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AIR QUALITY MONITORING SYSTEM USING VEHICLES BASED ON THE IOT

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***Abstract*:** In the recent years air pollution is becoming the main cause for major health issues among the living things, specifically in humans. It could lead to respiratory and cardiovascular diseases, which is estimated to be the cause for 920000 deaths in 2016. Thus it is need to control the air pollution and climate warming, especially in urban areas. Environmental parameters can be measured for critical information to control the air pollution and weather monitoring system. A novelty approach in monitoring the environmental parameters involves vehicle monitoring system (VMS). It consists of sensors including PM 2.5, NO2, CO and O3. The VMS can provide the information of emissions, smoke, vibrations and also GPS signals through driving a vehicle (Car, Bus etc.) on the street. Various sensor modules are used to record the different parameters, aggregate the measured data and transmit them to a cloud server using IoT Technology. The aggregated data such as GPS Position, weather parameters, vehicle information and air quality information can be obtained by the user and also by the government agencies by accessing the cloud. Based on the information given by the VMS the government agencies can make decisions on traffic planning and for taking certain actions to reduce the pollution.

Index Terms:Vehicle, monitoring system, smart city,IoT, Global Positioning System.

1.INTRODUCTION

Developing a smart city is a significant strategy that helps in economic upgrade of a country. It also helps people to make out incomes by smart means. This project mainly focuses on rendering social services and solution to the city problems regarding traffic and pollution. Taipei Smart City PMO (the project management Office) has been developed by the government of Taipei city located in Taiwan to promote various projects in the development of smart cities. In India, "Smart Cities Mission" has been developed by the Ministry of Housing and Urban Affairs under which many proposals is under implementation.
Our environment has been affected by air pollution due to the increased population, industries and traffic on the roads. Air pollutants like PM2.5/10, carbon monoxide, nitrogen dioxide, ozone, and sulphur dioxide are very harmful when inhaled. It creates major respiratory and cardiovascular problems. In order to deal with serious air pollution problems, the Environmental Protection Administration and Executive Yuan R.O.C of Taiwan has developed a system to monitor gas levels all over Taiwan. They have shown the results in real time. As the map is a GUI (Graphical User Interface), the people were able to obtain the information about the gas air pollution levels and the amount of fouling. The government agency has also manifested an air quality index (AQI), which indicates air quality levels. There were six levels in the list which includes good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy and hazardous.

The vehicle monitoring system (VMS) is equipped with several sensors that measures PM2.5, CO, NO2, O_3, GPS, OBD-II and temperature/humidity. The air quality parameters can be thoroughly measured when VMS enters a particular area. A technique called LoRa, which is a transmission protocol is used in VMS for communication purpose and is controlled by LoRa Alliance. LoRaWAN is a low power wide area network (LPWAN) specification which operates things in a regional, national or global network. Using LoRa technique in VMS possess many advantages like, it consumes vey less power and provides longer transmission. At the same time LoRaWAN possess some key elements of Internet of Things (IoT) which includes localization and secured communication. LoRaWAN algorithm is user friendly and it does not require complicated installations. It can be easily accessed in IoT application. IoT refers to the connection different devices like cars,home appliances and environmental monitors connected to the internet. In future, many more devices will have links with each other via IoT. This list of devices may also include VMS which plays an important role in the development of smart cities. The architecture of VMS is explained in the next section.

2. SYSTEM ARCHITECTURE

The environment air quality monitoring system using vehicle monitoring system consists of three major parts includes input part, processing unit and output part.

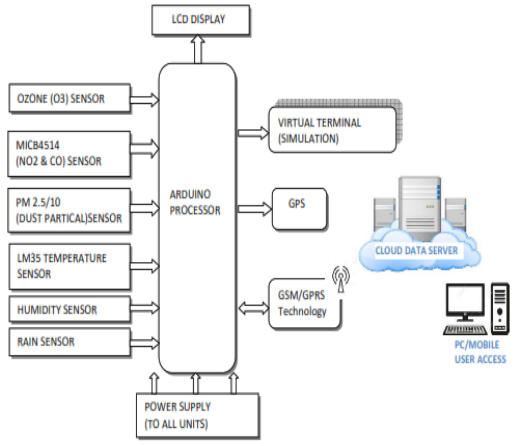

Fig.1:Block Diagram

The input part consists of a sensor's shield which composed of different kinds of sensors such as O_3, NO2, CO, dust particle, temperature, humidity and rain sensor. The sensor senses the environment air pollution parameters and emits the output to the processor for analysis.

The second part has an Arduino processor which obtained the analog output signals from the various sensors and processes the output value and determines the present rate of pollution in the area, weather information of the surrounding area, where the vehicle were travelling.

The final part displayed the output data of the amount of O_3,CO, NO2, dust particles, temperature, can be viewed at the end user device (PC's or mobile device) through IOT technology. The monitoring information can be viewed by any user to know the weather information, GPS localization, vehicle information and air quality of the environment.

2.1 Vehicle Shield Processor:

The VSP consist of Arduino processor and sensor shield board which contain the different sensors that are employed by the VMS. The Arduino mega 2560 is a 8-bit microcontroller, has feature of 54 digital input\output pins, 16 analog inputs, 4 UARTs, a USB port, 16 MHz clock speed oscillator and a RESET button. This microcontroller can be easily connected with PC. All the sensor are connected with the Arduino board through SSB.

2.2. Weather Information Module:

The DHT 11 is used to measure the temperature and humidity in the particular area. The humidity is the quantity of water level in the surrounding air. The DHT 11 detects water vapor by measuring the electrical resistance between two electrodes and it can also detect the air temperature. The sensing range of DHT 11 in temperature ranges from 0-50° C and measure relative humidity from 20-95%RH. The measurement accuracy in temperature and relative humidity of DTH11 is ± 0.5°C and ± 4.0%RH.

Fig.2:DHT 11 sensor

The DHT 11 uses one wire to transmit the measured humidity and temperature data value to the Arduino processor.

Rain Sensor Module detects the rain drop by using the beam intensity and the detected information is sent to the Arduino controller in the form of analog output.

Fig.3: Rain sensor

2.3. Air Quality Monitoring Sensors Module:

The air quality is measured in the VMS includes MQ-131(O_3), PM 2.5/10, MICS-4514(CO/NO_2). The sensor has the advantages of high sensitivity, wide range detection, simplified drive circuit and long life.

2.3.1. MQ-131:

MQ-131 is a semiconductor sensor, used to detect the ozone gas in the air through change the resistivity when it's exposed to ozone. The measured value of gas from sensor is an analog voltage. The sensor could detect the O_3 concentration in the range of 10 to 1000 ppm. MQ131 gas sensor has high sensitivity to Ozone, also sensitive to CL2, NO2.

Fig.4:MQ131 sensor

2.4.MICS-4514:

The MICS-4514 (SGX metal oxide sensor) has used to detect the dual gas as carbon di oxide and Nitrogen di oxide, mainly responsible for the pollution from

automobile exhausts. This device detect the target gases by the detecting of resistance, simply reducing gases remove some of the insulative oxygen species which leads to the overall resistance to go down

Fig.5:MICS-4514 sensor

2.5. PM 2.5/10:

PM 2.5 is particulate matter 2.5 micrometer,used to described the fine particles in the air are course particles With a diameters the tiny particles in the Air that reduce visibility&course the air to appear hazy.

Fig.6:PM 2.5/10

2.6. GPS Module:

The GPS module is interfaced with Arduino UNO. A GPS receiver is a navigation device, which could be able to receive information from GPS satellite and it starts to estimate the geographical location of the device.

Fig.7:GPS module

2.7. GSM Module:

In real time, all the data obtained by the sensors are viewed in the mobile phone or PC through GSM modem. The GSM modem is a mobile communication modem which accepts a Subscriber Identity Module (SIM) card. This modem is an external device connected via USB cable or a serial cable. The GSM modem is connected to the microcontroller through Max-232(level converter). Now all the datas collected are available in the cloud server and it can accessed by the user or any other government concern at anytime from anywhere through IoT.

3.SIMULATION RESULTS AND DISCUSSION

The simulations are performed using the proteus software and Arduino IDE. The designed sensor module consists of DTH-11, rain sensor, MQ-131 (O_3,CL2, and NO2), PM2.5/10, MICS-4514 sensors. These sensors are connected to the Arduino controller by analog port. The sensed analog data representing the level of air pollutants are converted into mg/m^3 values and simultaneously these data are sent to the database to be displayed after processed by the microcontroller.

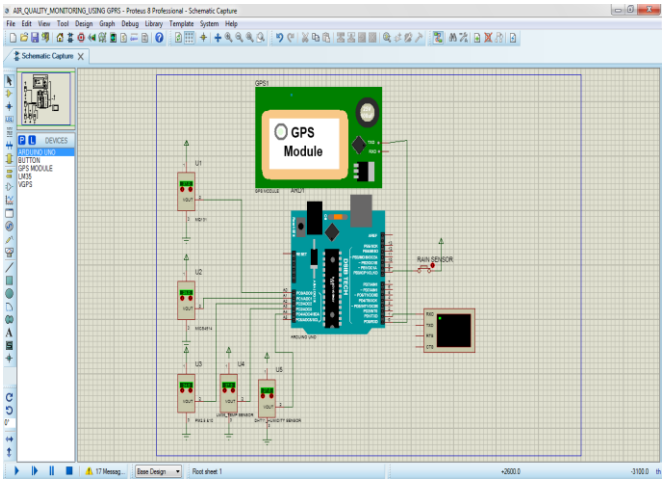

Fig. 8: Connection of sensor modules to Arduino

The GPS module shares the current location of the moving vehicle. By using the GPRS modem, the collected data are logged into the IoT server.

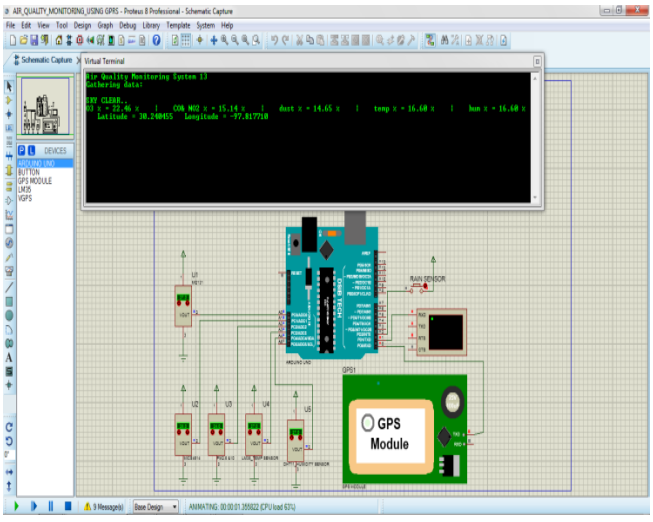

Fig.9: Simulation results of Pollutant parameters

The user can view the air quality parameters of the required area through mobile or PC by internet connection. The air quality parameters include temperature, humidity, dust, CO, NO2, O3 content.

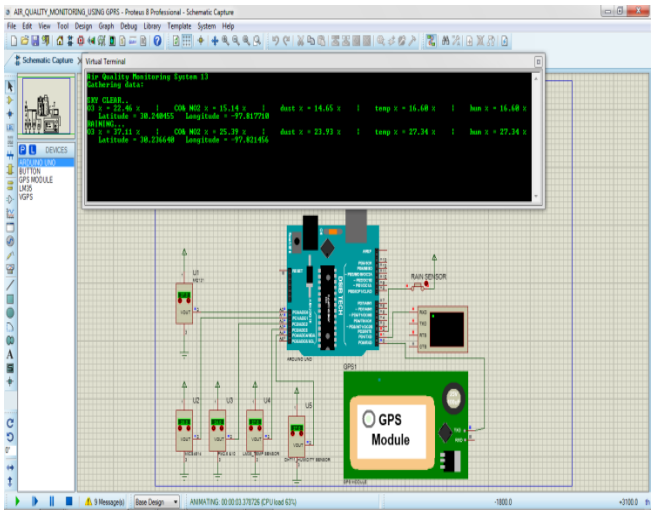

Fig .10: Simulation output for Identification of raining

4. CONCLUSION

In this paper, we have designed the efficient air quality monitoring system using vehicles based on IoT technology. Our system has the ability of monitoring the air pollution of any required area by fitting our module in the moving vehicle. The result gives us more information about the performance and efficiency of the system. The concentration of air pollutants can be monitored by the individual or government concerns for taking necessary actions regarding the pollution and put emphasize regarding in regulations concerning air pollution.

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