Automotive Crash Data Collection and Analysis: A Log-Based Case Study

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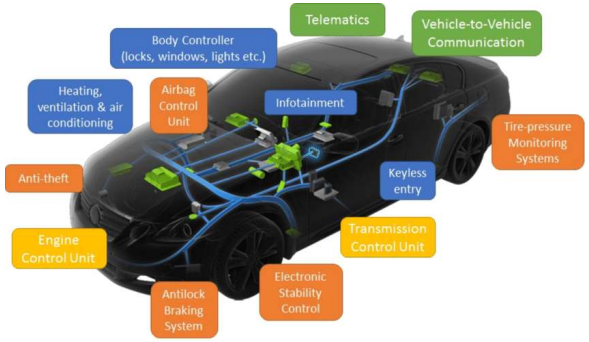
01 Introduction

Introduction

❖ Adoption of Digital Technology in Modern Vehicles

- Event Data Recorder (EDR), In-Vehicle Infotainment (IVI) Systems, Telematics, ...
- GPS navigation, Connecting smartphone to car,

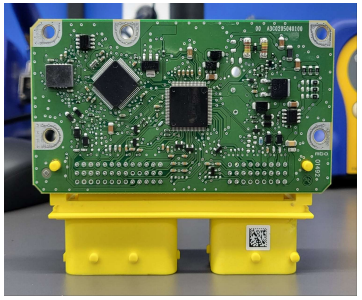
  Music streaming, Hands-free calling



[Source : "Security concerns in co-operative intelligent transportation systems" (2017)]

❖ Role and Limitations of EDR

- Vehicle accident data analysis has predominantly focused on event data recorders (EDRs)
- **Capturing crucial information** about the vehicle during a brief period before and after a collision
- Limitations of Accessing EDR Data
  - It varies across automobile manufacturers
  - Analysis is often restricted by its proprietary formats



ACM(Airbag Control Module)

Introduction

❖ This paper,

- proposes a novel method for analyzing log data of an IVI system to determine the cause of a car accident
  - Vehicle speed, seat belt status, airbag deployment, door status and revolutions per minute(RPM)
- **validates** the effectiveness of the proposed **method**:
  - Experiments were conducted using the **Hyundai Avante CN7**

❖Key finding: Log data of an **IVI** system can be a valuable resource for car accident analysis

- providing reliable legal evidence
- aiding in determining liability for vehicle collision.

02 Related Work

Related Work

❖ “Analyzing driver response in real-world fatal crashes using the event data recorder” (Y. Ahmad et al.)

- **Investigation of 16 accident cases** involving passenger cars equipped with EDRs from 2019 to 2021
- Analysis of driver responses 5 seconds before the collision (braking, acceleration, steering control, etc.)
- Data extraction using the ‘OBD Method’ and ‘Direct Method’

‘OBD Method’ **‘Direct Method’**

❖ “Accident posture reconstruction and analysis of a purposed vehicle event data recorder” (Putra I et al.)

- Limitations of traditional EDRs: insufficient accident-related data
- **Proposal for advanced event data recorders** with more comprehensive data storage

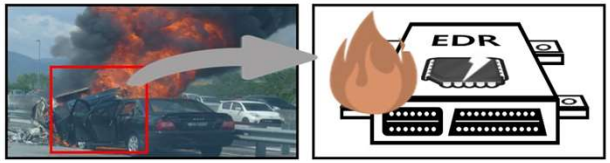
❖ “Identifying near-miss traffic incidents in event recorder data” (S. Yamamoto et al.)

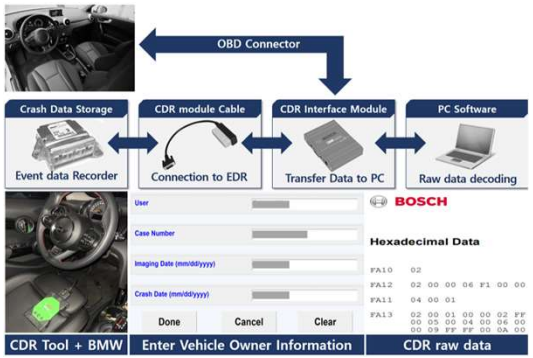
- Utilizing EDR data to identify near-miss traffic incidents
- **Developing a predictive model to assess accident** likelihood through EDR data analysis

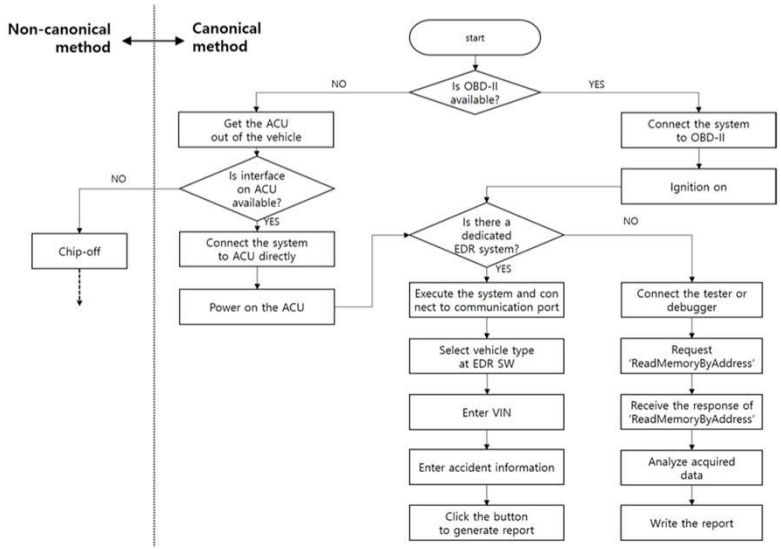
Related Work

❖ “Practical data acquisition and analysis method for automobile event data recorders forensics” (Lee et al.)

- **Proposing a comprehensive approach** for collecting and analyzing EDR data
- Classified into the ‘Canonical Method’ and ‘Non-Canonical Method’







❖ “Validation of EDR data for the purpose of the forensic expertise” (Nouzovský et al.)

- **Evaluate the reliability of EDR data**
- Assessment through comparison with video footage, skid marks, and witness statements
- Reliable information, but cross-validation with other investigative methods is essential

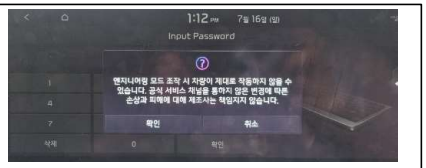
03 Forensic Method for car crash investigation

Forensic Method for car crash investigation

Identification

- Android OS version
- Model of the IVI system
- How to enter Engineering mode

Data collection

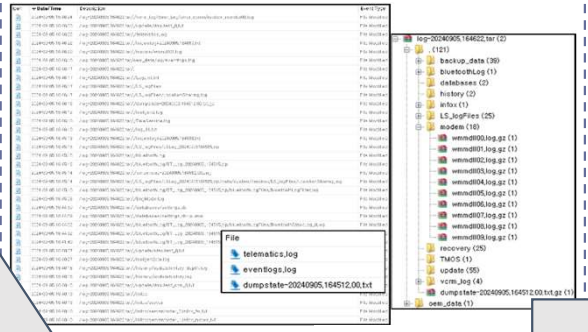


1. Enter the engineering mode

2. Select the 'Copy Logs to USB'

3. Dump the log data onto the USB drive

Data analysis



AUTOPSY DIGITAL FORENSICS

- Extract meaningful evidence related to the incident

Reporting

REPORTING

- Not include

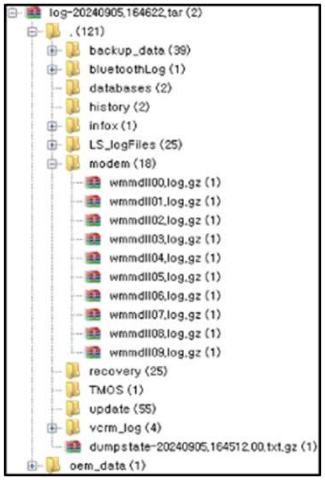
IVI system		Forensic tool	
Vehicle Model	Hyundai Avante	**Acquisition**	Sandisk cruzer blade 64gb usb 2.0
IVI Manufacturer	Hyundai Mobis		
OS	Android 4.4.2 (KitKat)	**Analysis**	Autopsy 4.20.0
Kernel Version	Linux 3.18.24-tcc		

Analysis of Automotive Crash Data

Data Analysis Stage

❖ Analyzing Log files of the IVI system

- Files were created or modified after starting driving
  - Telematics.log, eventslogs.log, dumpstate-[date].txt



- Dividing the log data into six categories

Index	Description
1	Vehicle Movement
2	Vehicle Speed
3	Vehicle Collision
4	Vehicle Location
5	Vehicle Assist System
6	Vehicle Door Status

Data Analysis Stage

1. Vehicle Movement data

- ./telematics.log
- **True**: started moving
- **False**: stopped moving

Time	File	logmessage
09-05 16:44:14	./telematics.log	[EngineIdleAlarmTask] Vehicle Movement Status Changed to **true**
09-05 16:44:14	./telematics.log	[EngineIdleAlarmTask] ADM ON: false Gear in Parking: false Vehicle Moving: **true** mPwrAutoOffTimer: -1 Validity Status: false

2. Vehicle Speed data

- ./dumpstate-[date].txt

A. Current vehicle speed

B. Current speed from the system

C. Changes in the vehicle's speed

	Time	File	logmessage
A	09-05 16:44:09	./dumpstate-[date].txt	SystemService: [SystemService.getVehicleSpeed] speed: **0**, called by 1400
B	09-05 16:44:14	./dumpstate-[date].txt	SystemService: SYS_SPEED_M: **12**
C	09-05 16:44:14	./dumpstate-[date].txt	SystemService: Vehicle Speed Changed to : **12**
	09-05 16:44:14	./dumpstate-[date].txt	UsageLoggingService: onVehicleSpeedChanged - speed: **12**

Data Analysis Stage

3. Data related to Vehicle Collision

- ./dumpstate-[date].txt

- Collision occurred
- Presence of passengers
- Seatbelt usage
- Rollover sensor activation
- Transmission position
- Engine Oil temperature
- RPM
- Airbag deployment status
- Parking brake activation.

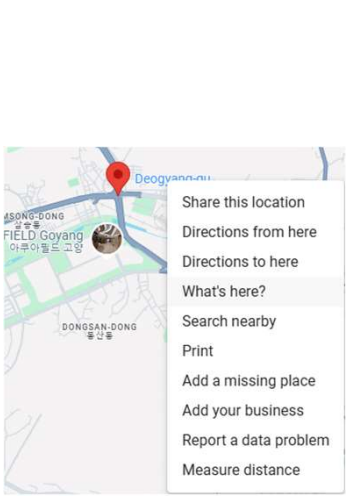
Time	File	logmessage
09-05 16:44:55	./dumpstate-[date].txt	TAS_HS : iBox| CrashPos_F_First:0| CrashPos_F_Full:0| CrashPos_Driver:0| CrashPos_Passenger:0| OccupancyDr:1| OccupancyPa:0| SeatBeltDr:0| SeatBeltPs:0| SeatBeltRrCtr:1| SeatBeltRrRt:1|SeatBeltRrLft:1| RolloverSensor:1| TransmissionPos:5| EngineTemperature:87.75| EngineTemperatureUnit:0| Rpm:796| AirbagsDeployed:1| ParkBreak:1

Data Analysis Stage

4. Vehicle Location data

- ./telematics.log, ./dumpstate-[date].txt
- 'Address_name' filed
- Latitude and Longitude are masked

Time	File	logmessage
09-05 16:40:17	telematics.log	[McpWeatherLooper]Weather == Received intent from navi : com.mnsoft.navi.request.mcp. DestNWaypoint.Weather wayPointID : -1, 99, 99, 99, Address_name : **Deogyang-gu, Goyang-si , , , ,**
09-05 16:43:34	telematics.log	[CMM][2]LastGps Lat:***580222** Lon:****876086* type:0 GMTTime:20240905074334 LocalTime:20240905164334 Head:235
09-05 16:45:12	./dumpstate-[date].txt	DUMP OF SERVICE location: Last Known Locations: gps: Location[gps **37.579692,126.875139** acc=6 accH=0 accV=0 accP=0 odoS=1 gyroS=1 back=0 modocount=0 gpsstatus=1 drstatus=1 accelstatus=0 angle=0 t=2012107079000 tv=0 et=+12m4s781ms alt=0.0 vel=0.0 bear=235.83252 gnssSpeed=0.0 gnssHeading=0.0 Bundle[satellites=0, DREHPE=8.543833]]



Lat:***580222**
Lon:****876086*

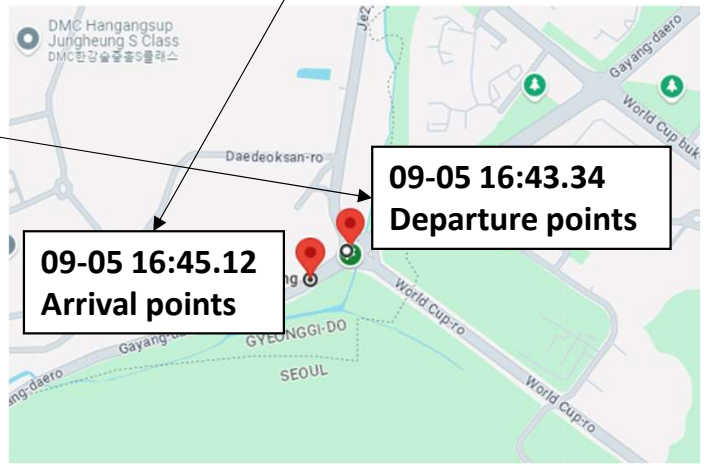
+

37.66044, 126.9205

Your location

Deogyang-gu

Latitude: 37.580222**
Longitude: 127.876086*



Vehicle Position

Data Analysis Stage

5. Vehicle Assist System data

- ./telematics.log
- Status of TCS (Traction Control System)
- Status of LKA (Lane Keeping Assist) system
- status of the LDWS (Lane Departure Warning System)
- 0: No issues
- Positive: issues

Time	File	logmessage
09-05 16:44:15	./telematics.log	[CAN] temp =0 mTroubleDiagMilLamp.TCS_LAMP=**0**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_LKA_Symbol State=**0**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_Lkas_Ldws SysState=**0**
09-05 16:45:58	./telematics.log	[CAN] temp =0 mTroubleDiagMilLamp.TCS_LAMP=**1**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_LKA_Symbol State=**4**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_Lkas_Ldws SysState=**15**

6. Vehicle Door Status data

- ./oem data/log/eventlogs.log, ./telematics.log
- **1**: Door opened
- **0**: Door closed

Time	File	logmessage
09-05 16:43:48	./oem_data/log/eventlogs.log	ivi_welcome_driver_door_opened:**1**
	./telematics.log	[RVP]notiDoorChange() prevDoor :**0**, curDoor :**1**
		[EngineIdleAlarmTask] Driver Door Open Status Changed to **true**
		[EngineIdleAlarmTask] IGN ON: true Parking Gear ON: true Driver Door Open: **true** Service Status: true

Data Analysis Stage

5. Vehicle Door Status data

- ./oem data/log/eventlogs.log, ./telematics.log
- **1**: Door opened
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09-05 16:43:48	./oem_data/log/eventlogs.log	ivi_welcome_driver_door_opened:**1**
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Time	File	logmessage
09-05 16:44:15	./telematics.log	[CAN] temp =0 mTroubleDiagMilLamp.TCS_LAMP=**0**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_LKA_Symbol State=**0**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_Lkas_Ldws SysState=**0**
09-05 16:45:58	./telematics.log	[CAN] temp =0 mTroubleDiagMilLamp.TCS_LAMP=**1**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_LKA_Symbol State=**4**
		[CAN] temp =0 mTroubleDiagMilLamp.CF_Lkas_Ldws SysState=**15**

05 Discussion

Discussion

❖ Timeline that reconstructs the driver's actions

- Vehicle's location information
- Estimation of Driver's behavior
- Vehicle's condition
- Estimating the time of the accident (09-05 16:44:21)

❖ Some limitations

- Considering to a specific car model
- Needed to enter Engineering mode

Time	Event	Description
09-05 16:40:17.2	Vehicle location information	Deogyang-gu, Goyang-si
09-05 16:43:34.4		Latitude: ***580222**, Longitude: ****876086*
09-05 16:43.48.1	Driver's door	Open
09-05 16:43:57.7		Close
09-05 16:44:09.2	Vehicle speed	0km/h
09-05 16:44:14.6	Vehicle start	12km/h
09-05 16:44:21.4	Vehicle speed	64km/h
09-05 16:44:21.6		29km/h
09-05 16:44:37.6	Vehicle stop	0km/h
09-05 16:44:55.8	Vehicle status	AirbagsDeployed, RPM 796
09-05 16:45:12.1	Vehicle location information	Latitude: 37.579692, Longitude: 126.875139

Vehicle Collision

Automotive crash timeline

05 Conclusion and future work

Conclusion and future work

Conclusion

- A new method for collecting and analyzing log data from IVI systems for vehicle accident investigations
  - It can help determine the cause of car crashes
- Critical data related to car accident could be obtained without relying on manufacturer-specific tools
  - Date type: vehicle speed, vehicle assist system data, vehicle movement, airbag deployment,
  - The data can be used to complement EDR data

Future work

- Our method should be extended to a wider range of vehicle models
- Automated tools are needed for efficient analysis

Q&A

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