ABSTRACT

While traffic crash reconstruction focuses primarily on interpreting physical evidence, the proper generation and preservation of digital data from Event Data Recorders (EDRs) can provide invaluable evidence to crash reconstruction analysts. However, data collected from the EDR can be difficult to use and authenticate, as exemplified through the analysis of a General Motors 2001 Sensing and Diagnostic Module (SDM). Fortunately, advances in the digital forensics field and memory technology can be applied to EDR analysis in order to provide more complete and usable results. This paper presents a developmental model for EDR forensics, centered on the use of existing digital forensic techniques to preserve digital information stored in automobile event data recorders.

KEYWORDS

Automobile Event Data Recorder, Digital Forensics, Evidence Production, Civil Procedure, Crash Reconstruction

1. INTRODUCTION

Vehicle collisions cause significant financial and personal damages on a daily basis. The importance of determining their cause has lead to the development of techniques and methods for traffic crash reconstruction. This field comprises the scientific gathering and interpretation of all evidence and using analytical tools to determine the events that precipitate a collision. Traditional evidence includes tire marks, vehicle damage, and other position based measurements. Newer vehicles, however, may augment the traditional evidence with digital evidence.

The advent of event data recorders (EDRs) in passenger vehicles has provided digital information concerning traffic accidents and has given crash reconstruction professionals a key analytic tool. Most research concerning EDRs has focused on the use of data coming from the recorder rather than the process of collecting data from them. All methods of retrieving data stored in the EDR vehicle modules are proprietary, either through the use of the Bosch Crash Data Retrieval Tool (CDR) or Hexadecimal Translation Tools (HTT); the former is only useable on some GM, Ford, and partner company automobiles, while the latter is produced by the EDR manufacturers.

Originally, EDRs were included in vehicles to understand “real-world” crash dynamics and diagnose airbag deployments. EDRs may record any of the following: (1) pre-crash vehicle performance data and system status, (2) accelerations during the crash, (3) safety restraint system use, and (4) driver control inputs. In 2003, the National Highway Traffic Safety Administration (NHTSA) estimated between 67% and 90% of new passenger vehicles are equipped with an EDR [5]. As vehicle and EDR technologies advance, additional data will be collected and new requirements will be mandated by regulatory agencies.

While their existence is acknowledged, event data recorders and third party data loggers designed for monitoring and fleet management are beyond the scope of this paper.

1.2 MODERN EVENT DATA RECORDERS

Bosch produces the only third party tool capable for obtaining and interpreting data stored in EDRs as of 2007. Only cars from GM and Ford have easily obtainable crash data due to their licensing agreements with Bosch. GM has contracted with Bosch to decode the binary data stored in many SDMs from 1994-present, and Ford has released their technology to Bosch to use for select vehicles.

Accident information is gathered by placing volatile memory within a data loop through which the information of interest passes. When an accident or other catastrophic event occurs, the computer automatically dumps the last five seconds of data from volatile to solid-state memory, where it can then be downloaded and investigated by proprietary cables and software. A good explanation of this process can be found in Chidester, et al [1].

The information currently captured by domestic and foreign passenger automobiles varies by the car’s make, model, and vehicle age. For example, only select GM cars from 1990 to the present contain storage for braking computer and air bag deployment information. Due to the increased inclusion of computers in automobiles for operational purposes, there is a large amount of untapped data that could be collected. The advances in memory technology also allow for greater storage capacities, either by increasing the number of inputs or a larger time span of collected data.

When considering the release of event data, concerns exist regarding accuracy, reliability and privacy. Therefore, the Society of Automotive Engineers (SAE) and the Institute for Electrical and Electronics Engineers (IEEE) joined with NHSTA to form working groups to discuss these issues [4]. The majority of the scientific inquiries concerning EDRs have focused on using data once recovered and decoded [2]. Most of the current research in this area has centered on the reliability of data only as it pertains to supporting the physical evidence of the case [6].

1.3 EVENT DATA RECORDER REGULATIONS

The NHTSA’s Title 49 CFR Part 563 defines what constitutes an EDR, standards for information collection and survivability, and accessibility / availability requirements. This rule was originally published August 28, 2006 for comments, and is expected to be finalized in the fourth quarter of 2008. Part 563 is solely concerned with “light-duty vehicles” consisting of models for sale to the general public with a maximum vehicle weight of 8,500 lbs. Initially, the request for comments stated that information contained on the EDRs be made openly available to the public. Due to concerns raised by the manufacturers, it was changed to state the following:

Each manufacturer of a motor vehicle equipped with an EDR shall ensure by licensing agreement or other means that a tool(s) is commercially available that is capable of accessing and retrieving the data stored in the EDR that are required by this part. [7]

These tool(s) are required for all model year 2011 vehicles, which will begin production starting September 2010. For vehicles equipped with an EDR, this rule defines a minimal data set that must be recorded (see Appendix A). Additionally, Part 563 defines data elements to be stored if the device(s) are capable of recording them, or if certain features are installed in the automobile such as multi-stage frontal airbags. Currently, there are no standards concerning the collection of information stored in other locations, such as the anti-lock brake system (ABS). At the 2007 Highway Vehicle Event Data Recorder Symposium, the NHSTA stated that it would look at other sources of data in vehicles once Part 563 has been finalized.

The Society of Automotive Engineers (SAE) is working closely with the American Trucking Association (ATA) to prepare SAE Standard J2728, which contains standards for medium and heavy vehicle EDRs. Much of the J2728 uses the ATA Technology & Maintenance Council Recommended Practice guideline, TCM RP 1214: Guidelines for Event Data Collection, Storage and Retrieval. NHTSA has indicated that they will develop a ruling after completion of light-duty vehicle EDR work to cover medium and heavy vehicles. This ruling is expected to resemble TCM RP 1214 and J2728.

2.0 CRASH DATA RETRIEVAL TOOL (CDR)

The CDR is currently the only publicly available product that has the capability to download data from an EDR. This system was developed in participation with GM, and has licensing agreements with GM, Ford, and [soon] Chrysler. At present, the CDR is only capable of downloading data from select vehicles manufactured since 1994.

<table>
<thead>
<tr>
<th>Year</th>
<th>Vehicles</th>
</tr>
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<tbody>
<tr>
<td>1994 – 2007</td>
<td>Buick, Cadillac, Chevrolet, GMC, Hummer, Isuzu, Oldsmobile, Pontiac, Saab, Saturn</td>
</tr>
<tr>
<td>2001 – 2007</td>
<td>Ford, Lincoln, Mercury</td>
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**TABLE 1 – A brief list of possible CDR supported vehicles.**

The list of supported vehicles is small, but information can be gathered from vehicles not included on this list through the investigation of persistent memory, which is common in many Electronic Control Modules (ECMs). Many of these ECMs are used by manufacturers for product improvement, and although not centralized, their data can be accessed and can be recovered for use in crash reconstruction.

2.1 USING THE CDR TOOL

The connection between the computer and CDR Interface Module is a standard 9-pin RS-232 cable. To connect the Interface Module to the EDR, a special 15-wire cable must be used. The connection to the Interface Module has a standard serial 15-pin connector, but only contains the pins required to make the connection: for most EDRs, two lines are necessary for power and one for signal. The other end of the cable has a specialized connector for the EDR or a vehicle’s OBD-II or DLC port (described later).

![CDR Interface Hookup](Image)

**Figure 1 – A schematic showing an example CDR/EDR connection.**

Connecting to the EDR can be accomplished in two ways. In the field, the primary method is to connect through the OBD-II or DLC diagnostic ports, typically located under the driver’s side dashboard. This technique is only possible if electrical power to the EDR can be restored. The second method requires direct access to the EDR, and is used if the electrical system has been compromised or if the examination is taking place in a laboratory environment. Although there is no standard location for the EDR, it is typically located inside...