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# Wireless Sensor Network Based Intelligent Automobile Monitoring and Controlling Using Event Data Recorder

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**Abstract**

It is observed that most of the accidents occur due to the driver's negligence of traffic and safety rules. Depending on the terrain, and other critical situations, speed restrictions may be imposed on drivers from time to time. Therefore, a system monitoring the speed and other desired automobile parameters can be installed in the automobile to warn the driver appropriately and also control if necessary. This paper presents a wireless sensor network based controlling and monitoring of automobile parameters as a single unit.

***Keywords****—Event data recorder, WSN, TPMS, Engine Control Module*

## 1. INTRODUCTION

In the present day everyone are running behind speed all want to come first. In such sceneries accidents are increasing. Daily new vehicles are being added on the road. This also increases amount of accident. It seems like that there won't be a day without road accidents. Many technologies are being enforced to reduce accidents but none of them have been able to stop them completely, but they are only able to decrease them to an extent. The highway association in Europe and America has been planning to implement some devices in vehicles which would safeguard the interest of passengers. The vehicles are equipped with air bags, anti-lock breaking system and many such things[1]. In order to do any research on the crash there is a need for the knowledge of real cause of the accident. The accidents may occur due to the mistake of others or problem in the working of the vehicle such as brake failure or fire accidents[2].

The presently available features which are incorporated in to vehicles are GPS tracking and mapping. The European Union and U.S, Government are planning to incorporate certain data recorders into vehicles which would record the vehicle parameters[3]. The IEEE also introduced some standards for this automobile event data recording. The system proposed to be like a black box which logs implementation inside the vehicles and the performance of the vehicles. The proposal of IEEE association is audio and video logging and engine parameters such as temperature, brake conditions, torque etc.[4] this is analogous to a black box billion dollar aircraft industry is affordable such costly systems cannot be incorporated in a car as such system will cost more than the car itself. And also there is no alert system in the IEEE proposal. So the system made is an initiative to design a data logger as an emergency alert system and the design is made as to decrease the cost so as to make it affordable to vehicle of all ranges[5].

Event data recorder (EDR) may record wide range of data elements like, engine rpm, brake position (whether the brakes were applied or not), speed of the automobile at the time of crash, steering angle, whether the seat belt were buckled or not, and also the acceleration applied[6]. These details are communicated with wireless sensor nodes as the vehicle pass through the wireless sensor network[7]. In case of critical situations like any security breaches these wireless nodes can be used to control the vehicle. EDRs installed in newer vehicles record and store up to five seconds of pre-crash data including vehicle speed, engine throttle position, engine revolutions per minute, and brake status. An accident reconstructions may download this data to determine, among other things, whether the driver was speeding, applied his/her
brakes prior to the crash, and/or was using his/her seatbelt at the time of the crash[8]. This information may have a significant effect on how an attorney or adjuster values a claim.

## 2. BACKGROUND KNOWLEDGE

### 2.1Automobile Event Data Recorder (EDR) Technology

An event data recorder or EDR is a device installed in automobiles to record the information related to vehicle

crashes or accidents. In modern diesel trucks, Event Data Recorders are triggered by the engine faults which is sensed electronically (often called faults), or a sudden change in speed. One or more of these situations may occur because of an accident. Information from the EDR is collected after the crash and analyzed to help determine what the automobile were doing before, during and after the crash. The event data recorders are nothing but a simple read-write memory, which is similar to the "black box" found in the flights.

There are many different patents related to various types of EDR features. Some EDRs may continuously record the data, overwriting the previous few minutes data until a event (crash) interrupts them, and others types are activated by crash-like events (such as sudden changes in velocity) and may continue to record the information until the crash is over, or until the recording time is expired. Event data recorder (EDR) may record wide range of data elements like, engine rpm, brake position (whether the brakes were applied or not), speed of the automobile at the time of crash, steering angle, whether the seat belt were buckled or not, and also the acceleration applied. Current EDRs store the information internally on an EEPROM until it is recovered from the module. Some automobiles have inbuilt communications systems (such as GM's On Star system) that may transmit data and automobile location such as an alert that the airbags have been deployed.

The sum total of the information collected by this unit amounted to 6 basic system data points:

- The "on" or "off" condition of the air bag system warning lamp at the time of the event.
- The length of time that warning lamp had been illuminated
- The crash sensing activation time or that the sensing deployment criteria was met
- The time from "impact" to air bag deployment command
- Ignition cycle count at deployment

Most EDRs in the vehicle is a part of the restraint system control module, which senses accelerations at the time of crash and decides what restraints (airbags and/or seatbelt tensioners) to deploy. After the deployment of the restraints if there is still power available, then data are written to memory which is usually an EEPROM. The older EDRs store 6 to 8 pages of data. Now newer systems include more data elements so it requires more pages to store information, depending on the model/year of manufacturing. There are different types of EDRs, depending on the deployment file or a non-deployment file or sometimes both, depending on the collisions and the time gap between them, among other things.

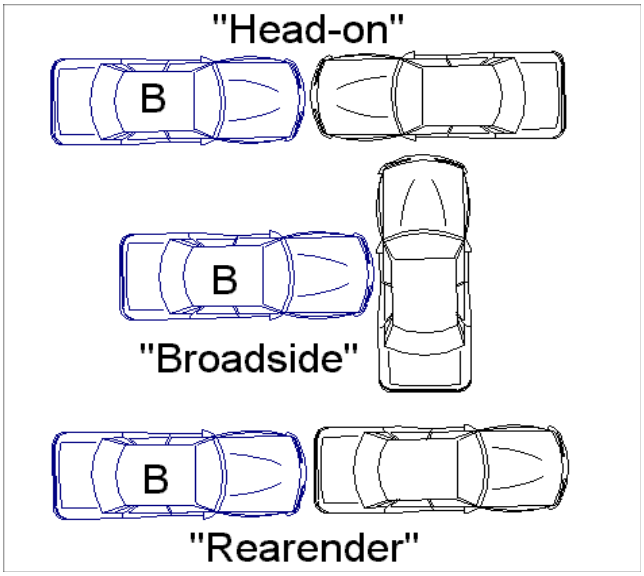


Fig 2.1 Collision Alignments

Collision alignments are often described by the terms "Head-on," "Broadside," "Rearender," and "Angled, Other Than 90." The first three are depicted in Figure 2.1. If, in those instances, the only moving vehicle is the "bullet" vehicle (labeled "B" in Figure 2.1), then the only momentum brought to bear in the collision comes from that vehicle and the direction of force can be simplified to that which can be measured directly along the bullet vehicle's "X" axis (as shown in Figure 2.2).

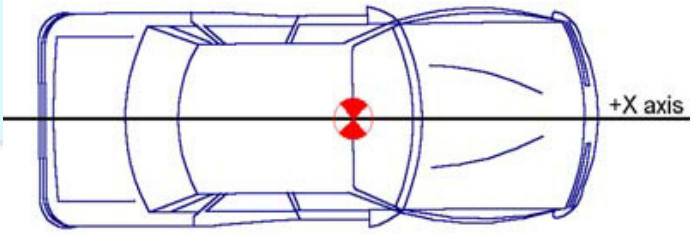


Fig.2.2Vehicle X axis

In the collision orientations depicted in Figure 2.1, the positive direction for that axis is forward (relative to the driver's orientation in the car), and what is measured by the SDM's accelerometer is front-to-rear acceleration or

acceleration in the negative direction, X axis. When the orientation is "Other Than 90 (degrees)" and both vehicles are moving, then the direction of force (PDOF) is no longer "simply" on one of the car's "X" axis. In that instance, the force applied can be measured as a vector relative to the X axis, individually for each car.

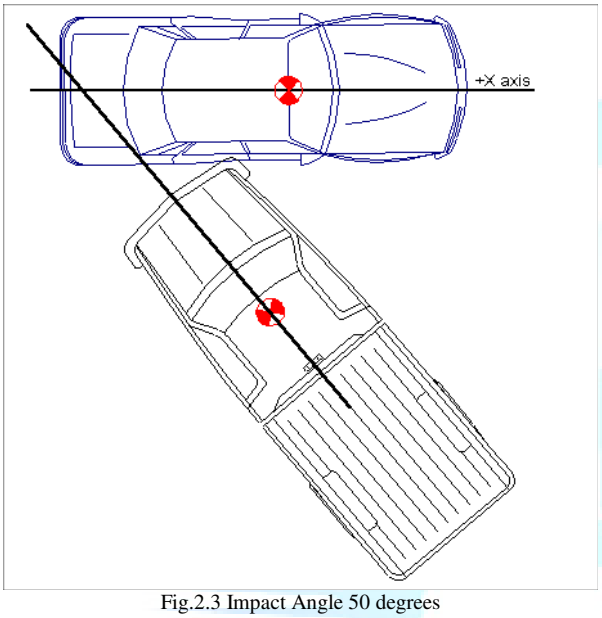


Fig.2.3 Impact Angle 50 degrees

It is also possible that no data can be recovered from the EDR. One situation where this might happen is the loss of electrical power supply early in a collision event. In this situation, the power reserve in the restraint system control module capacitor charge may completely used by the deployment of the airbags, leaving insufficient power to write data to the EEPROM. There are other situations where a particular module may fail to record the data file as well.

Most EDRs in heavy trucks are part of the engine electronic control module (ECM), which controls fuel injection timing and other functions in modern heavy-duty diesel engines. The EDR recording and features are different for different companies (manufactures), but most recognize engine events such as sudden stops, low oil pressure, or coolant loss. Detroit Diesel, Caterpillar Inc., Mercedes-Benz, MackTrucks, and Cummins engines are among those that may contain this function. When an event is triggered by reduction in the wheel speed is detected, and the data which is going to be written in to the memory contain the vehicle speed, brake position, clutch position and cruise control status. The data recorded in the EDR can be downloaded to PCs later using software and suitable cables depending on engine. Software often allow user to monitor the details like, driver time of service, fuel consumption, average speed of travel and other information related to the maintenance and working of automobile. Some EDRs only keep track of the car's speed along its length and not the speed going sideways. Analysts generally look at the position, momentum, energy, and damage, and then compare their speed estimates to the number coming out of the EDR to create a complete view of the accident.

## 3. Wireless Sensor Networks for Vehicle Monitoring and Controlling Using EDR

Status monitoring of automobiles has become more important in recent years, especially for the sake of automobile testing. Currently real-time automobile monitoring systems are of more interest to check as many details as possible by the means of intelligent and automatic fault detection algorithms and online analysis within the heterogeneous environment. However previous works have been used wired measuring devices or short range wireless devices like Bluetooth sensors that makes it hard to implement remote monitoring and apply heterogeneity into the system. Lack of wireless systems and devices which can monitor the parameters of vehicle is obvious in this field. Finding an optimized wireless automobile monitoring system is one of the necessities to reduce the costs and increase efficiency, therefore we try to investigate possibility of using wireless sensor based devices and wireless sensor networks to build up a wireless automobile monitoring system.

This thesis work tries to show that wireless communications and wireless sensor networks can perform a significant role to improve automobile status monitoring systems, and also show that the data acquired from different type of sensors can be used to have better optimization on automobile monitoring. In the other side integrating Wireless Sensor Network with networked embedded system equipped with different kind of measurement devices like IMU and CAN-Bus data readers, to acquire raw data from automobile's outside, inside and engine-side for remote and local monitoring enable analyzers to study automobile's mechanical and behavioral status remotely.

The basic functions of a EDR should include the status of the automobile (automobile speed, engine health ...), environmental status like outside temperature, climate and passenger seating arrangement. Pressure sensors will be used to determine the number of passenger in the

automobile and also to monitor where the each passenger is seated. Pressure sensors will also be placed on the chassis of the automobile in order to determine the location of the incident if an explosion or side/head on collision is to occur. Wireless communication is used in order to provide vehicle monitoring with a monitoring station.

## Sensors

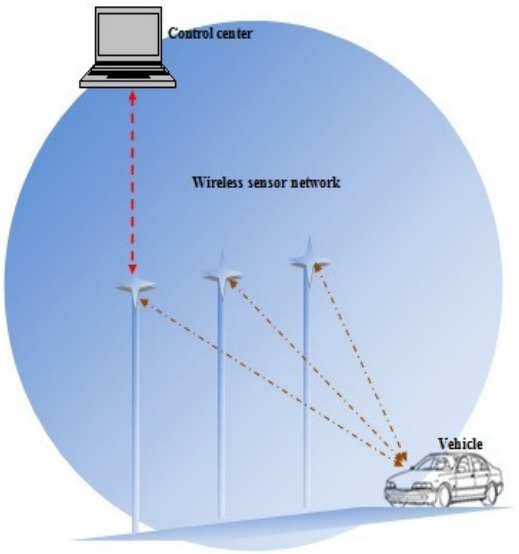


Fig.4 Vehicle monitoring

A sensor (also called detector) is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an (today mostly electronic) instrument. For example, Thermostat is a device whose resistance varies in accordance with the temperature. A thermocouple converts the temperature to an output voltage which can be measured by a voltmeter. For accuracy, most sensors are calibrated against known standards.

A tire pressure monitoring system (TPMS) is an electronic system designed to visualize the air pressure inside the tires on various types of automobiles. TPMS gives real-time tire-pressure information to the driver of the automobile, either via a gauge or simple low-pressure warning light.

Accelerometers are simple Micro electro mechanical system devices and are used to measure position, motion, tilt, shock, vibration, and acceleration (the rate of change of velocity). They are available in one, two, or three axes. Accelerometers are used everywhere. In transportation, they are used in aircraft to monitor the stability and control systems, missile guidance, and testing the smoothness of roads. Domestically, accelerometers are being added to washing machines that can balance loads, helps to faster drying times. Accelerometers are also being included in automobile alarms to detect if the automobile is being towed away. They are also used in user interface devices like cell phones and video game controllers, where the user rotates the device to control the screen instead of pushing buttons (motion sensing).

The engine coolant temperature sensor is used to measure the temperature of the engine coolant of an internal combustion engine. The output from this sensor is then fed back to the Engine control unit (ECU). Depending on the data from the sensor the ECU adjust the fuel injection and ignition timing. In some vehicles the sensor may be used to switch on the cooling fan. The output data may also be used to provide readings for a coolant temperature gauge on the dash. Internal resistance of the sensor changes as the temperature subjected to the sensor increases. Depending on the type of sensor used the resistance will either increase or decrease.

Automobile speed sensor may also be known as an output speed sensor (OSS). The output from this sensor is a varying frequency signal. This varying frequency signal is transmitted to the transmission control unit (TCU) to determine the current speed of automobile. The TCU uses this information to determine when a gear change should take place based on the various operating parameters.

Level sensor detects the level of substances that the flow, including liquids, slurries, granular materials,and powders. Fluids and fluidized solids flow to become essentially level in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form. The level sensor can be used in automobile to monitor the fuel level. The level measurement can be either continuous or point value types. Point level sensors will indicate the level of substance is above or below the sensing point. In the case of continuous level sensors, they measure level within a specified range and determine the exact amount of substance in a certain place. Usually automobile manufacturer uses point level sensor.

Wireless sensors are standard measurement tools equipped with transmitters to convert signals from process control

instruments into a radio transmission. Wireless sensor has two parts one is sensing section and the other section is transmission usually a radio transmitter. The signal from the sensor is suitably modulated and transmitted through the antenna.

PC front end is designed using Visual Basic software. This is provided for recording the vehicle details and also to provide the control mechanism in case of any security breaches occurs.

## 4. Simulation and Outputs

The basic function of the black box is to record the status of the automobile (speed, tire pressure, engine health, acceleration) and also passenger seating arrangement. The system has two parts, the first part handles the function of black box and also the recorded details are communicated through a wireless network. The second part receives the data which is send by the automobile when enters in to network. PIC microcontroller along with sensors is used for the implementation of the first part.

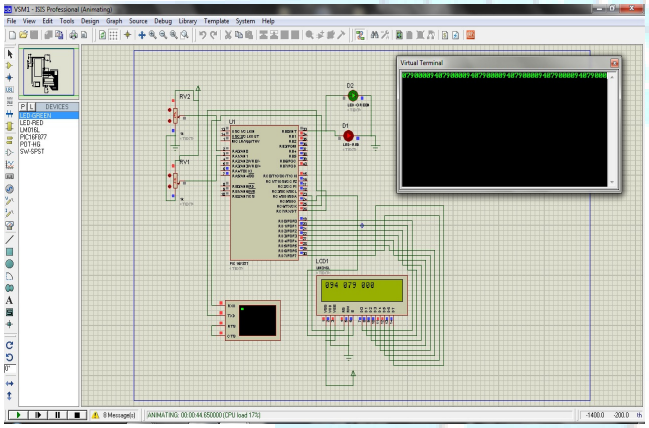

Fig.5Simulation of event data recorder using proteus

Simulation of wired as well as wireless network functions and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2.For WSN related projects NS2 gives detailed simulation results regarding nodes ,their signal transformation and their trace format details.

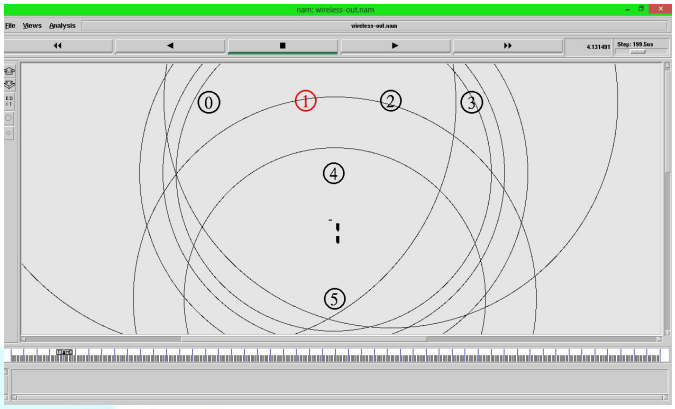


Fig.6 Simulation of wireless networking using NS2

## 5. Conclusion

This project presents architecture for automatic speed control of automobile to the circumstances of security breaches at check post. This approach is based on wireless sensor networks which gives the information of the automobile. The wireless sensor located in the automobile can send the automobile details like speed, acceleration, registration.no.etc. Sensor fusion is applied to the information received by these subsystems, and used to adjust the longitudinal speed of the automobile. The proposed on-board architecture is portable and easily adaptable to any commercial car with minimal modifications. The system shows promising results, since wireless sensor network permits to detect the presence of automobile reliably and sufficiently in advance, so corrective actions on the automobile's behavior can be taken.

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