PHASE 3 DEVELOPING PART

An IoT-Based Devoloping Air Quality Monitoring Platform

The IoT-based indoor air quality monitoring platform is primarily divided into the Smart-Air and the web server. The set of sensing devices necessary to collect the data to analyze air quality comprised a laser dust sensor, a CO sensor, a CO_2 sensor, a VOC sensor, and a temperature and humidity sensor. Each device transmitted data to the web server via the LTE module to determine air quality and visualize the result.

Furthermore, cloud computing technology was integrated with a web server. The main benefits of the cloud computing-based web server are faster speed, flexibility, and greater accessibility. The web server provided faster and more flexible data processing functions with a large amount of data, which is essential for a monitoring platform. The cloud computing-based web server is easily accessible through most browsers to allow ubiquitous monitoring.

In this study, Amazon Web Services (AWS) was used as the web server to analyze, visualize, and present the data collected from Smart-Air. Also, the web server provides a database to store that data in the cloud. Furthermore, a mobile application was developed for the system to visualize air quality with the web server “anywhere, anytime” in real time.

(i)We propose the use of the Smart-Air for the precise monitoring of indoor air quality

(ii)We propose the utilization of an IoT for efficient monitoring of real-time data

(iii)We propose the adoption of cloud computing for real-time analysis of indoor air quality

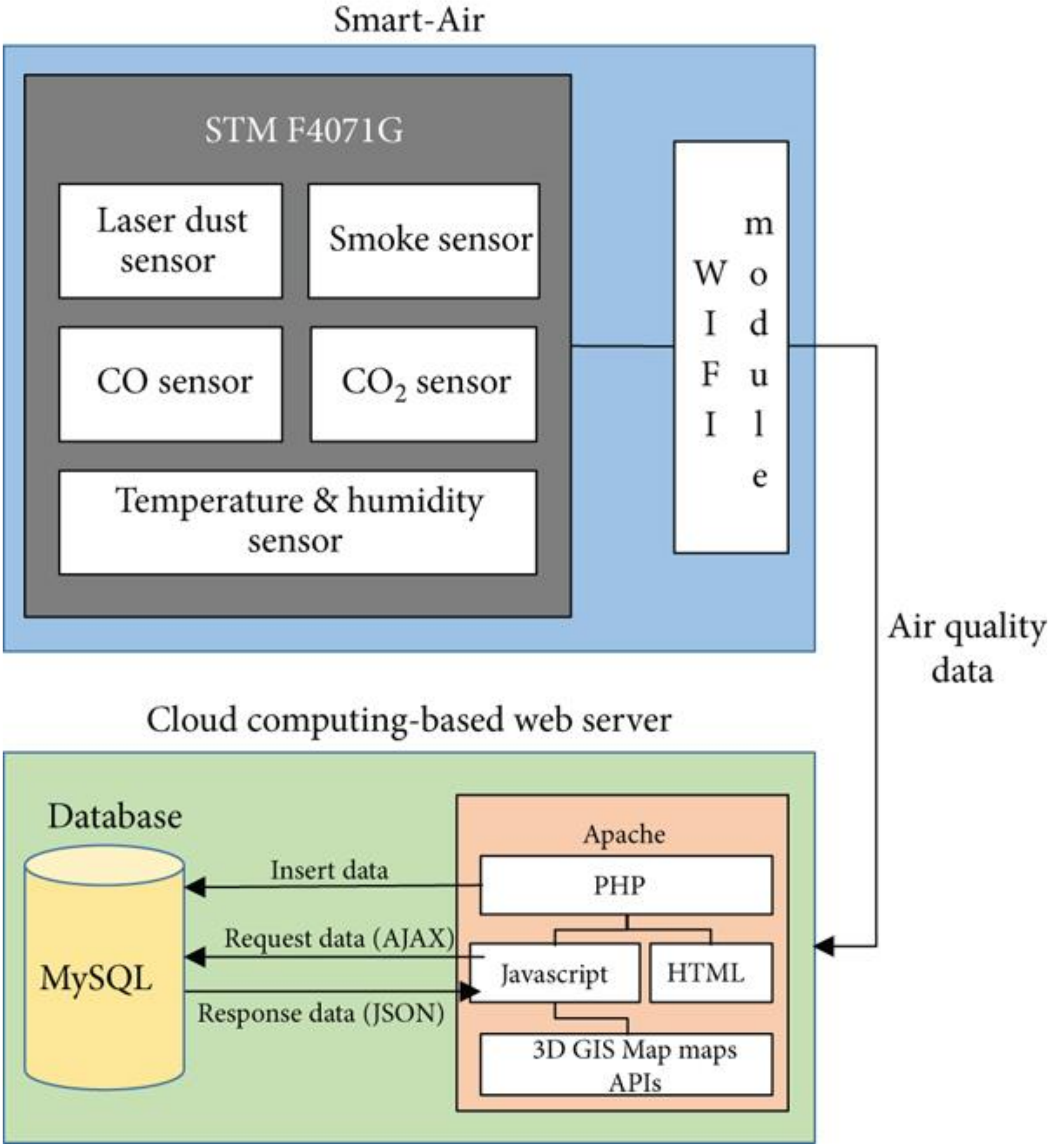
(iv)We originally developed a mobile application to make the proposed IoT system with features of anytime, anywhere

(v)The device has been tested for reliability of the data and the platform has been implemented in a building to test its feasibility

2. Smart-Air

An accurate data measurement of indoor air quality is the most important factor for the platform. Thus, Smart-Air was developed to collect accurate and reliable data for indoor air quality monitoring. Because the monitoring area is not constant, the device was designed to be easily customized to an environment by using an expandable interface. Thus, various types of sensors can be installed or adjusted based on the environment. Also, a Long-Term Evolution (LTE) modem is mounted in the device to transmit detected data directly to the web server for classifying and visualizing air quality.

For most IoT platforms, gateway or data loggers are installed to gather and transmit data wirelessly to the web server. However, in this study, a microcontroller was installed in the device to gather the data from the sensors and transmit it to the web server using the LTE modem, eliminating the need for a gateway and a data logger.



In this paper, an IoT-based indoor air quality monitoring platform, consisting of an air quality-sensing device called "Smart-Air" and a web server, is demonstrated. This platform relies on an IoT and a cloud computing technology to monitor indoor air quality in anywhere and anytime. Smart-Air has been developed based on the IoT technology to efficiently monitor the air quality and transmit the data to a web server via LTE in real time. The device is composed of a microcontroller, pollutant detection sensors, and LTE modem. In the research, the device was designed to measure a concentration of aerosol, VOC, CO, CO_2, and temperature-humidity to monitor the air quality. Then, the device was successfully tested for reliability by following the prescribed procedure from the Ministry of Environment, Korea. Also, cloud computing has been integrated into a web server for analyzing the data from the device to classify and visualize indoor air quality according to the standards from the Ministry. An application was developed to help in monitoring the air quality. Thus, approved personnel can monitor the air quality at any time and from anywhere, via either the web server or the application. The web server stores all data in the cloud to provide resources for further analysis of indoor air quality. In addition, the platform has been successfully implemented in Hanyang University of Korea to demonstrate its feasibility.

The most important purpose of Smart-Air is to precisely detect air quality in the perception layer of the platform that a primitive concept design of the device is shown in Figure 1. This device has an expandable interface such that multiple sensors can be installed simultaneously or easily added according to monitoring requirements. In the present study, the Smart-Air device consists of a laser dust sensor, a volatile organic compound (VOC) sensor, a carbon monoxide (CO) sensor, a carbon dioxide (CO_2) sensor, and a temperature-humidity sensor. Moreover, an LED strip was installed in the center of the device to visualize air quality using colors. When the quality of air changes, the device's LED changes color and wirelessly sends an alert message to the web server via LTE. Thus, the LTE modem transmits and receives data by communicating with the web server for detailed monitoring and determination of air quality as the presentation layer of the platform.

DEVOLOPING PYTHON PROGRAMMING:

```
# importing Randomforest

from sklearn.ensemble import AdaBoostRegressor

from sklearn.ensemble import RandomForestRegressor

# creating model

m1 = RandomForestRegressor()

 # separating class label and other attributes

train1 = train.drop(['air_quality_index'], axis=1)

target = train['air_quality_index']

 # Fitting the model

m1.fit(train1, target)

'''RandomForestRegressor(bootstrap=True, ccp_alpha=0.0, criterion='mse',
```

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                 max_depth=None, max_features='auto', max_leaf_nodes=None,
                 max_samples=None, min_impurity_decrease=0.0,
                 min_impurity_split=None, min_samples_leaf=1,
                 min_samples_split=2, min_weight_fraction_leaf=0.0,
                 n_estimators=100, n_jobs=None, oob_score=False,
                 random_state=None, verbose=0, warm_start=False)'''
 # calculating the score and the score is  97.96360799890066%
m1.score(train1, target) * 100
 # predicting the model with other values (testing the data)
# so AQI is 123.71
m1.predict([[123, 45, 67, 34, 5, 0, 23]])
 # Adaboost model
# importing module
 # defining model
 m2 = AdaBoostRegressor()
# Fitting the model
m2.fit(train1, target)
 '''AdaBoostRegressor(base_estimator=None, learning_rate=1.0, loss='linear',
               n_estimators=50, random_state=None)'''
 # calculating the score and the score is  96.15377360010211%
m2.score(train1, target)*100
 # predicting the model with other values (testing the data)
# so AQI is 94.42105263
m2.predict([[123, 45, 67, 34, 5, 0, 23]])
```