Development of road meteorological observation system using integrated vehicle sensor

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In order to provide safe road environment and user-centered road service, it is essential to have accurate real-time road environment information. For this, a large amount of road traffic information observation is required, but there are limitations in existing weather observation systems. First, existing radar, satellite and terrestrial meteorological observation systems are difficult to observe sudden and regional torrential weather occurrences. Road Weather Station(RWS) and Automatic Weather Station(AWS) observe weather information only at the installation point of the equipment, so shadow areas occur in space between equipment. Therefore, it is necessary to overcome the temporal and spatial limitations of existing radar, satellite and terrestrial weather observation systems. Second, existing systems also suffer from high cost of installation and inefficiency of maintenance. Thereby reducing efficiency in managing and providing city and road weather information. Third, there is a mismatch between weather information provided by the Meteorological Administration and actual weather on the road. The spatial resolution of the meteorological information provided by the Meteorological Administration is 5km×5km, which makes it difficult to accurately observe the precise weather conditions such as precipitation, snowfall, hydroplaning, black ice, and fog. More precise meteorological observations are needed to provide accurate weather information for autonomous vehicles. Therefore, it is necessary to provide road meteorological information that has continuity in time and space through developing driving environment observation and forecasting system using big data such as real-time vehicle sensor data and open API.

In this study, we developed a road meteorological observation system using integrated vehicle sensor. The details of the research are divided into 3 categories. The first theme is the development of prediction technology of road surface temperature and freezing using integrated vehicle sensor. We predicted the road surface temperature and the road surface condition such as icing, black ice, etc. using the temperature sensors. The second theme is the development of a technique for estimating the rainfall intensity of a road by developing a composite radar sensor that can be mounted on a vehicle. The third theme is the development of driving environment prediction platform based big data, which is a technology for collecting and analyzing data(road surface condition, rainfall intensity) generated by integrated vehicle sensor and open API.

(1) Development of prediction technology of road surface temperature and freezing using integrated vehicle sensor

Traffic accidents due to freezing of the road are constantly occurring every winter. It is anticipated that it will be possible to prevent traffic accidents due to freezing of the road through provision of road condition information to road drivers. Therefore, it is necessary to develop a technology that can estimate the pattern of road surface temperature considering various factors such as the weather condition, the road geometry, and the topographical characteristics. In this study, we selected test road sections and collected the information of test road sections such as road geometry, geographical characteristics, and road types to develop the estimation model of the road surface temperature pattern. In order to verify the performance of the estimation model of the road surface temperature pattern, the optimization test and a field test was performed in a new test road section. In order to analyze the accuracy of the estimation model of the road surface temperature pattern, the tolerance range of measured and predicted road

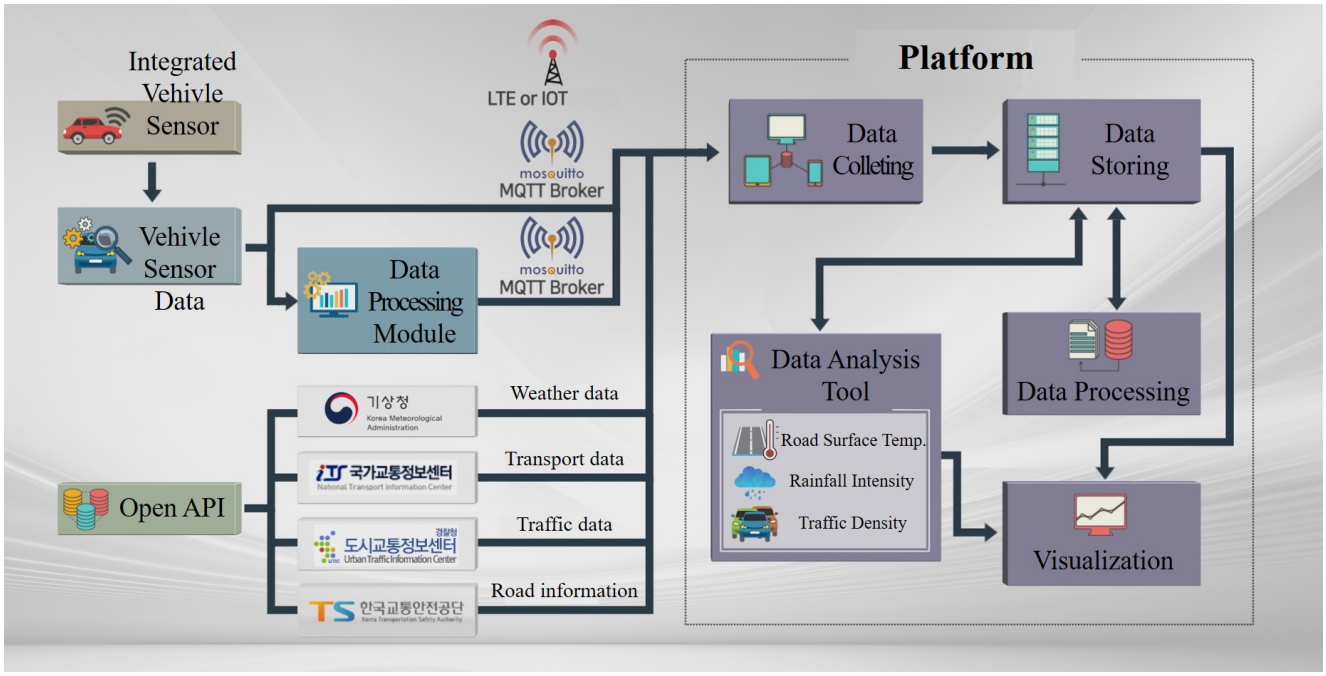
surface temperature was set to ±2 ℃ based on the previous research. As a result of checking the accuracy of the road surface temperature pattern estimation model, it was found to be 70% accurate.

(2) Development of rainfall intensity estimation technology using integrated vehicle sensor
Traffic accidents are increasing due to regional torrential rain caused by abnormal weather. Existing weather observation systems have limitations on forecasting and observation of regional torrential rain. To solve the problems, we developed a real-time rainfall intensity observation and estimation technique using integrated vehicle sensor. Integrated vehicle sensor was developed as a K/W-band radar sensor that can be mounted on the front and rear of the vehicle. The K/W-band radar sensor has been developed to quantitatively calculate the rainfall intensity using the 24GHz vehicle radar technology, which is used as the front sensor of the existing vehicle. In addition, we developed RFEU (Radio Frequency Front End Unit), which is the hardware that provides the antenna and transmission/reception path of the radar sensor.

(3) Development of web platform for analysis of integrated vehicle sensor data and open API
This study is the development of a driving environment analysis platform for collecting, storing, processing, analyzing and visualizing various kinds of big data The data collected and analyzed on the platform are divided into sensing data from integrated vehicle sensor(GPS, temperature sensor, radar, etc.) and open API. The Flume framework was used for real-time data of integrated vehicle sensor collection and the Sqoop framework was used for non-real-time data collection. The road surface temperature information based on GPS was collected as raw data and the radar data(weather condition, rainfall intensity) was collected as processed data through the data signal processing and information generation module installed in the vehicle.

Through the development of integrated vehicle sensor and big data analysis platform can provided more accurate real-time road environment information. Through this, it is expected that it will provide safer, smarter, and more satisfactory road environment to the driver. It is necessary to expand the probe vehicles and data to provide various driving environment information services in the future. In addition, it is required to develop various contents for user service such as road freezing risk information, high rainfall/snowfall guerrilla information, and incident Condition information using integrated vehicle sensor data and open API.

Keywords: Integrated vehicle sensor, Road meteorological observation, Road surface temperature, Rainfall intensity estimation


Integrated Vehivle Sensor
Vehivle Sensor Data
LTE or IOT
mosquitto MQTT Broker
mosquitto MQTT Broker
Data Processing Module
Open API
기상청 Korea Meteorological Administration
국가교통정보센터 National Transport Information Center
경찰청 도시교통정보센터 Urban Traffic Information Center
한국교통안전공단 Korea Transportation Safety Authority
Weather data
Transport data
Traffic data
Road information
Platform
Data Colleting
Data Storing
Data Analysis Tool
Road Surface Temp.
Rainfall Intensity
Traffic Density
Data Processing
Visualization