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Real Time Monitoring of Air Pollution

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Abstract - *Air pollution is a common issue faced in industries which releases a mixture of various toxic gases and particulates of various sizes. These gases when inhaled causes damage to lung parenchyma and the micro-particles settles in the lung inducing inflammation and damage to lung tissues. This makes an individual prone for occupational lung diseases.*

Industry pollution is a mixture of various gases including carbon monoxide, hydrocarbons, oxides of sulphur and nitrogen. These gases inhaled over period of time compromises the pulmonary functions and causes pulmonary diseases. Periodic assessment of these gas levels in the industry is mandatory to maintain health of the individuals. The instrument devised works based on air sensing technology. The instrument could be installed in the industry working area and the data collected through the instrument will be transferred to virtual data storage (CLOUD). These data could be accessed anywhere through internet connected mobile which could be used by Government agencies, Safety officers and industries to assess air pollution level which acts an alarm and helps in taking adequate protective measures to reduce air pollution level in the environment. As industrial safety is very important for workers, inventing a fast, easily accessible instrument helps in monitoring the air pollution level, which in turn helps to take adequate steps to promote worker's health and productivity of the industry.

Key Words: **Air Pollution, Monitoring, IoT, Access, Sustainable Development**

1. INTRODUCTION

According to a report published earlier this year by the World Health Organization, air pollution now kills approximately seven million people annually, worldwide. This accounts for as much as one in eight deaths, and is by far the single biggest environmental health risk. In order to counteract this alarming statistic and take action to clean up air around the globe, it's important to first understand where the pollution is most concentrated, how it occurs, what elements are involved and how we can neutralize them. In order to do this, comprehensive air monitoring must be undertaken on a national and international scale.

In developing countries, as the technology increases day by day at the same rate pollution is also getting increasing. Because of this problem people who are surviving in the nearby areas and the people who were working in the industries especially which are emitting pollution are affected at a higher rate. So it poses for causing various health problems in humans. At an initial stage it affects the people by causing respiratory problem. Due to Prolonged exposure to pollution it causes damage to the lung parenchyma and it causes inflammation in the lung tissues. Among other pollutants, air monitors assess the amounts of carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3) and particulate matter 2.5 (PM2.5). This project allows us to see where and why pollution occurs, so that we can not only actively avoid overly contaminated areas in our daily routines but also try to implement measures to curb such pollution.

2. PROPOSAL

Nowadays, air pollution is monitored by networks of static measurement stations operated by official authorities. These stations are highly reliable and can accurately measure a wide range of air pollutants using traditional analytic instruments, such as mass spectrometers. However, the extensive cost of acquiring and operating those stations severely limits the number of installations and results in a limited spatial resolution of the published pollution maps. We have done our project in such a way that the acquired data are made centralized so each and every citizen can able to know how much the air is polluted. It can be made possible by using IoT. The data acquired from the hardware component are updated to the cloud which can be made accessible to people by providing our channel ID. Using our channel ID, one can make use of it and get to know the quality of the air. As a result, everyone can access the pollution level and each can take some effort to reduce it as much as he/she can which results in sustainable development.

3. PROCESS IN BRIEF

The system consists of three modules

i. Data Collection

ii. Data Transfer to Cloud

iii. Cloud Computing

Data Collection: Sensors are primarily used for collection of pollutant levels in the atmosphere under various environmental conditions. These data can be acquired through Arduino for further analysis.

Data Transfer to Cloud: The acquired data is transferred to the cloud database via a microcontroller and a Wi-Fi module in order to make it accessible to everyone.

Cloud Computing: It is the practice of using a network of remote servers hosted on the Interne to store, manage, and process data, rather than a local server or a personal computer.

4. HARDWARE CHARACTERISTICS

4.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 as shown in Fig -1. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig -1: Arduino Uno

4.2 MQ2 Sensor

The Grove - Gas Sensor (MQ2) module as shown in Fig -2 is useful for gas leakage detection. It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer. The specifications of MQ2 Sensor is shown in Table -1.

Fig -2: MQ2 Sensor

Item	Paramter	Min	Typical	Max	Unit
V_{cc}	Working Voltage	4.9	5	5.1	V
PH	Heating Consumption	0.5		800	mW
R_L	Load Resistance	Adjustable			
R_H	Heater Resistance	-	33	-	Ω
R_s	Sensing Resistance	3	-	30	KΩ

Table -1: MQ2 Sensor Specifications

This is an Analog output sensor. It needs to be connected to any one Analog socket in Grove Base Shield. The examples used in this tutorial make uses of A_0 analog pin. Connect this module to the A0 port of Base Shield. It is possible to connect the Grove module to Arduino directly by using jumper wires, refer to the connection in Table -2. The output voltage from the Gas sensor increases when the concentration of gas increases. Sensitivity can be adjusted by rotating the potentiometer. Note that the best preheat time for the sensor is above 24 hours.

Arduino	Gas Sensor
5V	V_{cc}
GND	GND
NC	NC
Analog A_0	SIG

Table -2: Arduino to MQ2 Sensor Connection

4.3 MQ7 Sensor

The Gas Sensor (MQ7) module is suitable for detecting CO Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. The MQ7 sensor is shown in Fig -3. The specifications of MQ7 Sensor is shown in Table -3.

Fig -3: MQ7 Sensor

Item	Parameter	Min	Typical	Max	Unit
V_{cc}	Working Voltage	4.9	5	5.1	V
PH	Heating Consumption	0.5	-	340	mW
R_L	Load Resistance	Adjustable			
R_H	Heater Resistance	-	33Ω ± 5%	-	Ω
R_s	Sensing Resistance	2	-	20000	Ω
CO/CH_4/LPG scope	Detecting Concentration	200	-	1000/10000/10000	ppm

Table -3: MQ7 Sensor Specifications

This is an Analog output sensor. This needs to be connected to any one Analog socket in Grove Base Shield. The examples used in this tutorial makes uses of A0 analog pin. Connect this module to the A0 port of Base Shield. It is possible to connect the Grove module to Arduino directly by using jumper wires by using the connection as shown in Table -4.

Arduino	Gas Sensor
5V	V_{cc}
GND	GND
NC	NC
Analog A_0	SIG

Table -4: Arduino to MQ7 Sensor Connection

4.4 ESP 8266 Wi-Fi MODULE

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems. The Wi-Fi Module is shown in Fig -4.

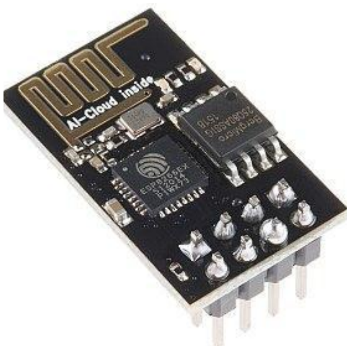

Fig -4: Wi-Fi Module - ESP 8266

The chip first came to the attention of western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted. The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation. The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi. The successor to these microcontroller chips is the ESP32.

5. THINGSPEAK CLOUD PLATFORM

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the TCP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. ThingSpeak was originally launched by ioBridge in 2010 as a service in support of IoT applications. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyze and visualize uploaded data using MATLAB without requiring the purchase of a MATLAB license from Mathworks. ThingSpeak has a close relationship with Mathworks, Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' MATLAB documentation site and even enabling registered Mathworks user accounts as valid login credentials on the ThingSpeak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and Mathworks, Inc. The project's ThingSpeak channel is shown in Fig -5.

CHANNEL NAME: POLLUTION SENSOR VALUES

CHANNEL ID: 438130

ACCESS: PUBLIC

SENSORS NOMINAL RANGE:

MQ-7 (CARBON MONOXIDE) RANGE: 20 to 2000 ppm

NOMINAL VALUE* OF CARBON MONOXIDE: 35 ppm

MQ-2 (PROPANE) RANGE: 300 to 10000 ppm

NOMINAL VALUE* OF PROPANE: 350 ppm

*Nominal Value - Maximum limit of the pollutant that is not harmful for the environment which is fixed by the Pollution Board of India (PBI).

Fig -5: ThingSpeak Cloud Computing

6. FLOW DIAGRAM AND PROTOTYPE

The Flow Diagram and the prototype of the project is shown in Fig -6 and Fig -7 respectively.

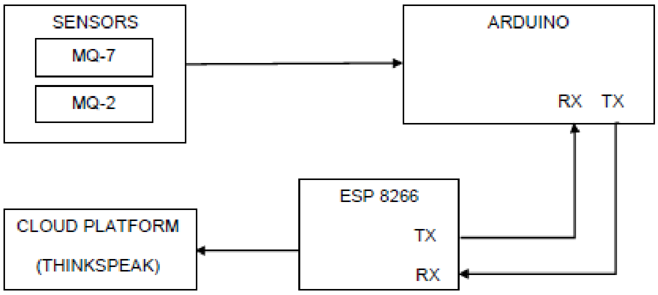

Fig -6: Project Flow Diagram

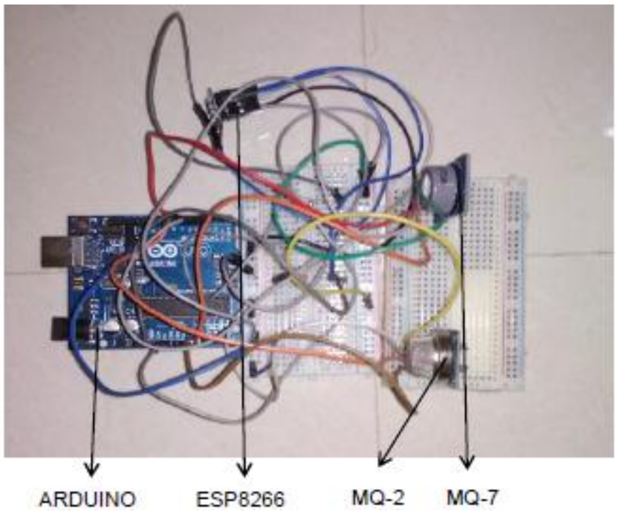

Fig -7: Project Prototype

7. ANALYSIS AND RESULTS

Carbon Monoxide ppm values displayed in the Field 1 chart of the ThingSpeak platform is shown in Chart -1 below.

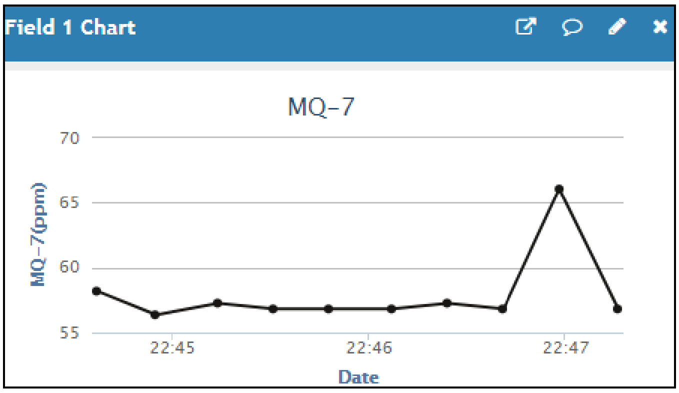

Chart -1: MQ7 Measurements

Propane ppm values displayed in the Field 2 chart of the ThingSpeak platform is shown in Chart -2 below.

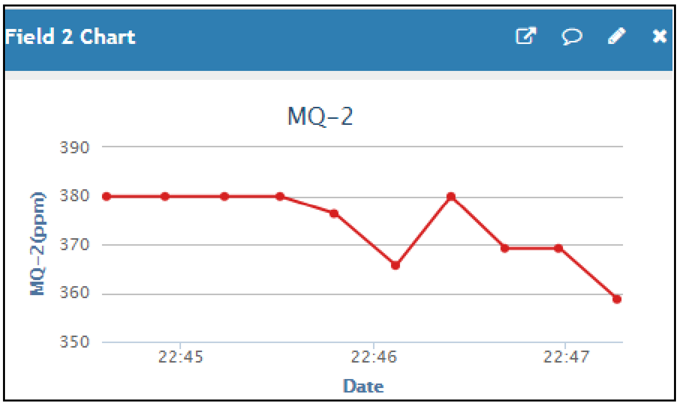

Chart -2: MQ2 Measurements

The data displayed in the ThingSpeak platform can be downloaded offline in the form of *.xml* and *.xls* format and the history of the data uploaded to the cloud can be seen which is shown in Table -5.

OBSERVED AT	ENTRY_ID	FIELD 1(MQ-7)	FIELD 2(MQ-2)
2018-03-15 17:47:14	1	50.03	365.63
2018-03-15 17:47:31	2	76.23	362.14
2018-03-15 17:47:47	3	70.97	348.53
2018-03-15 17:48:05	4	66.59	338.66
2018-03-15 17:48:21	5	65.03	313.68

Table -5: Data History in Cloud

The data displayed in the ThingSpeak platform can be downloaded offline and MATLAB analysis can be done. 2-D line plot analysis of Carbon Monoxide (CO) ppm levels obtained from the cloud platform is displayed in the below in Chart -3.

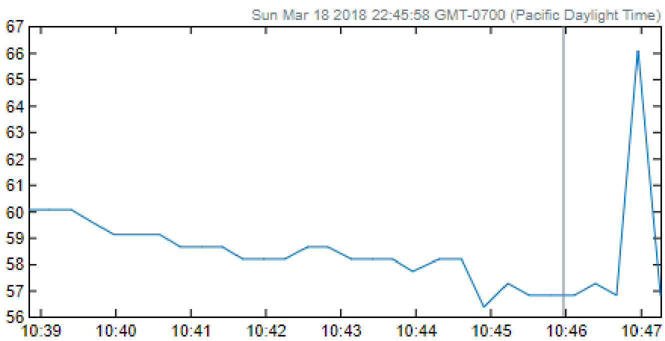

Chart -3: MATLAB Analysis - CO Measurements

2-D line plot analysis of Propane ppm levels obtained from the cloud platform is displayed in the below Chart -4.

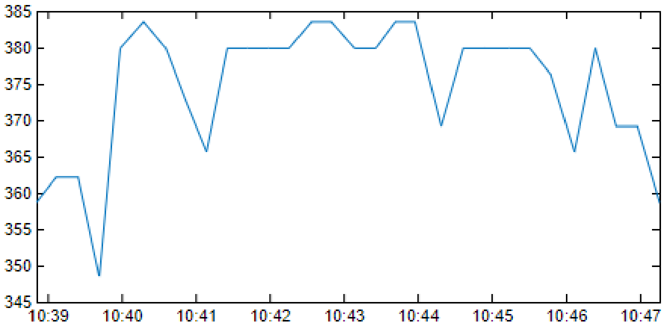

Chart -4: MATLAB Analysis - Propane Measurements

8. CONCLUSIONS

A wireless distributed mobile air pollution monitoring system was designed, implemented and tested using the Wi-Fi network. The system can be placed in the places where we intend to measure the pollution levels of CO and Hydrocarbons. The pollution data from various mobile sensor arrays is transmitted to a central server that make this data available on the Internet through a web channel using the channel ID. The data shows the pollutant levels and their conformance to local air quality standards. It is worth mentioning that much more work is required to commercialize the system.

This project uses small, low-cost and simple hardware to monitor the CO and propane concentrations. Finally, it is proved that it is feasible to use hardware in participatory sensing applications to increase public awareness and for sustainable development. Mobile phones are used in a wide range of application scenarios to facilitate data collection, such as visibility monitoring traffic conditions surveillance, sensing individual emotions, and bicycle localization. In future, it is possible to create an application to access the pollution levels directly on the smartphones using GSM module. The hardware can also be placed in various polluted cities and the pollutants can be monitored continuously and controlled with suitable control systems.

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