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IOT based environmental pollution monitoring system

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Abstract - *An extremely growth in an industrial and infrastructural frameworks creating environmental affairs like atmospheric changes, malfunctioning and pollution. Pollution is becoming serious issue so there is need to build such a flourishing system which overcomes the problems and monitor the parameters that affecting the environmental pollution. The solution includes the technology* ***Internet of Things (IOT)*** *which is a hook up of computer science and electronics. It can provide means to monitor the quality of environmental parameters like Air, Noise, Temperature, Humidity and light. To monitor pollution levels in industrial environment or particular area of interest, wireless embedded computing system is proposed. The system is using a prototype implementation consists of sensing devices, Arduino uno board, ESP8266 as wi-fi module. These sensing devices are interfacing with wireless embedded computing system to monitor the fluctuations of parameters levels from their normal levels. The aim is to build powerful system to monitor environmental parameters.*

Key Words: **Internet of Things (IOT), Arduino Uno board, wi-fi module ESP8266, MQ-7 gas sensor, M213 noise sensor, LM35 temperature sensor, SY-HS220 humidity sensor, LDR light sensor.**

1. INTRODUCTION

As we know the industrial growth drastically increasing, environmental pollution related issues rapidly comes into existence [1]. To fulfil the need of flourishing monitoring system, in our project we are establishing a network called Internet of Things, in which sensing devices are connected with wireless embedded computing system. Internet of Things is a technology that hook up the sensors with embedded system and allow the data from these sensors to travel over an Internet. We are implementing developing model which is able to monitors the inconstancy of parameter like Air, Noise, Temperature, Humidity and Light.

In the proposed model we use microcontroller ATMEGA328 that is mounted on Arduino Uno board. We are using 5 sensors, MQ-7 as a gas sensor. We are using 5 sensors, MQ-7 as a gas sensor. It detect the concentration of carbon monoxide in air. To measure the fluctuations in noise levels we use M213 high sensitivity microphone sensor module. LM35 is used as a temperature sensor and SY-HS220 as humidity sensor. To measure the intensity of light LDR sensor is used. To transfer the data

Over an Internet we are using flexible wi-fi sensor ESP8266. The data from these sensors is stored in the cloud. After processing, through hotspot web browser will ask about IP address, by putting IP address web page will create that allows us to monitor the system [4]. We can monitor the parameters on smartphones as well as pc or laptop.

1.1 History of IOT Based Monitoring System

IOT is newly developed technology in which the connectivity between physical objects along with controllers, actuators and sensors synchronized over an Internet. IOT able to provide means to monitor the quality of parameters like Air, Noise, Temperature, Humidity and Light [2]. It helps concern authorities to take action against pollution crossing beyond defined level.

Objective of the Project

The main objective of the project is to provide a platform that monitors the parameters and help to create better and pollution free future life.

1.2 Literature Survey of Existing System

In 'Smart Environment Monitoring System by employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities', Mr. Jamil invented ZigBee based wireless sensor networks to monitor physical and environmental conditions [3]. The sensor nodes directly communicated with the moving nodes. Which avoided the use of complex routing algorithm but local Computations are very minimal.

Drawback of existing system

- Required more time and space to operate
- Complicated designing
- Maintenance is difficult

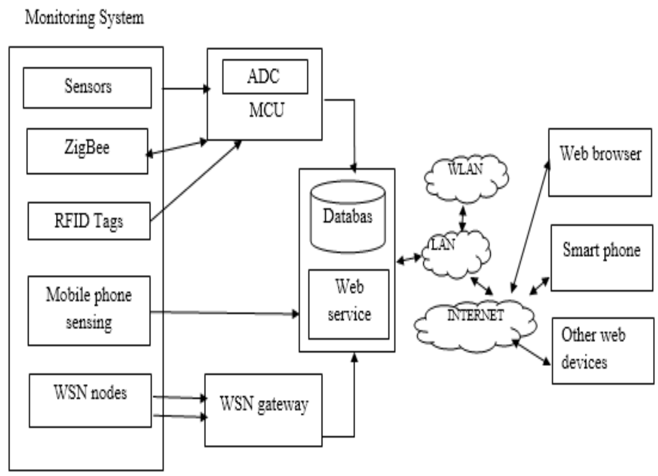

Fig -1: Model of Existing System

Problem Statement

Due to miscellaneous interactions, limited protocol standardization, security of data storage and complex identification systems to access data, problems arises in field of monitoring hence to overcome these problems we are designing, ' IOT based environmental pollution monitoring system', to gain pollution free future live.

Change to be implemented

- Devices must be easily integrated with IOT platform
- Uniform data format across multiple platforms
- Platform must be expandable and Fine-grained data visibility model

2. PROPOSED SYSTEM SPECIFICATIONS

Proposed system specifications include hardware requirements and software requirements.

2.1 Hardware Requirements

1. Arduino Uno board

Fig -2: Arduino Uno board

Arduino UNO is a microcontroller board based on ATmega328. It has 14 digital input/output pins of which 6 can be used as PWM output, 6 analog inputs. Arduino uno can be programmed with Arduino software Arduino IDE (integrated development environment). The Atmel 8-bitAVRRISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART.

2. ESP8266 W-fi module

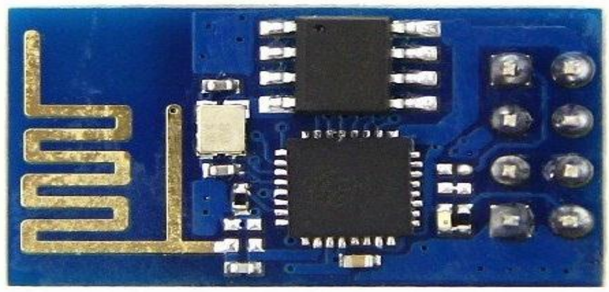

Fig -3: ESP8266 wi-fi module

ESP8266 is an UART to Wi-Fi module, a really cheap and easy way to connect any small microcontroller platform having network connectivity is good for any computing system. And add to a system utility we can fetch any data from www. We can push data to cloud for storage, computation or monitoring. We need an external hardware that convert wi-fi data into data format that understood by common microcontroller like UAT, SPI, and I2C

3. MQ-7 Gas Sensor

Fig -4: MQ-7 Gas Sensor

This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing CO concentrations in the air. The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm. This sensor has a high sensitivity having heating time 60 seconds. The sensor's output is an analog resistance. The drive circuit is very simple operating at 5V. Operates at temperature- -20°C-50°C.

4. M213 Noise Sensor

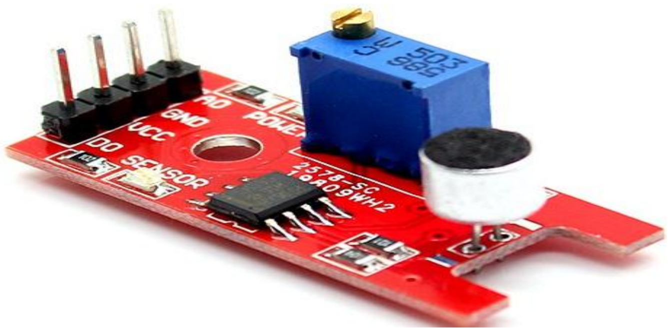

Fig -5: M213 Noise Sensor

The sound sensor module detects sound and its intensity. It uses a microphone which supplies the input to an amplifier, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage to a microcontroller. Normal voice sound level-19 to 60 dB. Operating at 3.3V-5V.

5. LM35 Temperature Sensor

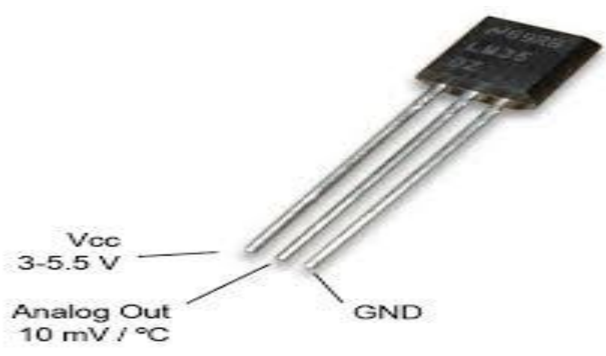

Fig -6: LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It operates at 4Vto 30V. It has low impedance 0.1W for 1mA Load. It has Linear + 10.0 mV/°C scale factor.

6. SY-HS220 Humidity Sensor

This sensor module converts relative humidity (30-90%RH) to voltage and can be used in weather monitoring application. Operates at DC 5V. Output humidity-1.98V (at 25 degree and 65RH).

Fig -7: SY-HS220 Humidity Sensor

7. LDR Light Sensor

LDR sensor module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labeled as AO and DO respectively on the board. When there is light, the resistance of LDR will become low according to the intensity of light. The greater the intensity of light, the lower the resistance of LDR [5]. The sensor has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards light. LDR's are less sensitive than photo diodes. It operates at DC 3.3V to 5V.

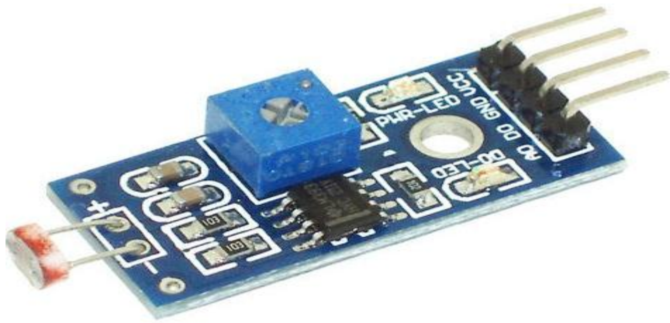

Fig -8: LDR Light Sensor

2.2 Software Requirements

The microcontrollers are typically programmed using a features from the programming languages C and C++. To install the Arduino software on windows following steps are useful [5].

Step 1- Download the Arduino software from google.

Step 2- Install the software. Plug in your board and wait for Windows to begin its driver installation process.

Step 3- Open the control panel and open the system device manager.

Step 4- Connect Arduino Uno board to system through USB cable. After connecting select board and COM port in Arduino IDE.

Step 5- Develop an Arduino Code for sensors to cloud system in Arduino IDE, compile and upload the code in Arduino Uno board.

Fig -9: Arduino Software

3. PROPOSED SYSTEM DESIGN

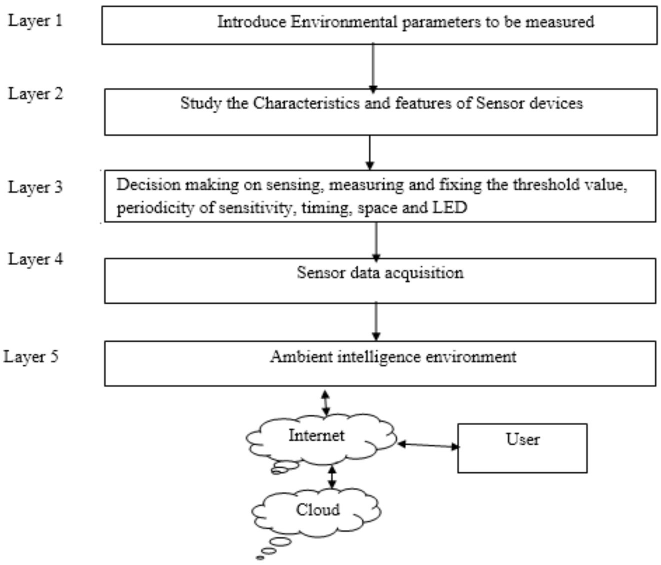

Fig -10: Model for Proposed System

From the above model, process is divided in 5 layers. The environmental parameters which are to be measured are introduced in layer 1. Study of the characteristics and features of sensor devices is in layer 2. In layer 3, there is decision making on sensing, measuring and fixing the threshold value, periodicity of sensitivity, timing, space and LED. Sensor data acquisition is done in layer 4. And layer 5 as ambient intelligence environment. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates it to the Internet through Wi-Fi module connected to it. User can monitor the parameters on their smartphones as well as pc or laptop.

3.1 Block Diagram

Transmitter Section

In the transmitter section, to monitor the parameters, we mount 5 sensors like MQ-7, M213, LM35, SY-HS220 and LDR to sense these parameters. The data from these sensors integrated with microcontroller ATMEGA328 which is mounted on Arduino Uno board operates at 5V. To allow the data to travel over an Internet we are connecting flexible wi-fi module ESP8266. It works at 3.3V.

Receiver Section

In the receiver section, hotspot is to be activated on user's smartphone or pc to access web browser. An IP address is to be entered in web browser to access related web page which will show the monitoring results on user's smartphone screen.

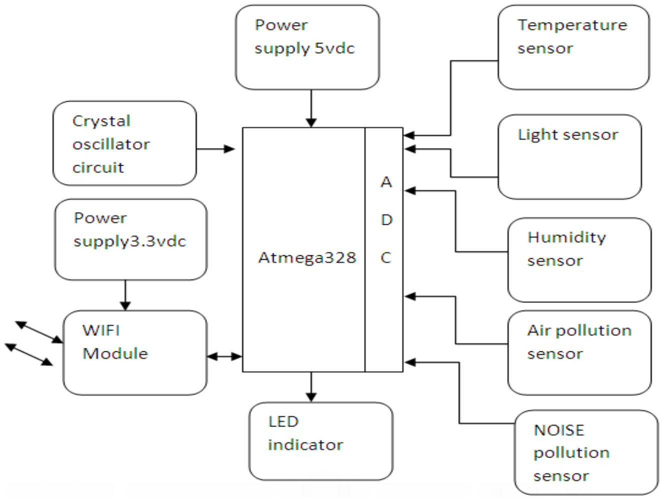

Fig -11: Block Diagram for proposed System

3.2 Flow of the System

After starting the system, we have to connect all the sensors to the microcontroller so that sensors get interfaced with microcontroller. Then process the data using microcontroller and embedded 'c' in Arduino uno. Send AT commands to wi-fi module 8266. Microcontroller starts processing data over an Internet. After processing, the embedded 'c' is uploaded in Arduino.

Using hotspot, user can access internet browser on their smartphones or laptops. Web browser needs specific IP address. By putting IP address on browser, web page is displayed. Web page shows the monitoring results of the respected parameters.

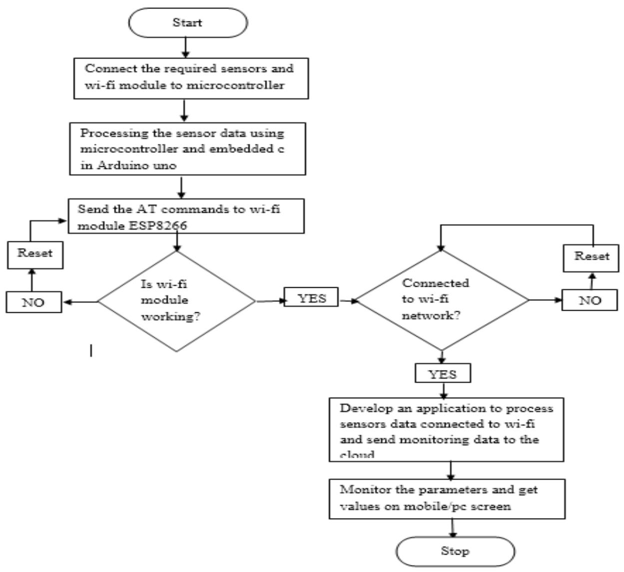

Fig -12: Flow Chart of the Proposed System

4. COMPUTATIONAL ANALYSIS

1. MQ-7 Gas Sensor

The concentration level of carbon monoxide present in environment is measured in units 'parts per million (ppm)' and %. The conversion is shown below.

Table-1: Carbon Monoxide source concentration

Level of Carbon Monoxide	Source
0.1 ppm	Natural atmosphere level
0.5 to 5 ppm	Average level in homes
5 to 15 ppm	Near properly adjusted gas stove in homes
100 to 200 ppm	Exhaust from automobiles in the city
5000 ppm	Exhaust from a home wood fire

Conversion factors -

1 ppm = 1.145 mg/m3

1 mg/m3 = 0.873 ppm

1% = 1/100

1ppm = 1/1000000

1ppm = 0.0001%

Table-2: Conversion from ppm to percentage

ppm	Percent (%)
0 ppm	0%
5 ppm	0.0005%
50 ppm	0.005%
500 ppm	0.05%
1000 ppm	0.1%

2. M213 Noise Sensor

Intensity of sound level is also known as sound pressure level (SPL). It is measured in W/m^2 as well as in decibels (dB). Threshold intensity is the sound level at threshold of hearing. Threshold of hearing is $I_0 = 10^{-12}$ W/m^2. To calculate the intensity level in decibels, find the ratio of the intensity of sound to the threshold intensity. Multiply the logarithm of the ratio by 10. The resulting equation is,

$$\beta = 10\log (I/ I_0)$$

Conversion factor -

Suppose the intensity of noise is 10^{-7} W/m^2 then to convert it in dB as follows,

$$10^{-7}\, W/m^2 / 10^{-12}\, W/m^2 = 10^5$$

$$\mathrm{Log}10^5 = 5$$

Multiply the ratio by 10 i.e. 50 dB. Now in reverse manner, to calculate noise intensity from decibel level. Suppose 100 dB,

Divide the decibel level by 10 i.e. 100/10= 10

Use that value as the exponent of the ratio= 10^{10}

$$I / 10^{-12}\, W/m^2 = 10^{10}$$

We get result, intensity I= 10^{-2} W/m^2

Table-3: Standard for Noise values

Night (10pm-7am) Unit in decibels	Day (7am-10pm) Unit in decibels	Type of region
45	55	Residential
40	60	Residential-commercial

55	65	Commercial
60	70	Residential-Industrial
65	75	Industrial

3. LM35 Temperature Sensor

The LM35 temperature sensor provides an output of 10mV per degree Celsius, with an accuracy of 0.5°C at25°C. It can be powered by any DC voltage in the range 4V-30V. The operating range is –55°C to +150°c.

Table-4: Conversion of Output in mV per degree Celsius

Temperature in °c	Output voltage in mV
5	50
10	100
20	200
50	500
100	10000

Suppose at 20°C,

We will get 20 x 0.01 = 200 mV, or 0.2 volts.

4. SY-HS220 Humidity Sensor

Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100%

If actual vapor density =10 g/m^3, at 20°C. Saturation vapor density =17.3 g/m^3, then the relative humidity is,

RH= (10 g/m^3/17.3 g/m^3) x 100% =57.8%

Put the sensor in water we get its maximum raw ADC value, suppose we use 10bit ADC then raw ADC value is in the range 0 to 1023.

If we get raw ADC value 1023 for RH 90 i.e., 2970 mV

then 1023 = 90

1023 * x = 90

x = 0.0879765395894428

%RH = (raw ADC value * 0.0879765395894428)

e.g. - if raw ADC value = 920 then 920 * 0.0879765395894428 = 80.93841642228739 % RH

Table -5: Relative Humidity in % per °c

Temperature in °c	Relative Humidity in %
+40°	45%
+30°	40%
+20°	35%
+10°	30%
+0°	25%
-10°	20%

5. LDR Light Sensor

Lumens is the total amount of light output from a light emitter. Lux is the amount of light cast on a given area. The beam angle is the angle of radiation for a light source. A change in the beam angle affects the luminous intensity (lux) of a light source but not the luminous flux (Lumens).

Lux = lumens/ m^2

I = L Cu LLF / A

Where,

I = illumination (lux, lumen/m2)
L = lumens per lamp (lumen)
Cu = coefficient of utilization
LLF = light loss factor
A= area per lamp (m2)

10 incandescent lamps of 500 W (10600 lumens per lamp) are used in an area of 50 m2. With Cu =0.6, LLF = 0.8

I = 10 (10600 lumens) (0.6) (0.8) / (50 m2)

= 1018 lux

Table -6: Various light levels

Activity	Illumination (lux, lumen/m^2)
Public areas with dark surroundings	20 – 50
Simple orientation for short visits	50 – 100
Warehouses, Homes, Theaters, Archives	100 – 150
Easy Office Work, Classes	250
PC Work, Study Library, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops	750

5. IMPLEMENTATION

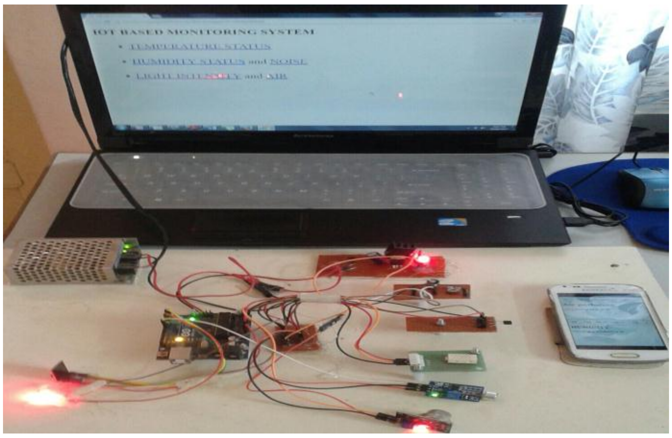

Fig -13: Implementation view

From the implementation analysis, we can able to build flourishing system that monitors the pollution causing parameters and make reliable and pollution free environment. This project is done keeping in mind the small scale industries and hence it is affordable. Sensing systems in the environment itself will considerably raise the degree of environmental protection.

6. RESULT

Result will display on user's smartphone screen or pc.

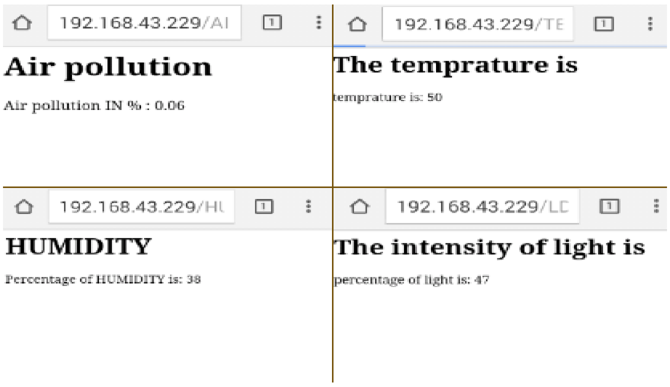

Fig -14: Monitoring Screen Display

7. CONCLUSION

The proposed system which is designed shows the simulation output of sensing the carbon dioxide gas in air, humidity, noise pollution and temperature pollution in Environment. The sensor output is pushed to cloud and can be viewed through internet. This is a flourishing system which is very useful in industries because of the increasing pollution due to increase in industries. This system is user friendly and cost of the product is affordable. The results of the project are accurate and hence can be implemented in any industries for the safety of workers and the environment.

ACKNOWLEDGEMENT

Inspiration and the guidance are valuable in every aspect of life, especially in the field of academics, which we have received from our respected project guide & Head of Department **Prof. G.A Kulkarni,** who has put his careful guidance and we will complete our project work. More word won't sufficient to our gradient to his untiring deviation. He undoubtedly belongs to the members of the artistic gallery who are master in all aspect.

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BIOGRAPHIES

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