Development of Integration Vehicle Sensing Data Platform for Collection and Analysis of Road Driving Environment Big Data

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ABSTRACT: In recent years, traffic accidents have increased due to severe weather such as strong torrential rainfall and freezing of road surface. It is necessary to predict and prepare road traffic risks through big data analysis of road driving environment. For road traffic safety management, RWIS(Road Weather Information System) based on fixed sensor is in operation, but there is a space limitation, which makes it difficult to collect information. Accordingly, this study developed an integrated platform system that measures, collects, analyzes, and services real-time road driving environment information through the convergence of vehicle sensors and big data technology. This system uses various vehicle sensors such as front and rear radar, temperature and humidity sensor, GPS, and camera to collect road driving environment information, and analyzes big data collected on the platform to provide road ice, rainfall and traffic density information. In addition, the accuracy of data provided by fusion analysis of public data related to road driving environment such as weather and traffic has been improved. The integrated vehicle sensor big data platform consists of H/W such as web server, platform server, image processing server, and server storage. The SW of the platform consists of MQTT for collecting vehicle sensing data, Kafka, Spark for data processing, and PostGIS for information visualization. It is expected to the integrated vehicle sensor big data platform utilizes various road traffic data such as public data and sensor data to improve driver's driving safety by providing micro-road driving environment information and improve the reliability of traffic prediction information.

1. BACKGROUND

The driving environment of the road can be changed drastically according to various event situations such as musical instruments, road frost, traffic congestion. Road environment information is not provided to drivers, leading to many different traffic accidents. This requires a faster and more accurate road driving environment observation and analysis system utilizing advanced information and communication technology. Existing road environment observation system has a limitation of providing the driving environment information of the point by the fixed sensor equipment installed on the roadside and a specific point. In addition, it does not provide continuous information of the road in real time. In order to supplement the limitation of the fixed sensor system, it is necessary to utilize vehicle sensing data generated from various sensors (GPS, temperature / humidity, radar, camera, etc.) installed in individual vehicles. For this reason, it is necessary to develop a system equipped with big data distributed processing technology in order to collect, store, and process vehicle sensing data of a nationwide unit. Therefore, this study intends to develop a road driving environment analysis platform using various big data such as vehicle sensing data and public data.

2. DEVELOPLMENT STATUS OF DOMESTIC & OVERSEAS

At present, various countries have recognized the importance of road weather measurement in relation to traffic safety and have made technological progress. Among them, the US Idaho Road Bureau collects road, weather and traffic data using the equipment installed on the roadside as a Motorist Warning System. The environmental sensor station collects road pavement, wind speed, wind direction, precipitation type, precipitation, air temperature, and humidity. In the United Kingdom, road surface condition information is classified into nine types considering weather forecasting data, and a system was developed to express road surface conditions as GIS maps. In Germany, a weather sensor is installed in the test bed to provide an algorithm that reflects weather conditions when providing traffic information. Slovenia is currently conducting traffic congestion prediction studies by fusing traffic data and road weather data. Korea's Traffic Information Center provides traffic and CCTV video information on managed and connected roads. The traffic information cycle of the traffic information center varies from 30 seconds to 5 minutes depending on the type, and CCTV video information is provided by real time streaming.

3. DEVELOPMENT OF DRIVING ENVIRONMENT BIG DATA PLATFORM

The final goal of this study is to develop a big data-based driving environment analysis platform for collecting, storing, processing, analyzing, providing information, and visualizing a variety of big data such as vehicle sensing and public/private to provide road driving environment information. The platform developed in this study consists of H/W and S/W. H/W has developed a small platform server with a multi-physical node structure for distributed processing of large data. S/W has developed a program for collecting, storing, processing, analyzing and visualizing various data using various open sources.

3.1 ESTABLISHMENT OF BIG DATA PLATFORM H/W

An integrated server system was constructed to collect and store vehicle sensor information and public data. The hardware of the system consists of web server, platform server, server storage, and network switch. The platform system is a structure of publish and subscribe based on MQTT (Message Queueing Telemetry Transport) broker for real time data transmission. The platform hardware was developed to run as 10 servers to distribute big data. As a result of the performance test of the developed MQTT server, it is possible to transmit about 24000 data per second.

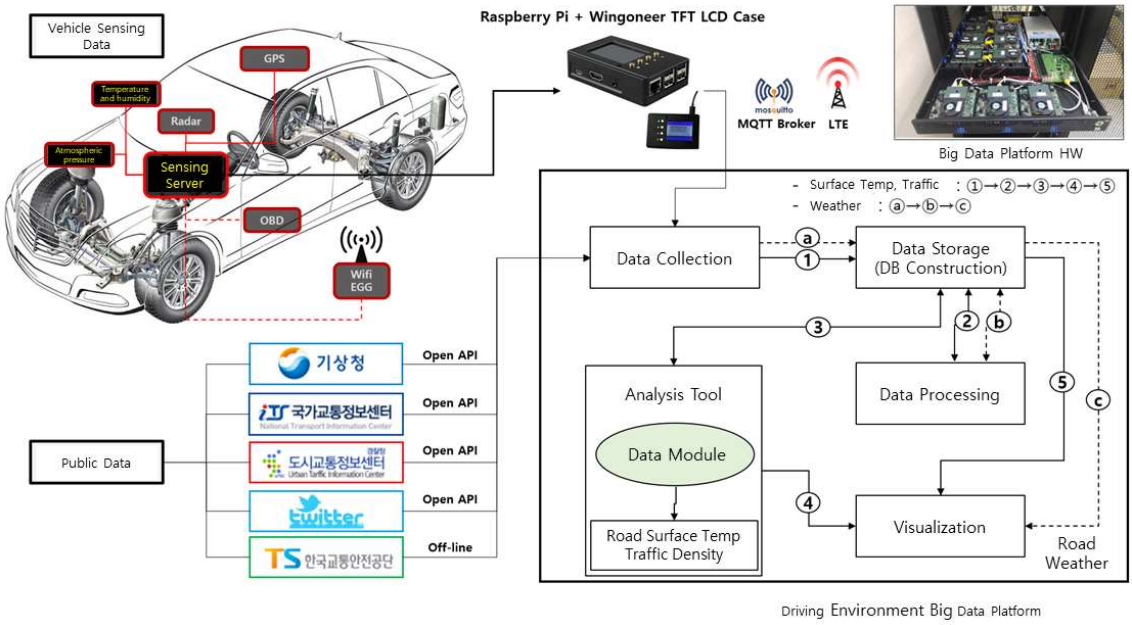

Figure 1. Structure of big data platform H/W

3.2 ESTABLISHMENT OF BIG DATA PLATFORM S/W

Big data platform S/W was constructed by dividing into collection, storage, processing and analysis agent. The data collection agent was developed by dividing into Kafka/Flume framework for real-time data collection and Sqoop framework for non-real-time data collection. Real-time data are collected from Twitter Agent, ITS Agent, KMA Agent, SK Planet Agent, and Korea Expressway Corporation. Non-real-time data are collected from KMA Agent, Korea Road Traffic Authority, ITS Agent, and Korea Highway Corporation. The data storage framework was developed using Hadoop Distributed File System (HDFS), HBase, and PostGIS. The processing framework was developed using Hadoop and Yarn/ Spark for high speed data distributed processing. In addition, we developed a collection data analysis tool for platform users based on Zeppelin Notebook..

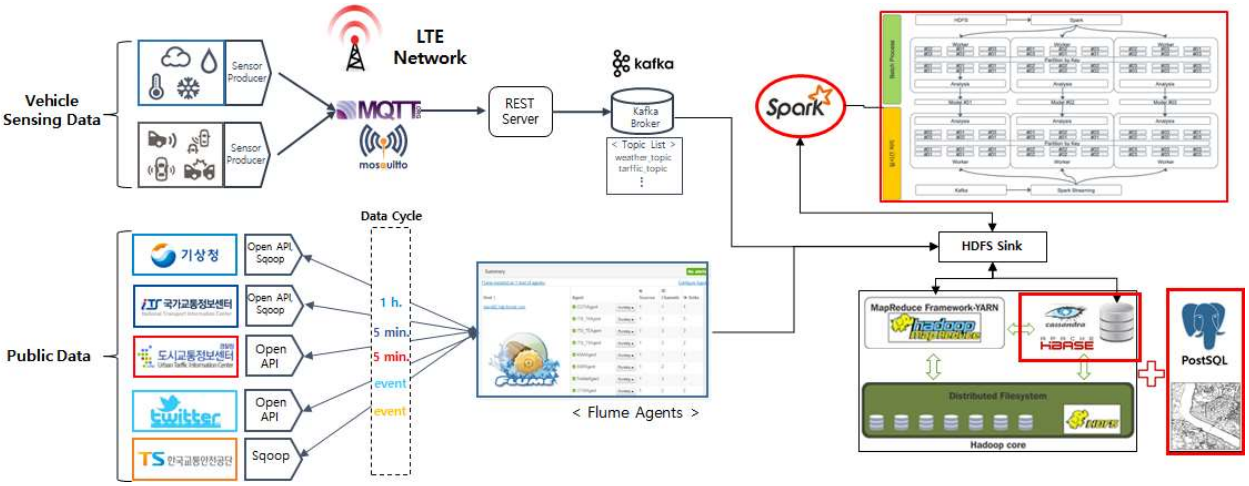

Figure 2. Structure of big data platform S/W

As a result of analyzing the large data processing performance of the development platform S/W, the development platform S/W has improved the speed of data operation compared with the existing big data processing tool. It is analyzed that the operation time decreases as the data size increases. The types of data collected, stored and analyzed in the development big data platform are shown in the table below. Collected data is classified into vehicle number, GPS, temperature sensor and radar sensor. Data is collected and stored in the form of time, date, letters and numbers.

Table 1. Type and Value of Collected Data

Division	Data Parameter	Data Type	Data Value
Vehicle No.	Device ID	varchar	KICT9687
GPS	Date	date	2019-09-06
	Time	time	12:15:31
	Latitude	Float8	37.67102803
	Longitude	Float8	126.73485934
Temp. Sensor	Sensor Value	Float4	25.9
Radar	Air Type	varchar	Clear, Rain, Snow, Fog..
	Air Level	Float4	1.34
	Heading	Float8	0.000
	Section No.	Int	135
	Lane No.	Int	2
	Total Lane No.	Int	4
	SVCount	Int	4

3.3 DRIVING ENVIRONMENT BIG DATA WEB PLATFORM

Driving Environment data collected, stored and analyzed from big data platform are provided through a web-based GIS Map. The driving environment information is expressed in the form of dots, and the value of each information is expressed in colors. Road surface temperature and weather information are provided as point information in x, y coordinate units, and traffic density is provided as line information in ITS standard link units. In addition, all information is analyzed by grid and provided as local information. Vehicle sensing data such as road surface temperature, weather information, and traffic density are linked to the vehicle sensor H/W and platform to be displayed in real time on the road driving environment big data web platform. In order to advance the web platform, this study carried out the development of real-time monitoring dashboard, information presentation and visualization of Web GIS, and the design of UI for convenience of user development..

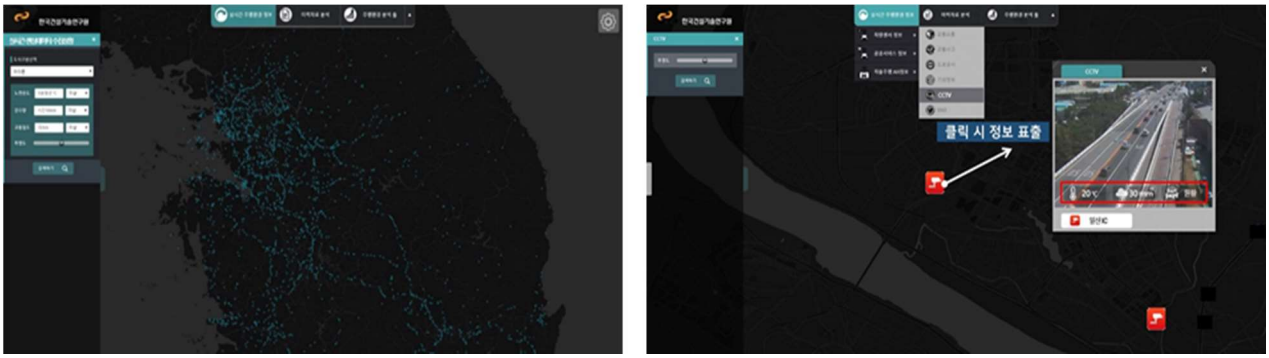

Figure 3. Driving Environment Web Platform

4. CONCLUSION & EXPECTATION

The driving environment platform technology developed in this study is expected to be applicable to the combined weather sensor information estimation technology. In addition, it is expected that the accuracy of road weather observation and precipitation information estimation will be improved through the joint utilization of existing fixed weather sensor and platform development technology. Vehicle sensing data can be used for future cars and autonomous vehicle data. Through this, road safety and operational efficiency can be improved to provide road services. It is expected to be used as a supporting technology for safety commercialization of autonomous vehicles and technology commercialization for a large number of vehicles. The developed integrated sensing server is mounted on individual experimental vehicles and is undergoing field test and advancement. It is expected to be used as a supporting technology for safety commercialization of autonomous vehicles and technology commercialization for a large number of vehicles.

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