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Project Title: AIR POLLUTION LEVEL DETECTOR FOR VEHICLES USING CLOUD GREEN-IOT

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ABSTRACT

Every vehicle has its own emission of gases and some of it emits toxins like **nitrous oxide, benzene** which is the major source of global warming and causes serious health issues and visual disturbances like **heart and respiratory disease, breathing problems, Asthma attacks** etc…

By placing **sensor device(WASPMOTE)** near to the exhaust of the vehicle ,the emission level from the vehicle is continuously monitored.

If pollution level is recorded beyond the standard level from the government, then the necessary steps will be taken by the administrator.

INTRODUCTION

Pollution is now a common place term that our ears are attuned to. In the beginning of 21st century it was the time when importance for Environmental awareness was instigated. Air is the mixture of gases that fills the atmosphere, giving life to the plants and animals that make Earth such a vibrant place. One of the major concerns regarding the environment is air pollution. Air pollution occurs when any harmful gases, dust, smoke enters the atmosphere and makes it difficult for animals and plants to survive as the air becomes dirty. We hear about the various forms of pollution.

Air pollution is one such form that refers to the contamination of the air. Air pollution is defined as the presence in the atmosphere of one or more contaminants in such quality and for such duration as is injurious, or tends to be injurious, to human or welfare of animals or for plants life. As the usage of vehicles is more in these days, the air pollution is increasing drastically. There are several reasons for air pollution. They are the release of burnt fuel byproducts into atmosphere and lack of vehicle maintenance. The largest source for air pollution includes power generation, motor vehicle and industry.

Emission of carbon monoxide(co), nitrogen oxides (NOx) and hydrocarbons are controlled by catalytic converters on gasoline driven cars. For vehicular emissions, the list of compounds is long and variable depending on fuel type, type of engine and operating conditions. Exposure to higher concentration to these pollutants harms lungs and increase respiratory infections. It may trigger asthma by damaging or irritating and sensitizing the lungs. At higher concentrations, it can result in acute bronchitis or death.

LITERATURE SURVEY

- In paper 1[7], the authors find the pollutants using **INTERNET OF THINGS**. Sensors used were **UVI-01** for ultraviolet radiation, **BMPO85** for pressure and temperature sensor, LDR , TGS 2600 for general air quality .The proposed system monitors all types of gases and sent the data to cloud and action will be taken based on the result.
- In paper 2[5], the author mainly focus on measuring air pollution caused by the vehicles on city roads using **IOT**. The air quality that is measured is reported to the respective agencies and owner of the vehicle. The proposed system implements lowcost sensors and give a good results in controlling the air pollution.
- In paper 3[9], the author uses sensor namely **MQ135, MQ4, MQ9 to transmit data to cloud through IOT.** The proposed system uses **WASPMOTE sensor** which is a open source and it also have the capacity to recharge. It can take tests in real time.
- In paper 4[10], the author uses sensor with WIFI modules. The proposed system measures the level of gases by sensor and send the data to cloud by 4G mobile network. And it is implemented by using python scripts. Sensors like MQ2 for Carbon Monoxide and MQ135 for nitrogen dioxide is used.
- In paper 5[1], the authors chooses a specific area (Agra) and make a extensive study about NAAQS standards, USEPA standards, EUPAQ standards, WHO standards on Air pollution monitoring.

Table 1.0: Exceeded air pollution level to that of standard level

Year	Pollutant	Days exceeded I-Grade	Over standard rate/ %	Days exceeded II-Grade	Over standard rate/ %
2014	$PM_{2.5}$	251	68.77	95	26.03
	PM_{10}	347	95.07	160	43.84
	SO_2	49	13.42	-	0
	NO_2	41	11.23	41	11.23
2015	$PM_{2.5}$	228	62.47	99	27.12
	PM_{10}	333	91.23	104	28.49
	SO_2	10	2.74	-	0
	NO_2	45	12.33	45	12.33
2016	$PM_{2.5}$	173	47.40	114	31.23
	PM_{10}	306	83.84	85	23.29
	SO_2	4	1.09	-	0
	NO_2	51	13.97	51	13.97

EXISTING SYSTEM

In Existing system the vehicle will automatically be stopped, since the fuel supplyhas been paused which might be dangerous incase if that person meet with an accident. And also it have limitations like, if the sensor are kept in the exhaust of the vehicle, there might be a chances of it **getting melt because of the heat sensation.** It detects only **carbon monoxide** using the gas sensor which is major disadvantage.

PROPOSED SYSTEM

In proposed system CO, NO, NO2, N2O, SO2 are detected from the exhaust of the vehicle by placing the **waspmote sensor device** near to the exhaust of the vehicle and the data from the sensor is then reported to the **Green-IOT cloud via the mobile network.** Stationary sensor will be placed in one part of the city and it will be connected to the Green-IOT cloud via **sensor gateway through IPv6 protocol.** In Green cloud data comparison will happen between emission level and the standard level.

Green-IOT cloud is used for **data storage, processing and visualization.** If the emitting level exceeds the standard level then it will alert the user by sending the notification message. The pollution control board will also get alerted and GPS is enabled to get the position of the vehicle. Also a fine amount will be imposed to the owner of the vehicle if he exceeds this more than three times. If this repeats, finally the vehicle will be seized. The proposed also have certain advantages like **Accuracy, cost-effective, Interoperability and cooperation.**

TOOLS REQUIRED

HARDWARE:

- Waspmote sensor (Plug & Sense),
- Stationary sensor,
- GPS/GSM,
- The Proposed systems use selected sensors made by Figaro:
- **TGS2442**- Carbon Monoxide sensor(CO), Response time: tens of seconds
- **TGS2106**- Nitrogen dioxide sensor(NO2), Response time: several seconds
- **FECS43-20**- Sulfur Dioxide sensor(SO2), Response time: <25 seconds
- Power supply,
- Analog to Digital converter,
- Microcontroller,
- Amplifiers and R/U converters,

SOFTWARE:

- Waspmote API
- Waspmote IDE
- **Long range**: 4G/NB-IOT/LoRaWAN/Sigfox/868 MHz/900 MHz
- **Medium range**: ZigBee 3/ 802.15.4/ DigiMesh/WiFi
- **Short range**: RFID-NFC/Bluetooth 2.1/BLE
- Over the Air programming (OTA)
- **Encryption libraries**: (AES, RSA, MD5, SHA Hash Algorithm)
- Industrial protocols: RS-485, Modbus, CAN bus, 4-20 mA
- Green-Cloud software
- IPV6 protocol
- Sensor Gateway
- Application Programming Interface(**API**)
- Message Queuing Telemetry Transport (**MQTT**) broker

SYSTEM DESIGN

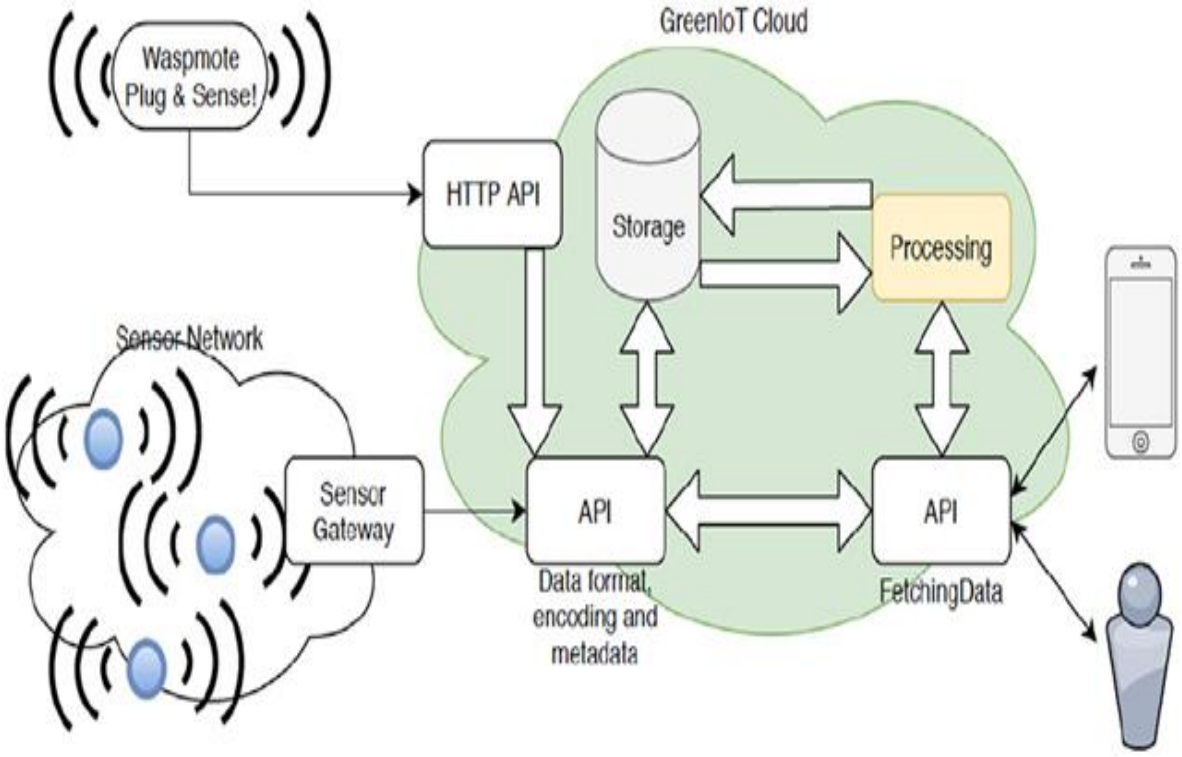

Figure 1.0: Green-IOT cloud system design

METHODOLOGY

The proposed work is to identify a set of bus routes that can provide good coverage of the town and pass through the highly polluted areas that require attentions. Route planning is studied in this work to select bus routes that can acquire measurements from the important locations and to deploy the sensor on a public vehicle and evaluate the capability of a moving sensor in comparison with that of a stationary sensor. The sensor program developed must be robust enough for long periods of operation without maintenance. The further idea is to evaluate sensor performance and data quality.

The evaluation of sensor performance is based on data collected by the sensors deployed on public vehicles over a period. Data quality is evaluated by comparing the measurements with those from other sensors deployed in the city. Data from the sensors is then reported to the GREEN-IOT cloud via the mobile network through the HTTP interface. Data analysis is performed based on a variety of techniques to process data, which are implemented by Python scripts. GPS is mainly used to find location of the vehicle and GSM is used to send message to the service center.

The microcontroller plays a vital role in this embedded system. The remaining modules are controlled by the micro controller. It takes input from smoke sensor output and based on smoke sensor output; microcontroller controls the remaining modules. The microcontroller is used to perform the following functions, compare emission values with standard values prescribed by the government. GPS is used to find location of vehicle and display in terms of longitude and latitude. GSM module is activated by microcontroller to send GPS values to service center through text message. Visualization of the sensor data is implemented via web programming on Google Maps to show the location and information of the measurements for public awareness.

IMPLEMENTATION

The Project has three modules as follows:

- SENSING Module
- MEASURING Module
- MONITORING AND PROCESSING Module

SENSING MODULE:

Figure 1.1: Waspmote plug & sense

WASPMOTE SENSOR:

Waspmote is a sensor device to develop internet of things (**IOT**) projects. **Waspmote hardware architecture** has been specially designed to work with extremely lowpower consumption. It is a open source wireless sensor platform specially designed for low power consumption. **Waspmote** can obtain information from more than 70 sensors currently integrated in the platform by using specific sensor boards and information can be read from any industrial device connected to the vehicles.The **AES algorithm** is implemented. It also uses technologies like Ultra low power (7µA),120+ sensors integrated on 8 Sensor Boards15 radio technologies.

The following data has been extracted from EH40 and OSHA for some common toxic gases:

Table 1.1 : Gases emission level (in ppm)

SUBSTANCE	CHEMICAL FORMULA	LTE(8hr TWA)PPM	STEL(15 min TWA)PPM	LTEL(8hr TWA)PPM
Carbon Dioxide	CO2	5000	15000	5000
Carbon Monoxide	CO	100	100	50
Nitrous Oxide	N2O	-	-	-
Nitric Oxide	NO	-	-	25
Nitrogen Dioxide	NO2	1	1	5
Sulphur Dioxide	SO2	1	1	5

Prototypes of monitoring units for proposed systems use selected sensors made by Figaro:

TGS2442- CO sensor, Response time: tens of seconds

TGS2106- No2 sensor, Response time: several seconds

FECS43-20- Sulfur Dioxide sensor, Response time: <25 seconds

MEASURING MODULE:

A pipe or an enclosed space with several openings for taking gases in and out of a engine. Calculation of a gas concentration is made by server using nonlinear equations derived during calibration procedure. Data transmission uses GPRS/EDGE radio link and TCP/IP protocol stack. To avoidwriting special software at a server side, data records are encoded as special HTTP request.

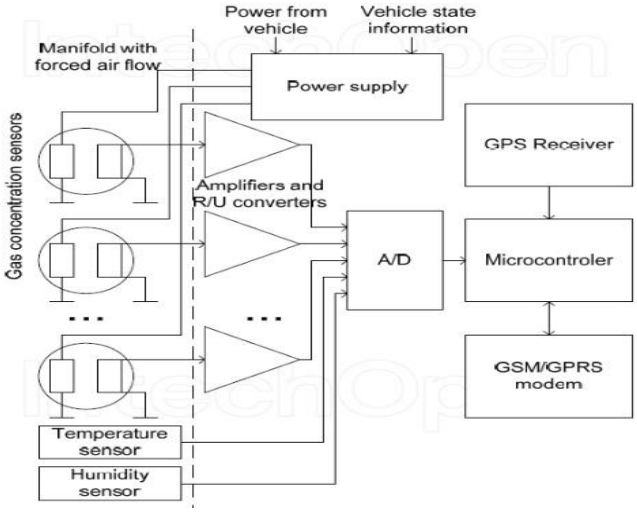

Figure 1.2 : Monitoring unit for sensor

MONITORING MODULE:

Stationary sensors are connected to a sensor gateway via a low energy consumption network protocol called IPv6 over Low-power Wireless Personal Area Networks. The sensor gateway relays sensor data to the GreenIot cloud in Sensor Markup Language (SenML)format via WIFI connection. In the cloud, the data is stored in NoSQl database and published to a MQTT (Message Queuing Telemetry Transport) Broker. The data is stored into MongoDB

Data sent from the measuring unit are sent to server in every packet are monitoring unit identification number

- Geographical coordinates of measurement point (from GPS receiver);
- speed and direction of movement (from GPS receiver);
- temperature and humidity of air in manifold;
- state of vehicle engine in case of mounting the device on car/bus;
- error flags which indicate condition of monitoring unit

SENSOR PROGRAM:

The sensor code must be reliable, efficient and robust without requiring frequent maintenance and checkups. The efficient code was developed by using some reliable example codes provided by **waspmote IDE** and it is implemented by adding more advanced functions. The **waspmote IDE** involves two functions: **setup & loop.**

The **setup function** executes only after the switching on the power or restarting the sensor. And it can be used only once. It formats the SD card, initializes the Real Time Clock(RTC) ans sets nodeID for the sensor. The RTC is used to send the difference between sensor starting time and the time of measurement. The nodeID is used as an identification name for sensor when sending measurements to the Green-IOT cloud.

The **loop function** is executed after the setup function is initiated and keep on executing as a loop till the power of the sensor is turned off. In the loop function the CO and the NO2 function are turned on first, for warm up and the rest of the sensors are shutdown by setting the sensor in sleep mode. RTC is used to wake the sensor after every 2 minutes.

In waspmote plug and sense, GPS module is included in the 4G module. Thus the 4G module is turned on to fetch the GPS coordinates. After receiving the GPS coordinates, the sensor stores the data in PHP request string and tries to send the data to **Green-IOT cloud**. If the 4G connection fails it will be sent in a text format.

RESULTS

Expected Outcome:

1. Complete design if the device and fully tested and deployed measuring device on moving vehicle to measure the concentrates of air pollutant gases like C6H6, COx, NOx, SO2.
2. A complete documentation of the project
3. Publication and patent applying for the project.
4. The developed product could be implemented in densely populated traffic.

SOCIAL IMPORTANCE:

To reduce air pollution through active monitoring, traffic management, better city planning and pubic awareness. The prototype developed will be patented and the technology will be transferred to the industry for large scale manufacturing and distributed to the needy through government.

CONCLUSION

Thus the system can be used to monitor and detect the air pollution caused by the vehicles by placing the sensor device on top of the vehicle and the monitoring process plays a vital role and used to reduce the pollution of air caused by vehicles with low cost. This work has a part of Green-IOT implemented that also included other stationary sensor in a city. Over The Air Programming (OTAP) could be invested and implemented. And also implementing **Green-IOT cloud** have certain advantages like Energy source, Energy efficiency, Number and size of servers, Number and size of requests. It also have the capacity of recycling of data. Future may include further development of sensor program and analysis of sensor data quality.

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