Internet of Things Based Air Pollution Monitoring System

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Abstract - *The biggest challenge of every country is air environmental deterioration. Health problems have increased rapidly mostly in urban areas, where the major pollution is due to the industrialization and growing number of transportation vehicles, which leads to increase in polluting agents like Sulphur and nitrogen compounds. The aim of the project is to make an IoT based air pollution monitoring system, which will measure the air pollution level and send it to the web server and trigger an alarm when the air pollution levels go beyond the safe threshold." The Internet of things (IoT) is an extension of Internet connectivity into physical devices and everyday objects. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled". Initially the hardware was assembled and then the microcontroller was programmed using an Arduino. The main idea is to alert the people when they are entering any area, which has high content of toxic gases or particulate matter so that person can take necessary actions to protect themselves. The hardware has sensors for the detection of PM (particulate matter) 2.5 level in air and also for the detection of other harmful gases such as carbon monoxide, carbon dioxide, oxides of nitrogen, etc. The output of the project would be a portable device, which can be installed at any location to capture air pollution level.*

***Key Words*: Microcontroller, IoT, Arduino, Environment, Air Pollution, UART, GSM**

1.INTRODUCTION

"The Internet of things (IoT) is the extension of Internet connectivity into physical devices and everyday objects. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled" [1]. Generally, MQ135 sensor is used for monitoring air quality as it detects most toxic gases and can measure their amount precisely. Additional hardware includes a PM 2.5 sensor, which can give the level of PM 2.5 particles in the air. The PM 2.5 sensor and the GSM (Global System for Mobile Communications) module are both connected to the microcontroller using UART (Universal asynchronous receiver-transmitter) protocol. This project aims to develop a device that can monitor the environmental air deterioration level and users can see the air quality level in any portable device such as mobile phone via a web server. This device can be easily used and installed, apart from this a user alert feature is also there. It will show the air quality in PPM on the LCD and also on webpage so that air environmental deterioration level can be monitored easily.

1.1 MOTIVATION

Effects of environmental deterioration include mild allergic reactions such as suffocation or irritation of the throat, eyes and nose as well as some serious life-threatening problems such as pneumonia, lung bronchitis heart diseases, and aggravated asthma. According to a study, due to air environmental deterioration 55,000 to 110,000 premature deaths per year occur in the United States alone. In Europe, this figure reaches to 350,000 and over 3,500,000 across the globe. Every day, we listen to the news where millions of people die due to cancer, which is supposed to be a direct consequence of air pollution. If we want to survive in long run then we have to control this, and in order to control we must initially know about it. People need to be made aware about quality of air, which surrounds them at every moment.

2. LITERATURE SURVEY

The increase of manufacturing industries and the use of vehicles and in cities results in increase of emission load of various toxins into air. As a result, increase in environmental problems which will affect the human health in urban places. The IoT concept was put forth in 1999 by a member of the Radio Frequency Identification (RFID) development community. The increasing growth of the mobile devices and development in the area of communication, cloud computing, embedded systems have made the IoT concept more relevant. In [2] it is stated that IoT is a converging technology to create the smart environment and the integrated ecosystem. The shortcomings of the traditional instruments which are used to monitor air quality are their heavy weight, large size, and extraordinary expensiveness [3].

The programming approach that we have used is the Arduino IDE, which utilizes the C programming language. This gives you access to an enormous Arduino Library that is constantly growing thanks to open-source community.

3. UART PROTOCOL

In UART communication, two UARTs communicate directly with each other. The transmitting UART converts parallel data from a controlling device like a CPU into serial form, transmits it in serial to the receiving UART, which then

converts the serial data back into parallel data for the receiving device. Only two wires are needed to transmit data between two UARTs. Data flows from the Tx pin of the transmitting UART to the Rx pin of the receiving UART. UARTs transmit data asynchronously, which means there is no clock signal to synchronize the output of bits from the transmitting UART to the sampling of bits by the receiving UART. Instead of a clock signal, the transmitting UART adds start and stop bits to the data packet being transferred. These bits define the beginning and end of the data packet so the receiving UART knows when to start reading the bits. When the receiving UART detects a start bit, it starts to read the incoming bits at a specific frequency known as the baud rate. Baud rate is a measure of the speed of data transfer, expressed in bits per second (bps). Both UARTs must operate at about the same baud rate. The baud rate between the transmitting and receiving UARTs can only differ by about 10 percent before the timing of bits gets too far off.

Table -1: Configuration of PM 2.5 Sensor (uses UART Protocol)

Wires Used	2
Maximum Speed	Any speed upto baud 115200
Synchronous or asynchronous	Asynchronous
Serial or Parallel	Serial
Max of Masters	1
Max of slaves	1

4. SYSTEM ARCHITECTURE

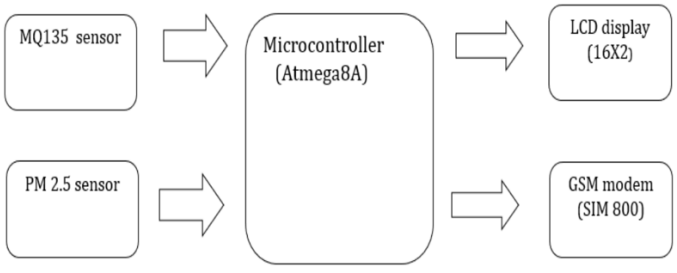

Fig -1: Hardware representation of IoT based air pollution monitoring device

The system architecture of the device consists of the following essential blocks:

1. MQ135 Gas Sensor
2. PM 2.5 Sensor
3. Microcontroller (Atmega8A)
4. LCD Display (16x2)
5. GSM modem (SIM 800)

5. CIRCUIT DIAGRAM

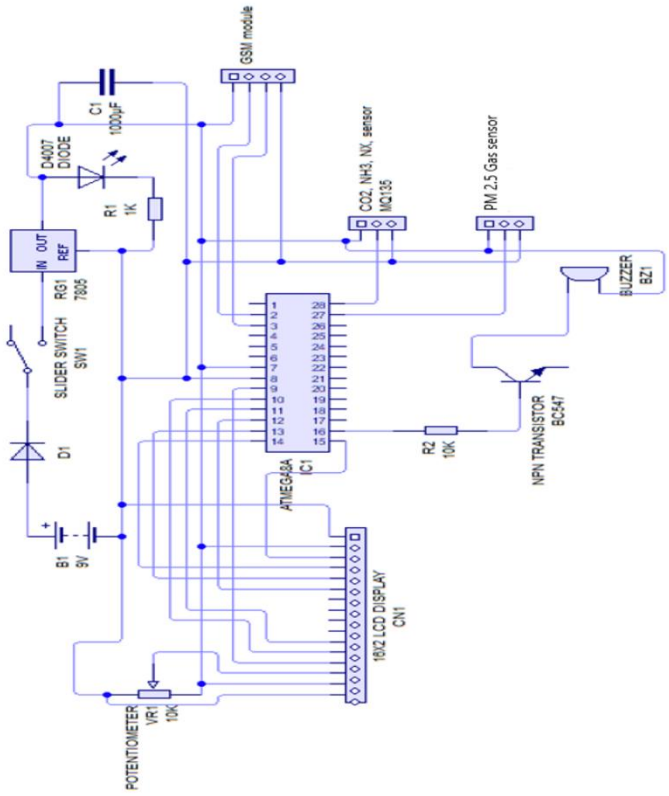

Fig -2: Circuit Diagram of IoT based air pollution monitoring device

6. METHODOLOGY

All the above-mentioned hardware components are connected with microcontroller. The sensors give the analog value as input to the microcontroller which converts it to the corresponding digital output value using programming and will display it on the LCD. The power adapter provides the potential difference of 9V and the required potential drop is 5V for proper working of the components, hence a voltage regulator is used to provide the required drop. GSM module requires 4V of potential drop, hence a separate potential regulator have been used for it. The PM 2.5 sensor works on UART interface and is connected to the microcontroller. The value will be transmitted using the GSM module and the alarm will be triggered and a message will be sent when the value crosses a certain threshold. The GSM module is connected to the microcontroller using UART interface and by default there is only one set of pins which are configured as UART in the microcontroller, hence there was a need to explicitly make another set of UART pins in the microcontroller, which was achieved with the help of programming. Additionally, the capacitors and resistors are used to give the required current output to the sensors. Also, the appropriate baud rate for the sensors and microcontroller used is 9600, hence the GSM module is configured at the baud rate of 9600.

7. RESULTS

After completing of the assembling of hardware and implementation of the coding the system was linked to the web server and system testing was done at different times and locations to monitor air pollution levels.

8. CONCLUSIONS

In this project an IoT based air pollution monitoring system was implemented using the presence of harmful gases and particulate matter in the air as parameters. In this we tried to implement a device which can sense the not only the presence of harmful gases and particulate matter but also alert the user when it reaches threshold. The contribution of the project is as follows:

1. The proposed device is having multiple sensors that too for different types of pollutants present in the air which makes it an overall broad-spectrum device as compared to the devices made earlier.
2. The real time data of the number of pollutants present in the air can be measured.
3. We get notified when the level of pollutants crosses the threshold level and the user gets a message alert.

9. FUTURE SCOPE

This section tells us about the various aspects of the project, which when addressed can make this project very helpful to the society and humanity.

1. This device can be very helpful when it is linked to the air purifier, as the working of the purifier i.e., when it has to stop – when it has to start, what type of gas has to be treated etc., can all be made dynamic and much more effective.
2. This device can be easily scaled to operate on a large scale.
3. Multiple such devices can be built and can be fixed at different places and can be linked with each other, which will make it more efficient, increase its spectrum and make it more reliable in case of individual device failure.

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