Digital Forensic Analysis of Navigation Apps on an Android Phone Connected to a Car via Android Auto

ICGHIT 2025

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01 **Introduction**

Introduction

❖ Increasing Research on **Digital Evidence in Automobiles**

  ❖ Cars have become an integral part of our daily lives

  ❖ Modern cars are becoming key source of digital evidence.

❖ **Scientific Working Group on Digital Evidence (SWGDE)**

  ❖ A group which develops standards for collecting and analyzing digital evi

  ❖ It provides a guideline to categorize digital evidence in automobiles**.**

  ❖ Key Data related to automobiles

    ❖ **Navigation data**: Saved Locations, Previous Destinations, Active and Inactive routes

    ❖ Vehicle system information

    ❖ Device Information

    ❖ Connected devices

    ❖ etc.

Scientific Working Group on Digital Evidence

Handle and image media associated with the infotainment or telematics system in a forensically sound manner.

4.5   Data Analysis

Analysis of data can be conducted using a variety of validated tools. Data of importance may include but is not limited to:

Vehicle/System Information
- Serial Number
- Part Number
- VIN Number(s)
- Build Number

Installed Application Data
- Weather
- Traffic
- Facebook
- Twitter

Connected Devices
- Phones
- Media Players
- USB Drives
- SD Cards
- Wireless Access Points Logs

Navigation Data
- Tracklogs and Trackpoints
- Saved Locations
- Previous Destinations
- Active and Inactive Routes

Device Information
- Device IDs
- Calls
- Contacts
- SMS
- Audio
- Video
- Images
- WiFi Access Point Information

Events
- Doors Opening/Closing
- Lights On/Off
- Bluetooth Connections
- Wifi Connections
- USB Connections
- System Reboots
- GPS Time Syncs
- Odometer Readings
- Gear Indications

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Introduction

❖ Connected cars are incorporating smartphones into their systems, due to the widespread adoption of Android Auto and Apple CarPlay

❖ In this paper

    ❖ We collect and analyze **digital data of navigation apps** on an Android phone connected to a car through Android Auto

    ❖ Based on SWGED's guideline, key types of the digital data are categorized as

        ❖ **Tracklogs and Trackpoints**

        ❖ **Saved Locations**

        ❖ **Previous Destinations**

        ❖ **Active and Inactive Routes**

02 Related Work

Related Work

❖ "Automotive digital forensics through data and log analysis of vehicle diagnosis android apps" (J. H. Jung et al.)

    ❖ Analyze various artifacts using app data, Bluetooth Host Controller Interface (HCI) snoop logs, and the main buffer of the Android logging system

❖ "A study on artifact analysis and decryption methods of map applications in Android environment"(G. E. Park et al.)

    ❖ Analyzing artifacts and Decrypting encrypted data on KakaoNavi, Naver Map and Tmap

    ❖ However, this study was not conducted in an environment where car and smartphone were connected.

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Related Work

❖ "Forensic analysis of a vehicle using Android Auto: A case study" (H. J. Seong et al.)

    ❖ Collecting artifacts related to Android Auto, Kakao Navi, and Google Assistant

    ❖ **Only** analyzed **Kakao Navi**

❖ "Digital forensic case studies for in-vehicle infotainment systems using Android Auto and Apple CarPlay" (Y. H. Shin et al.)

    ❖ Information from Kakao Navi, the default app of Android Auto, was obtained through network sniffing, the internal storage of the smartphone and IVI.

    ❖ **Only** analyzed **Kakao Navi**

❖ Our study analyzed both **Kakao Navi** and **Naver Map** by **connecting** an Android smartphone to the **IVI system** and directly operating it during experiments.

03 Experiment Environment &
Data Collection

Digital Forensic Process

| Connection | Driving | Data Collection | Data Analysis |

devisesd driving scenario

```
(base) PS C:\Users\yeonsu> adb shell
a23:/ $ su
a23:/ # tar -cvf /data/local/tmp/contact_bac
```
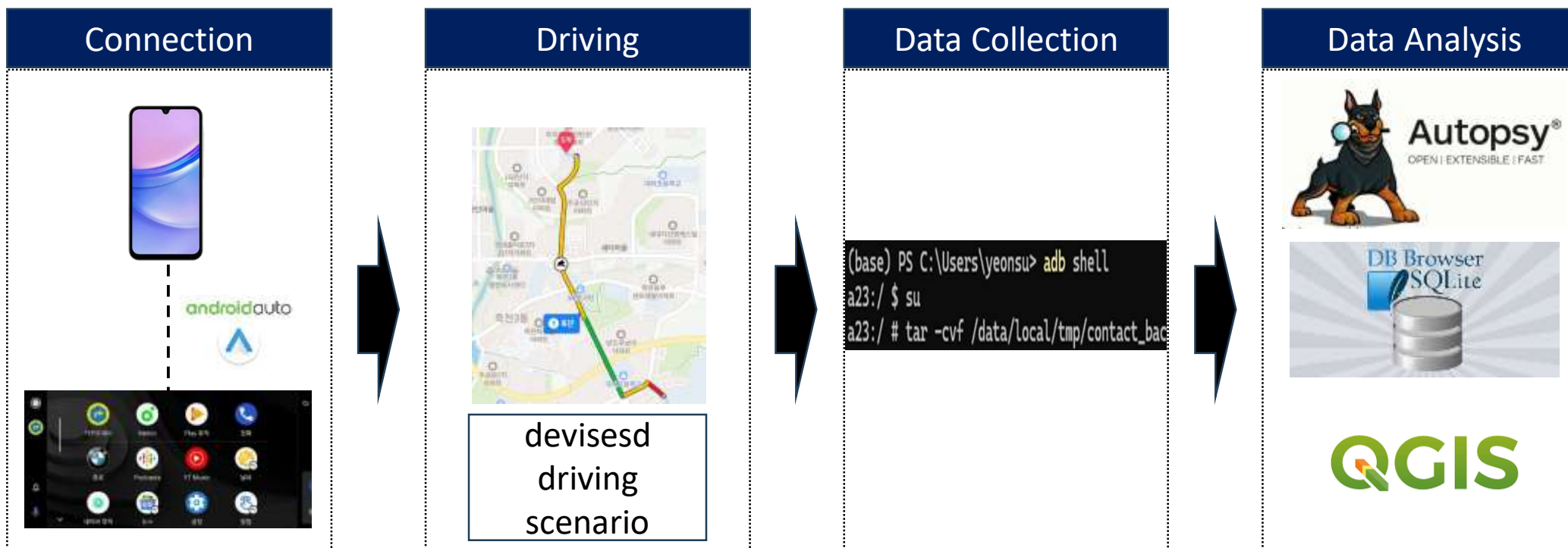
Automotive	Hyundai Avante 2024
IVI system	Android 4.4.2(KitKat)
Android phone	Samsung Galaxy A23, Android 14
Android Auto	13.3.644654-release
Navigation apps	Naver Map 5.31.0.7
	Kakao Navi 4.30.1

Data Collection
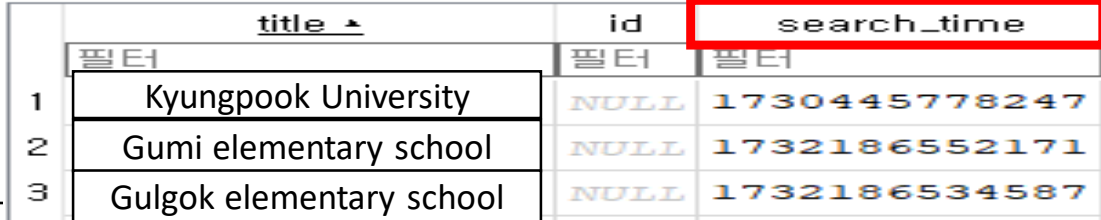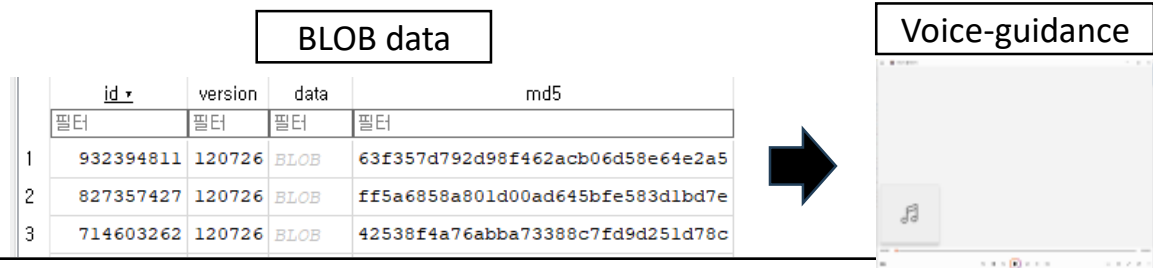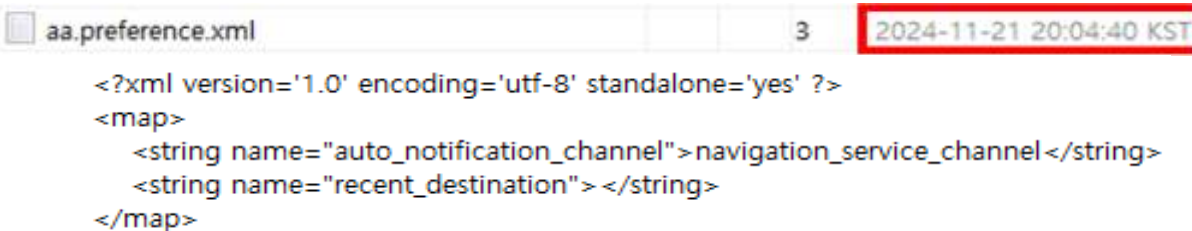
❖ adb tar –cvf [Storage] –C /data/data/[Name of Compressed Package]

❖ adb pull [Local PC] /[Storage]

Kakao Navi		Naver Map	
Data	Path	Data	Path
Package directory	com.locnall.KimGiSa	Package directory	com.nhn.android.nmap
Previous Destinations	/databases/kakaonavi. db	Arrival at destination	/shared_prefs/NativeNaviDefaults.xml
Tracklogs and Trackpoints	/files/KakaoNavi/KNSDSK/Resource/resour ce.sqlite	Driving route within 2km	/files/nmap-offline.db
Arrival time	/shared_prefs/aa.preference.xml	Surrounding road information	/files/NaverNavi/tile_v2/link /real-link-[num-num-num]
		Searched destination	/cache/cache_http/[String].0
		Locations and directions	/cache/clova_tts_cache

04

Analysis Results

Analysis Results – Kakao Navi's Data Categorized by SWGDE

SWGDE Category	Key Information	Related data	Collected Data
Location info	X	X	X
Active and Inactive Routes	X	X	X
Previous Destinations	Searched destinations	• Locations • Time of search	
Tracklogs and Trackpoints	locations and directions	• BLOB data	
Etc.	Arrival time	• File update time	

Analysis Results – Naver Map's Data Categorized by SWGDE

SWGDE Category	Key information	Collected data
Location info	X	X
Active and Inactive Routes	Driving route within 2km	• PBF file • access time field in tiles
	Surrounding road information	• File contents
Previous Destinations	Searched destination	• Locations • Current location • File modification time
Tracklogs and Trackpoints	Locations and directions	• Voice-based route guidance • File update time
Etc.	Arrival at destination	• Latitude and longitude • Time information

Arrival at destination	NativeNaviDefaults.xml 0 2024-11-21 20:29:18 KST deLinkKey">747;67310000001635;1;58 37.33770551960023;127.11904035836898 37.33768637;127.11909005<,
Driving route within 2km	Take PBF file | id	url_template	pixel_ratio	z	x	y	accessed
---	---	---	---	---	---	---
필터	필터	필터	…	필터	필터	필터
639	https://map.pstatic.net/nvb/mvt/...	1	16	55906	25430	1732188546
645	https://map.pstatic.net/nvb/mvt/...	1	16	55906	25429	1732188523
652	https://map.pstatic.net/nvb/mvt/...	1	16	55907	25428	1732188516	
Surrounding road information	Road name Poeun-daero" Daeji-ro 51beon-gil" Dongbaekjukjeon-daero" Jeongdeun-ro 20beon-gil" Jeongdeun-ro" Jeongdeun-ro 6beon-gil" Bojeong-ro"
Searched destination	694bf261fcd7863f01c0955753f6d0bc.0 0 2024-11-21 20:21:50 KST https://apis.naver.com/mapmobileapps/maps-search/instantSearchV2?caller=android_NaverMap_5.31.0.7 &query=%EA%B5%AC%EB%AF%B8%EC%B4%88&coords=37.324924722725175,127.123246531154628&types=place%2Caddress&screenid=AA.search.home&msgpad=1732188110117&md=hF9EEE%2BdGtB1AoT1CUL6bUdGFcc%3D Gumi elementry school ← → The location at the time of the search
Locations and directions	Voice-guidance 	♪ f226e2ac62d2a38f3b87f6dc18a6a667.mp3	4	2024-11-21 20:29:07 KST
♪ cad801cecb041cdedf01baf480f6b4d9.mp3	0	2024-11-21 20:28:18 KST
♪ a3a942bfb4a4117a71a412c864494ab4.mp3	0	2024-11-21 20:26:55 KST
♪ d8a6ce341b68bacdb8d3d06b546fa7fc.mp3	3	2024-11-21 20:26:46 KST
♪ fbb357b46eebd40b7b6b765832557ee5.mp3	4	2024-11-21 20:26:41 KST	

Analysis Results – Comparison of Collected Data between Kakao navi and Naver map

	Kakao Navi	Naver map
Saved Locations	X	X
Active and Inactive Routes	X	Driving route within 2km
		Surrounding road information
Previous Destinations	Searched destinations	Searched destination
Tracklogs and Trackpoints	locations and directions	Locations and directions
Etc	Arrival time	Arrival at destination

Analysis Results – Comparison of Event Reconstruction

Kakao Navi

Artifact	devised	reconstructed	data
Searching for destination	19 : 55	19 : 55	Search history for destinations
Starting driving	19 : 56	-	-
Making 1st right turn	20 : 01	-	-
Making 2nd right turn	20 : 03	-	-
Arrival at destination	20 : 04	20 : 04	Arrival time at the destination

Naver Map

Artifact	devised	reconstructed	data
Searching for destination	20 : 21	20 : 21	Searching time for destination
Starting driving	20 : 22	20 : 22	Voice-based route guidance
Making 1st right turn	20 : 23	-	-
Making 2nd right turn	20 : 27	20 : 26	Voice-based route guidance
Arrival at destination	20 : 29	20 : 29	Arrival time at the destination

Voice guidance is provided before making a right turn, which causes a time difference.

05 Conclusion

Conclusion – Limitations and Future

❖ **Limitations of our study**

   ❖ Cache data is deleted after two weeks

   ❖ Encoded(encrypted) data exists

   ❖ Kakao Navi has nothing in Android internal storage

❖ **Future work**

   ❖ Adopting other data gathering methods

      ▪ e.g., hooking, memory dump, etc.

   ❖ Performing digital forensics other navigation apps

      ▪ e.g., IVI system's basic navigation, T-map, google map

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Q&A