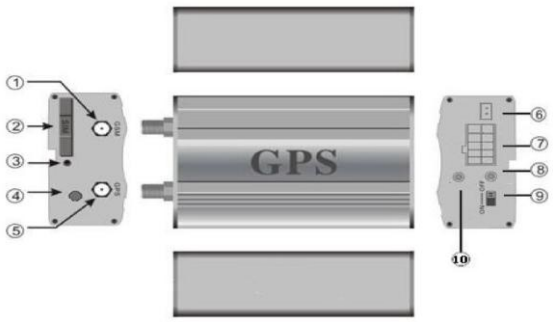
the number of times the engine had started since the fault was generated. Don Gilman (2) concludes that this was one step towards storing of data and its recovery. Any technology that allows vehicle safety researchers to collect objective, accurate data on crashes opens the door to a new generation of understanding and modeling. Black Box technology (3) has come to stay as a data recovery system that allows measuring the change in velocity or delta V in case of severe collision wherein the crash severity is determined using delta V. The Black Box technology is technically called the "Event Data Recorder" (EDR).

Car black boxes are in the news because the National Highway Traffic Safety Administration (NHTSA) in US is proposing that all automakers may think over equipping their new consumer vehicles with the devices beginning in Sep' 2014. White House Office of Management and Budget believes that the exercise of EDRs across the entire light vehicle flight could contribute to advancements in vehicle designs and advance restraints and other counter measures. In keeping with its tenor of belief, NHTSA has its announcement that EDR data would be treated by NHTSA as the property of the vehicle owners and would not be used or accessed by the agency without owner's consent.

Auto insurers delighted the owners with the lower insurance rates if they came forward to fit in on-board devices that track mileage and other driver behavior. According to NHTSA, 96 percent of all 2013 vehicles have the devices, but not all automakers that install Black Boxes reveal their existence and location. The agency further mandated that all vehicles manufactured after September 2011 that include EDRs record a minimum of 13 data points in a standardized format. Despite being called a " Black Box, an EDR records data from a variety of sensors in a vehicle and is typically attached to the vehicle's floor, But EDR's can also be mounted to a Car's steering column, firewall or other out-of-the way location. When a crash occurs, an EDR captures and store information about the incident. In addition to the data and time of the crash, modern EDRs records vehicle speed, engine speed, steering angle, throttle positions, braking status, force of impact, seat-belt status and airbag deployment. The EDR does not any have any information about who was driving or where an incident took place nor can it reveal any personal driver information. An EDR cannot tell whether the driver was intoxicated or using a mobile phone during an accident. Sherwood (4) asserts that systems are designed to record a short time before and after an airbag deploys.

An Overview of GPS System

The GPS system includes (5) a GPS chip, GPS antenna, the processer and a GPS software driver. The driver allows the processor to communicate with GPS chip via serial communication to receive environment data such as latitude, longitude, velocity, time etc. The antenna connects directly to the chip.



①. GSM Antenna connector, ②.SIM card slot ③. SIM card slot Pop-up switch, ④. Monitor jack ⑤.GPS Antenna connector ⑥. Sensor jack ⑦. External harness connection jack ⑧.Power/GSM/GPS LED indicator ⑨. Backup Battery switches ⑩. Remote controller receiver Antenna Option, for model B only）

GPS Receiver Chip- GPS Receiver chip will receive signals from the GPS satellites and in turn, communicates the necessary environment data information to the processor. The information that can be sent to the processor includes the car's latitude, longitude, time, velocity and so on.

GPS Antenna- The GPS receiver will need an antenna to accurately receive the signals from the GPS satellites.

IR Sensors- IR Sensors are mounted in the center to detect head-on collisions and rear- end collisions.

Software- Software is embedded in the processors (EEPROM). The software will include many drivers. A driver is used control the GPS chip, allowing communication to take place between the GPS chip and the processor. Another driver will control and communicate with IR sensors, still another driver facilitates the collision detection and yet another one is employed to communicate with GPS to find the correct location. All these software components are controlled by a main program. The GPS coverage is subject to known geographic and weather conditions.

The factors like terrain (under deep vegetation), urban canyons (large or tall buildings), vehicles (signals can be lost when an offender is riding a car) and weather (Rainfall, fog or snowfall) may complicate the GPS coverage at all times. To obviate this difficulty, Omni-multidirectional antennas are recommended instead of flat batch antennas. Radio frequency technology (RF), cellular towers and Advanced Forward Link Trilateration (AFCT) could be paired with GPS to enhance system accuracy.

GPS tracking system was originally designed and utilized by the military to provide location and or velocity information of objects or individuals around the world. In order to provide accurate location information, a receiver must be in clear sight of at least three satellites. In most normal situations a human being is likely in view of between five and eight satellites.

Applications

Zheng et al. (6) has listed out the following GPS applications. The GPS make many applications possible such as emergency notification, roadside assistance, stolen vehicle recovery, navigation assistance, real time traffic alerts and mobile "Yellow Pages".

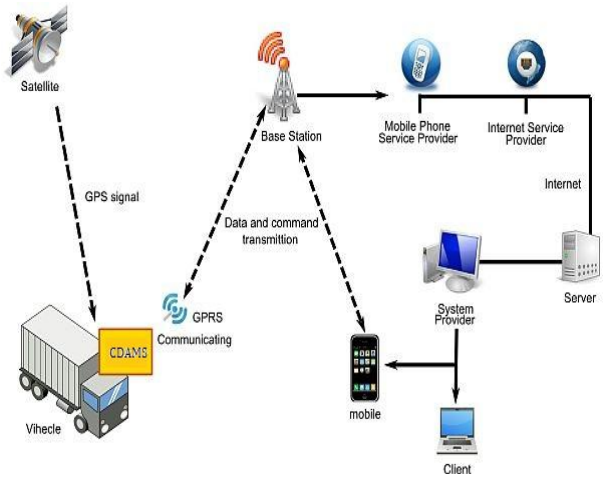
Operating Procedures

Weiss et al. (7) are of the opinion that GPS identifies the vehicle's location based on the technique of Time-Difference-Of-Arrival (TDOA). The technique calculates the delay of the consecutive signals transmitted by the satellite GPS system that covers everywhere on the earth surface. However, a GPS receiver needs at least four satellites to calculate 3D position. The satellites are often blocked by terrain factors, buildings, foliage etc. The requirement of line-of-signals for satellites limits the application area of GPS.

Melgard T.E et al. (8) is of the opinion that it may be very difficult to improve the location accuracy using only GPS device alone because of high-rise buildings and its consequent blockage of satellite. Grewal et al. (9) gives out a feasible solution that demands an integration of GPS with Inertial Navigation System (INS).

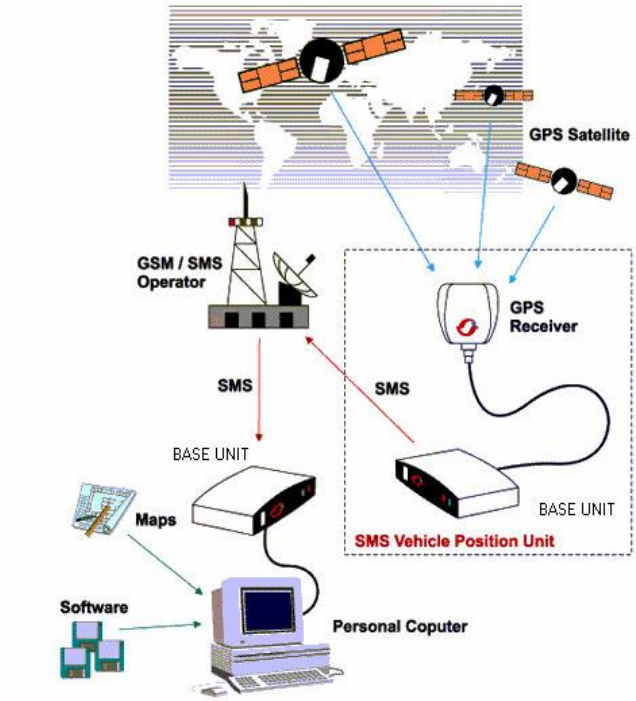
In this paper Cellular tower is paired with GPS to enhance system accuracy. GPS software driver will allow the processor to communicate with the GPS chip via serial communication to receive environment data such as latitude, longitude, altitude, velocity and the heading.

The GPS tracker is a new product based on GSM/GPRS network and GPS satellite positioning system. The GPS tracker can track and monitor remote target by SMS or internet.



The main processor used in CDAMS is ARM926J that supports video and voice compression. The video compression technology supports MPEG4 standard format and voice compression technology of 30 frames per second. The CDAMS having a hardware component based on embedded system and its software is designed using embedded Linux.

CDAMS is incorporated with four distinct functions. The function of collision detection enables to detect the external shock to the car. The function of audio and video encoding facilitates the task of encoding video and audio signals. The function of saving data performs the work of storing information data of the car and last, GPS (Global Positioning Satellite) function furnishes the current location of the car.



Location Problem with SMS

Dialing the tracker device from the authorized number, a reply, by way of a SMS, the positioning status in terms of latitude and longitude. Also, the provision is made to track with unlimited times continuously at 30 seconds interval. Using GPS drift suppression facility, the GPS data stop updating if the vehicle is not moving but GPS updates data automatically when the vehicle starts moving.

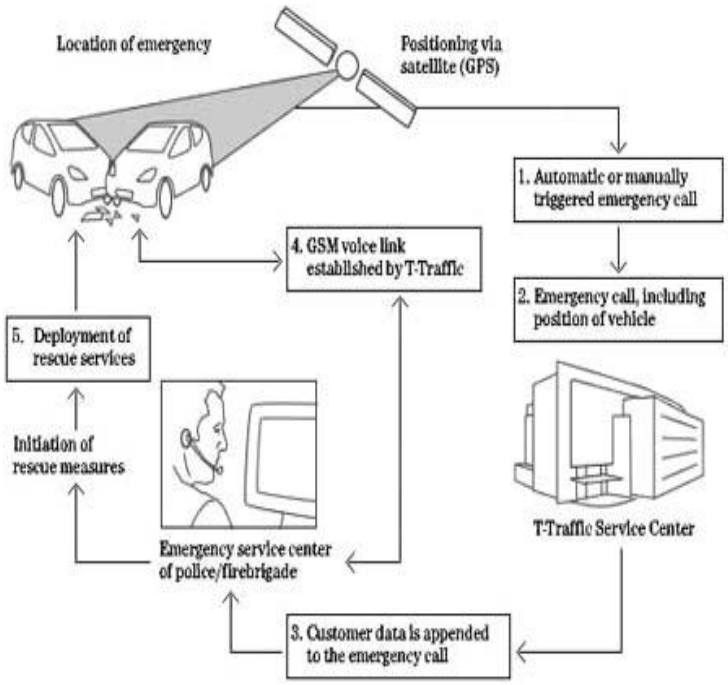
Absolute Street Address by SMS

After configuring Access Point Name (APN) send SMS to device, and it replies through SMS indicating Real Street and Address/Name. The configuration of APN is as follows: text the tracker a SMS "APN+ Password+ space+ Local APN" via Mobile phone and if succeeded, the tracker will return the message "APN OK". For Example

"APN 123456 CMNET"

Password of a tracker

APN of China Mobile



Forward to Third Parties

Third parties may consist of service provider, police, fire brigades and owner of the vehicle etc.

Send SMS "forward + password + space + Third parties Mobile /Phone number" from authorized phone number; the tracker will reply "Forward OK". After setting the phone number of the service provider of the sim card in the tracker, the tracker will forward it to authorized Phone/Mobile number.

Accident Alarm

When tracker detects accident occurred (severe impact), it will send "Accident! + Latitude & Longitude" to all authorized phone numbers.

CONCLUSIONS

When the videos of the road and location information are transmitted using the network periodically, the traffic jam occurs. In this context GPS system loses its strength. In an attempt to cope up with real time problem, Hwase Park and Daesik Ko (10) designed Intelligent Black Box using Mining Algorithm. Harris (11) has pointed out that the data records do not match the physical evidence in a crash-not even close. Hence there is a need to take into account other mitigating factors for a full scale investigation to see its completion.

US federal Government mandatorily requires automakers to install EDRs in vehicles by 2014. But according to NHTSA law enforcement authorities cannot access data without search warrant because the data on a recorder is considered to be the car owner's personal property. Attorneys and Insurance companies cannot typically access or use the data in a court case without the car owner's consent. This is the practical difficulty in the way of using data for the purposes of investigation. Despite this limitation, Toyota is emplaning to incorporate EDRs in their vehicles as a necessary adjunct to safety devices.

ACKNOWLEDGEMENTS

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Foot-Notes

Goyer, Robert, "The Secrets of Black Boxes." Flying, December 1996, P. 88.

Black Box the Event Data Recorder (EDR) is a technical term for Black Box that records data in the wake of crash. When a crash occurs, an EDR captures and stores information about the incident. In addition to the date and time of the crash, the modern versions of crash record vehicle speed, engine speed, steering position, throttle position, braking status, force of impact, seat belt status and airbag deployment.

William Stallings, *op citra,* P.89.

Communication Satellite- Communication satellite is, in effect, a microwave relay station. It is used to link two more ground based- microwave transmitters/receivers, known as earth stations, or ground stations.

Steve Heath Embedded Systems Design, Elsevier, New Delhi, 2003, P.2.

Embedded System- An embedded system is a microprocessor- based system that is built to control a function or range of functions. Zhang, Wang and Nihan, Tracking Vehicles with GPS, 2007, P.13.

GPS & GPS Tracker- GPS, the Global Positioning Satellite systems identify the vehicle's location on the ' Time-Difference -Of - Arrival' (TDOA).

Singh. S. K, Industrial Instrumentation, Tata Mc Graw Hill, New Delhi, 2005, P.460.

Sensors- The sensor is a device that converts a signal into a signal in a different form. The output of the sensor may be force, displacement, voltage, electric resistance, or other physical quantity. Usually, a signal conditioner is required to convert sensor output into electrical or mechanical signal suitable for use by a controller or display device.

Yu-Cheng Liu and Glenn A. Gibson, Microcomputer systems: The 8086/8088 family, Prentice-Hall of India, New Delhi, 2004, P.349.

Serial Communication- Many I/O devices transfer information to or from a computer serially, ie, one bit at a time over a single conductor pair or communication channel, with each bit occupying an interval of time having a specified length.

William Stallings, Data and Computer communications, Prentice-Hall of India, New Delhi, 1997, P.85.

Wireless Transmission - For transmission, the antenna radiates electromagnetic energy into the medium (usually air), and for reception, the antenna picks up electromagnetic waves from the surrounding medium.

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11. Jim Harris, Harris Technical Services, Florida, USA, 2011.