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Feasibility Study of Using Event Data Recording System "EDR" in Vehicles and Retrieving Precise Information in Iran

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Abstract: **New technologies used in transportation system have great effects on collecting precise crash data and recognition of their main causes and finally increasing safety. Similar to EDR technology found in airplanes, we can record the most important time dependent crash data such as longitudinal and lateral acceleration , vehicle rotation, ignition, lights status, gauges, braking conditions, timing of airbag operation and activation, and also seat belt status. EDRs have the potential to make a significant contribution to highway safety. For example, EDR data showed that in several cases vehicles Cobalt's ignition switch turned the engine off while**

The car was still moving, causing the car to lose power steering and crash. In-depth crash investigations, however, produce more precise measures of crash and injury severity as Change in velocity (delta-V) for crash severity and Abbreviated Injury Scale (AIS) scores for injury severity. This article attempts to evaluate the operation process, advantages and disadvantages of crash data recording systems and also the process of accessing the recorded data. An effective step has been taken to build a reference crash database, especially in places where observing and reviewing the accident scene and finding out the causes of it happening is very hard. In addition, data that have been recorded and collected with this system would be useful for route design and traffic analysis too.

Keywords: **Accident Prevention, EDR, Data Recovery, Event Data Recorder, Safety.**

I. INTRODUCTION

Considering that in current conditions in Iran there is less systematic method for recording accident data (notice that USA has the National Automotive Sampling System-Crashworthiness Data System which is an in-depth crash reconstruction database with over 400 data elements), police officers do this task by hand and their methods depend on their tact and occurrence of an error in recognizing the reasons of accident and other effective parameters that it would be possible in Iran. Although over 90% of the new cars and light trucks sold in the United States already come with EDRs intended to capture information about the final seconds before a crash,[1] these are installed voluntarily by the manufacturers; NHTSA's current rules mainly specify certain types of information that must be recorded if a vehicle is equipped with an EDR. NHTSA's proposed regulation [2] would make EDRs mandatory, but would not substantively change federal requirements about the information the devices must collect. So, an intelligent system for recording accident data is needed. Whenever an airplane crashes, experts use the data recorded in its EDR to discern the reasons and causes of this disaster. After Just like usage of EDR in airplanes accident event data recorder can be used in order to improve safety of transportation equipments and collection of accurate accident data. The importance of using this system is very much as National Highway Traffic Safety Administration (NHTSA) has assigned some standards for the EDRes used in vehicles and obliged these standards for the cars since 2012[3]. Crash data are so precious because they give us information on what has happened to vehicles, in the few seconds before the crash. So feasibility study of using Event Data Recording System "EDR" in vehicles and retrieving precise information in Iran is so important to use in vehicles which manufactured in factories.

II. LITERATURE REVIEW

In the early 1970, the national transportation safety board gave a recommendation that car manufacturers and national highway traffic safety organization cooperate on collecting accident data with accident processing sensors and data recording tools [4].NHTSA's Special Crash Investigations (SCI) program first used EDR information in a crash Investigation in 1991 (in conjunction with GM, which had manufactured the vehicle involved in The crash being reviewed) [5]. In the years following, NHTSA worked with automakers to improve Understanding of how electronic sensors could contribute to the evaluation of crash conditions. In 1997, the National Transportation Safety Board (NTSB) recommended greater use of EDRs Because of their potential to improve highway safety [6]. In 1997, the NTSB recommended that NHTSA "pursue crash information gathering using EDRs" and that it established an EDR working group of industry, academic, and other government organizations, Which met from 1998-2000[7].

In 2005, 1.3million people were killed in 3500 accidents per day where more than 40 percent were younger than 30 and just had passed half of their lives. Forecasts imply that up to 2015, highway mortality will increase to 60 percent. About 90 percent this increment will take place in countries with low and medium income. Simple, cheap and accessible technology of event data recording systems like EDR's can widely reduce highway mortality problems. EDR known as EDR is installed in about 80 percent of present cars all around the world. This equipment is so important that (NHTSA) has assigned standards and laws for its usage [8].

Electronic sensors had a wide usage in automobile industry in 1970. With the extension of industry, this technology improved more and more and led to electronic fuel injection control in engines. Engine control modules, process and analyze the data collected by sensors and send proper signals to exciters which can change the time of fuel injection pulse or the ignition advance in engine. These systems play an important role in fuel economy. The ECM was just able to record and save the problems in engine ignition and could not recognize the nature and quantity of errors. EDR's were a big step toward saving and retrieving data and also detecting problems and errors. These are among the variables which are recorded by EDRs. But over time, as automakers sought ways to evaluate the sensors and make the new systems easier to service, the role of the ECU was

Expanded to include a diagnostic component which stored data on problems detected through the sensors. This new source of information was helpful to mechanics attempting to address vehicle performance issues, but also laid the groundwork for data recovery technology. For example, the airbag sensor could store a fault, but also could count the number of times the engine had been

Started since the fault was generated [9].EDRs have evolved over the past 40 years as motor vehicles have increasingly come to rely on electronic sensors. Greater energy efficiency was a primary goal of the move to electronics. A key component in the electronics system is the engine control unit (ECU), which collects and analyzes information about the engine's operation, such as throttle position, revolutions per minute, and airflow. Based on these engine variables, the ECU sends instructions to the fuel injectors varying the length of time a fuel injector pulses or specifying how much spark advance the engine receives in order to improve fuel economy.

III. Retrieval Information Systems ''EDR' 'and the Purpose of Using Them

The EDR is the key electronic component in recording an accident. It accumulates data from a dedicated sensor or, sometimes, from a vehicle network. Passenger vehicle EDRs are usually incorporated within an air bag electronic controller. A crash-sensing algorithm decides within 15-50 milliseconds (msec) after an impact when the airbag should be inflated, based on model-specific criteria

Stored in a sensor [10]. The algorithm also determines when the pre-crash data will be recorded. As discussed later in this report, a current NHTSA rule specifies that if the vehicle has an EDR, information on data elements must be recorded at the time of a crash [11]. EDRes contribute to improve safety by supervision and control over the vehicle performance. EDRes could save the data in a period of time. This tool records accident data in seconds before the crash and its purpose is monitoring and accessing the proper and safe function of vehicle. Design and performance of these boxes are an advanced technology. Nowadays EDRes have been extensively developed and changed and in addition to collect automotive technical information, they are able to gather some data like system status, driver status, and crash severity and also crash location. According to its manufacturer this device might have different functions. However, EDRes' information is designed in a way to be readable by current computers. Various parameters exist to contribute highway users in identifying the causes of accidents. These variables are vehicle speed, speed limits, longitudinal and transverse acceleration, velocity and acceleration changes, driver's reaction, status of driver's seat belt, using brakes, driver's maneuvers to prevent accident, air bags and positioning of accident.

IV. EDRes Function and the Algorithms

As indicated in figure 1, when a crash occurred all the failures in vehicles sensors are transferred to EDR and will be saved there. To protect that information, EDRes have been installed in protective places. The location of EDRes is different according to manufacturer. They are usually installed under vehicle seats (Figure 2). Or in the hood. In some cases the EDR is connected to other sensors, such as the anti-lock brake computer (Figure 3). It collects data from these sensors and continually replaces previously stored data every five Seconds. Only the most recent data are retained when airbags are deployed in a crash situation. The data are retrieved by a cable to the EDR or, alternatively, to the vehicle's onboard diagnostic Port located near the steering wheel [12].

Figure 1: vehicle collision with obstacle


Figure 2: EDR installation under the seat

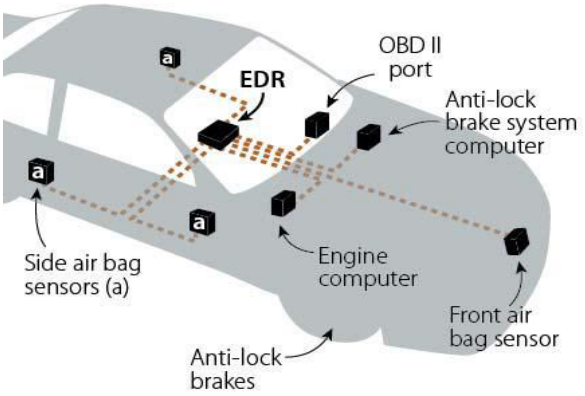

Figure 3. The EDR System in a Motor Vehicle

Preserved information scale has some limitation for each accident. Memory cards' capacities are limited for recording data of real collisions. Hence, data of sensors are continuously recorded before collision. At the crash moment custom available algorithms start working and memory cards begin to record events. This device automatically saves the information before crash and removes other information. It should be noted that the information will be saved in memory cards in time period of 3 seconds before and 15 seconds after the crash. It's impossible to remove or edit the stored information. This device is capable of saving the data for only 3 crashes; In this case if the maximum velocity changes are more than the previously stored speed variation in the previous accident, the new and close related ones will be stored. Data in memory before the accident are removed after each 250 ignition cycles or about 60 days on average. Figure 4 shows how the pre-impact data of sensors appear in computer. Note that the recorded data could be skewed in time of the crash after one second.

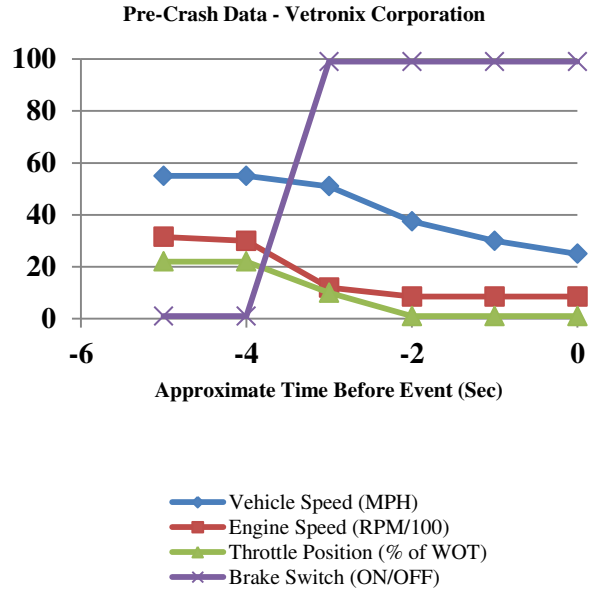

Figure 4: approximate time before event including information like vehicle speed, engine speed, sensors position and braking switch

By applying global positioning system (GPS) these boxes can show what has happened during the crash and help rescue teams and medical staff to assess injury severities more accurate compacted and tested according to bulk specific gravity (ASTM D2726) [12], stability and flow test (ASTM D1559) [13], and maximum theoretical specific gravity (ASTM D2041) [14] standard procedures. The optimum bitumen content was found to be 5.2% by weight of aggregate for the asphalt mixtures. Specimens were prepared with 4.5%, 5%, 5.5%, 6% and 5.2% (OBC) bitumen content. For the Marshall Stability and flow test and indirect tensile stiffness modulus test, the specimens were compacted by using 75 blows on each side of cylindrical specimens at 4±0.5% air void. As for the indirect tensile strength test the specimens were compacted in order to have 6–8% air void.

V. Advantages of Using EDRes

Advantages of using EDRes in vehicles are:

Many current computer algorithms rely on stiffness parameters derived from short duration (35 mph) rigid barrier impact tests to estimate delta v. These recorded data can provide exact changes for most real world crashes and can also authenticate usual software results. Figure 5 shows a crash occurred in a roundabout with a parked truck in 1998 in Chevrolet, Malibu. As it can be seen the crash severity is high and it has a long collision pulse time. Computer programs and experts have estimated the speed variation of 23 miles per hour for this crash [13].

Figure 5: crash occurred in a roundabout with long collision pulse time.

Reducing road crashes

It is experienced that drivers who know that their cars have EDRes, drive more carefully. Case studies from Europe and the U.S show that the number of crashes can be reduced by 20 to 30 percent [14]. Crash severity is also reduced. In addition to reducing casualties and costs, data from EDRes help to eliminate disagreements of experts. EDRes have decreased the quantity of crashes by using detecting mechanisms during repair and maintenance time. In figure 6 we can see a fatal crash in London where EDR evidence of extreme speed helped to secure the conviction

of the young driver for the serious charge of " causing death by dangerous driving" and encourage people to drive slowly.

Figure 6: Fatal crash in London and using EDR in the vehicle

EDRes can provide accurate, objective and readable data about what happened during a crash. Such data would reduce arguments over facts and lead to more fair conviction, protecting the crash victims, vehicle owners and drivers. It would be helpful to speed up court judgments and insurance proceedings. In several North American court cases, EDR evidence was used to exonerate a driver when brake failure had caused the crash.

Climate change

Fleet management and insurance policies using EDR data potentially help to reduces casualties and emissions. This device can be a powerful data recorder like an observer or hidden camera and can contribute to reduce accidents. Smoother driving improves vehicle fuel consumption and reduces CO2 emissions.

Improving medical response and rescue time

EDRs could be joined with an automatic crash notification system, such as the proposed "'e-call". This would reduce emergency response times and improve outcomes of crash victims. Rescue and medical service providers could improve their efficiency and reduce their costs. It has been estimated that automatic crash notification on its own could reduce road deaths in Europe by 10% .This issue is important especially when injured people are unconscious. A study in Germany showed that about 4% of urban crashes and 12% of rural crashes resulted in victims being trapped or unconscious and also being unable to call for help [15]. But use of these EDRes would provide possibilities for geographic positioning by police officers and rescue teams.

Improving the accident data collection procedure

EDRes could increase the quantity, accuracy and reliability of evidence for crash investigations and make it available in less time. In an appropriate regulatory frame works EDR data could be accessed by police, crash investigators, car manufacturers, road safety researchers and insurance claims assessors. Traditional methods of crash investigation have always had a high degree of uncertainty. In recent years, the increasing use of advanced braking systems (ABS) to prevent wheels from locking has eliminated valuable skid-mark evidence but using this tool can show the vehicle speed and braking time. Retrieving information can identify the vehicle speed and punish the drivers who disobeyed the law.

VI. Terms of EDR

At the beginning of September 2011-2012 the national highway traffic safety administration proposed final rules for vehicle manufacturers which install the automobile EDR or vehicle event data recorder must comply with the following summary[16] :

- Being able to record a minimum set of data elements.
- Sensors must have acceleration about ±5 percent.
- EDR data should be accessible and recordable as commercial tools.
- EDR survivability and crash test should be taken. Crash test should be taken in real conditions. In these tests an artificial dummy is used with collision sensors to estimate severity and finally evaluating this for real conditions.

Survivability tests for EDRes check resistance by intense collision.

VII. Prioritization of EDR Installation on Vehicles in Transportation System

Since in many developing Countries especially in Iran, EDRes have not been installed yet; there is a need for installation of EDRes with prioritization of vehicles as follows:

-Vehicle with young or novice drivers.

-All public sector agencies, including emergency services and police services.

-International aid project vehicles.

-Finally, the remaining transportation vehicles such as personal ones.

Some of the drivers don't have enough information of EDR installation in their vehicle and maybe this tool could be used against them and these data not only provide some information about vehicle but also provide some data about person. Maybe this data would not satisfy you but it might be of great interest to the manufacturer of your car, to national highway traffic safety administration, or some other government entity (including a court of law or insurance companies).

So the question is, if your vehicle is driven by another person and recorder gather data, who owns that data? And could this information prove that you are guilty or innocent?

There is a consensus among the expert group members imply that the recorded data are all for the owner of the vehicle. Note that the state police investigator insisted that they do not and will not access the data without a search warrant and they will not use the data to replace accident scene reconstruction. To access EDRs information, the national highway traffic safety administration states that

ownership of EDR data is a matter of state law, however, the NHTSA considers the owner of the vehicle, the owner of data. In situation like investigation, though, courts do have the right to subpoena EDR data. Otherwise the owner of vehicle may give permission to a third party to download data. Also if medical and rescue teams or NTSB (national transportation safety board) or insurance companies require these data , the law allows them and with this appliance they can diagnose the guilty for occurrence of this event or if the environments condition or roads factor cause this event have been diagnosed[17] .

VIII. CONCLUSION

Deployment and use of this new technology "EDR" in vehicles could considerably contribute to reduce road death and injuries. Retrieved information from these boxes has been effectively helped to various road users in order to diagnose real crash causes, crash severity and their location. Applying this technology in all vehicles achieves some purposes like reducing injuries (especially young users) and vehicle speed with the result of decrease in air pollution. We hope that with expansion and development of this technology and making it up to date and having the possibility to record nesecceray and suitable data, a dramatic reduction in accidents and casualties in all countries, especially Iran occur. Also by applying this system in vehicles we can achieve comprehensive database of accidents which have the least error in its data. Experts and researchers can use this database to promote road safety.

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