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IoT enabled Air Quality Monitoring and Visualization System

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Abstract—Air pollution is one of the major problems that we are facing in our day-to-day life. It affects human health by causing allergies and other lung diseases which may lead to loss of life. The increase in the number of industries and vehicles contributes to air pollution to a greater extend. Fresh air is necessary for all human being and many technologies were employed for real time monitoring of air pollutants. This paper puts a kind of real- time air pollution monitoring system in which the concentration of major pollutant gases like carbon monoxide (CO), carbon dioxide (CO_2) in air are sensed by using commercially available sensors. By employing an Internet of Things (IoT) platform, this system displays the air quality in PPM, on a real time basis, in a webpage which can be monitored easily through our PC or smart phone. In addition to that, the system offers a provision to store previous measured data. This allows the authorities to analyze the air quality of desired area, for a period of time for making valuable conclusions. Also, the system detects air quality and if the amount of pollutants increases beyond a particular level it alerts the stake holders by sending messages. And, due of its compact design, it can be installed almost anywhere for monitoring air quality.

Keywords—*Internet of things, air pollution, sensors, real time monitoring system.*

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I. INTRODUCTION

Air pollution has been a huge concern in these days. It became necessary to monitor air pollution and to keep it well within the limits for a better future and healthy living. Air pollutants cause various health issues. Among this, CO, which is a product of incomplete combustion of fuels, is the major contributor. Vehicular exhaust is a major source of CO. The health threat due to constant exposure to CO is most serious, for those who suffer from cardiovascular disease. Particulates, alternatively called as atmospheric particulate matter (PM), or fine particles, are tiny particles of solid or liquid suspended in a gas. Increased levels of fine particles in the air are linked to health hazards such as heart disease, alter lung function and causes lung cancer.

Air pollution is responsible for many health problems in the urban areas. Of late, the air pollution status in Delhi has undergone many changes in terms of the levels of pollutants and the control measures taken to reduce them. It was estimated that about 3000 metric tons of air pollutants were emitted every day in Delhi, with a major contribution from vehicular pollution (67%), followed by coal-based thermal power plants (12%). There was a rising trend in pollution as monitored by the Central Pollution Control Board (CPCB). The network consists of 621 operating stations covering 262 cities/towns in 29 states and 5 Union Territories of the country. There are state pollution control boards (SPCBs), guided and technically assisted by CPCB. The Kerala State Pollution Control Board is a body of under Department of Health and Family Welfare. The board is committed to provide pollution free environment to the people of state. But currently their monitoring confines too few sites, which is a major drawback.

The rest of this paper is organized as follows. Section 2 deals with the literature review. The section 3, deals with the proposed system. Obtained results are shown in Section 5 followed by concluding remarks in section 6.

II. LITERATURE REVIEW

The authors of [1] proposed a system which consists of a Mobile Data-Acquisition Unit and a fixed Internet-Enabled Pollution Monitoring Server. The Mobile-DAQ unit integrates a single-chip microcontroller, air pollution sensors array, a General Packet Radio Service Modem and a Global Positioning System Module. The Pollution-Server is a high-end personal computer application server with Internet connectivity. The Mobile-DAQ unit gathers air pollutants levels (CO, NO2, and SO2), and packs them in a frame with the GPS physical location, time, and date.

In the paper [2], presents a novel technique to monitor 2.5µm sized particulate matter level in smarter way. Internet of Things based cloud services have been incorporated to store and analyze the measured data in cloud servers. An optical sensor is integrated with the system which enables the user to visualize the density level of particulate matters in real time. Serial output empowers the user to monitor the process of capture of data, network connectivity, and data transmission towards the clouds.

The author of [3], presents an ambient real-time air quality monitoring system. The system consists of several distributed monitoring stations that communicate wirelessly with a backend server using machine-to-machine communication. Each station is equipped with gaseous and meteorological sensors as well as data logging and wireless

communication capabilities. The backend server collects real time data from the stations and converts it into information delivered to users through web portals and mobile applications.

The author of [4], portrays the usage of single board computers (SBC) for integration of IoT with wireless system networks for Air Quality Monitoring System (AQMS), where SBC are capable of performing even complex task with enhanced speed and reduced complexity. The integration of cloud services with SBC makes alerting process smart and real-time.

In the paper [5], system will have ARM7 LPC2138, which is heart of the system. Sensors like temperature, smoke, CO, NO are interfaced with microcontroller for the environmental monitoring air pollution. All the parameters of the sensors are displayed on the LCD. All the values are sent to the nearby mobile using Bluetooth.

In the paper [6], present a mobile system for air quality and pollution measurement suited for the urban environment. The device can acquire information about the air quality of its surroundings, store it in a temporary memory buffer and periodically relay it to a central on-line repository. Real-time gathered data can be freely accessed by the public through an on-line web interface. Users can select and view different gases and concentrations overlapped on a map of the city.

III. PROPOSED SYSTEM

The block diagram of proposed air quality monitoring and visualization system is shown in Fig.1. The presence of different air pollutants is recognized by the sensors [2]. The sensed analog data is converted to digital values by ADC. The output of ADC is taken to the microcontroller which will be processed and send to the IoT platform. The real time values are visualized in our mobile app with the help IoT. The measured values are also displayed through the LCD display. The controller will also send alerts if the measured value is greater than the prescribed limit.

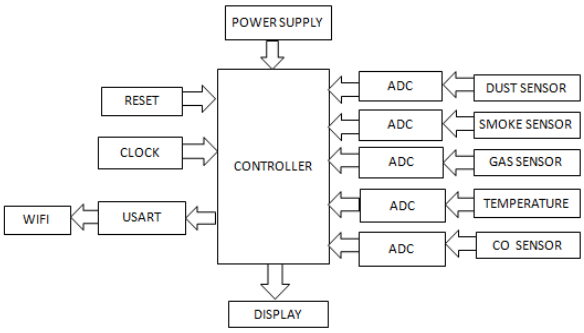

Fig1.Block Diagram

The power supply unit consists of transformer, rectifier, regulator and capacitor. The 12V, 2A DC supply is given to the regulator IC LM7805. The regulated 5V DC is given to the circuit. External clock is given to the controller with a crystal oscillator frequency of 1MHZ. ATmega32 is the controller used here, in which its port A is used as ADC. It is an 8 bit port in which the sensors are connected. ESP8266 is the Wi-Fi module which is connected to the transmission and reception pins of controller. When the supply is given, the sensors starts to sense the corresponding pollutants, given to microcontroller and its values are displayed on LCD. The data from the controller is transferred serially to Wi-Fi module and it is graphically visualized in IoT platform, Ubidots.

A. Hardware Requirement:-

- LM35 Temperature sensor
- MQ135 Smoke sensor
- MQ6 Gas sensor
- MQ7 Carbon monoxide sensor
- GP2Y1010AU0F Dust sensor
- ATmega32 Microcontroller
- Wi-Fi module ESP8266
- 16X2 LCD

B. Software Requirement:-

- AVR Studio 5
- Arduino programming

AVR Studio 5 is a software development environment produced by Atmel for its AVR 8-bits and 32-bits family of AVR microcontroller. It is a full software development environment with an editor, simulator, programmer, etc.It comes with its own integrated C compiler the AVR GNU C Compiler (GCC). As such you do not need a third party C compiler.It provides a single environment to develop programs for both the 8-bits and 32-bits AVR series of microcontrollers.

Arduino programming is used for app generation. It is used in Ubidots for real time visualization of pollutants.

C. System Implementation

The heart of this system is ATmega32 microcontroller. It has four ports. Among these ports A is analog to digital converter (ADC). The MQ135, MQ6, MQ7, LM35 and GP2Y1010AU0F sensors are interfaced with port A. The code for microcontroller was generated in software AVR Studio 5. Then we will connect the wifi module ESP8266 with the controller.The values of sensors are sent to the mobile using the IOT central server and also it is displayed in LCD display. Then the values are displayed on the screen of the personal computer. When the controller initially activated and the all sensors will start to work according to the code transferred to the board [5]. All sensors will start to collect the values depending on the

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parameters and it will update according to the delay values. There is particular range for particular sensors and it will act according to the threshold value [6]. The real time Visualization of the data is done with the help of IoT platform Ubidots.

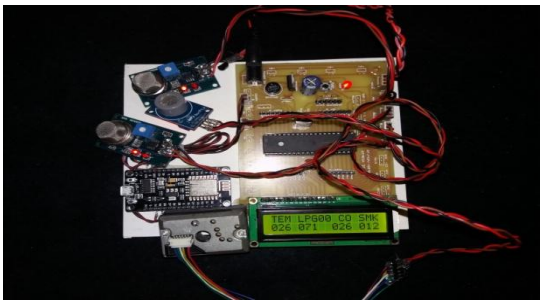

Fig 2. Implemented Hardware

Ubidots offers a platform for developers that enable them to easily capture sensor data and turn it into useful information. Device friendly APIs (accessed over HTTP/MQTT/TCP/UDP protocols) provide a simple and secure connection for sending and retrieving data to and from our cloud service in real time. This application enablement platform supports interactive real time data visualization [7], [8].

IV. RESULT

This shows the final output scenario of the project. Fig 3 represents the real time values of carbon monoxide and carbon dioxide that are obtained in our IoT platform. Fig 4 and 5 represents the graph of all recorded values of these pollutants. Here the x axis represents the time at which the value measured and the y axis represents the amount of pollutants. These readings are collected from our collage campus.

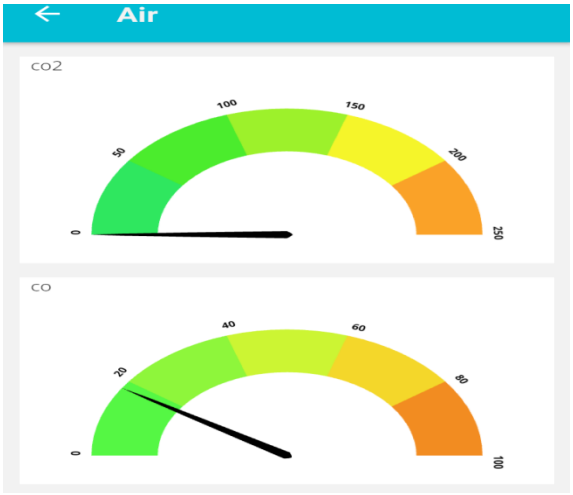

Fig 3. Real Time Values of CO2 and CO

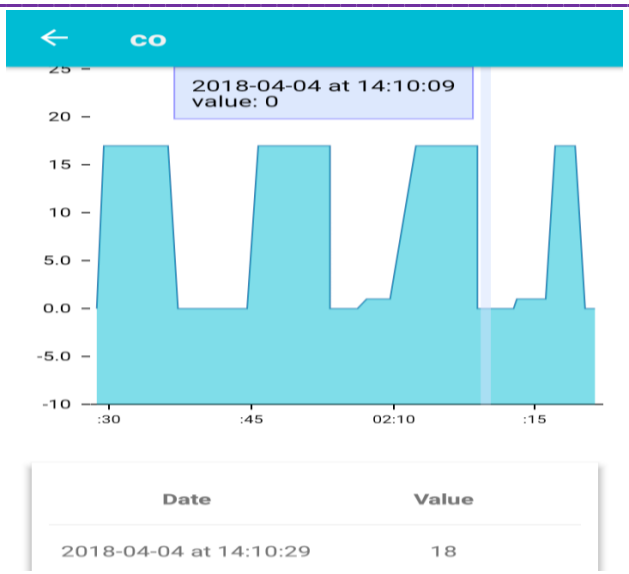

Fig 4. Recorded Values of CO

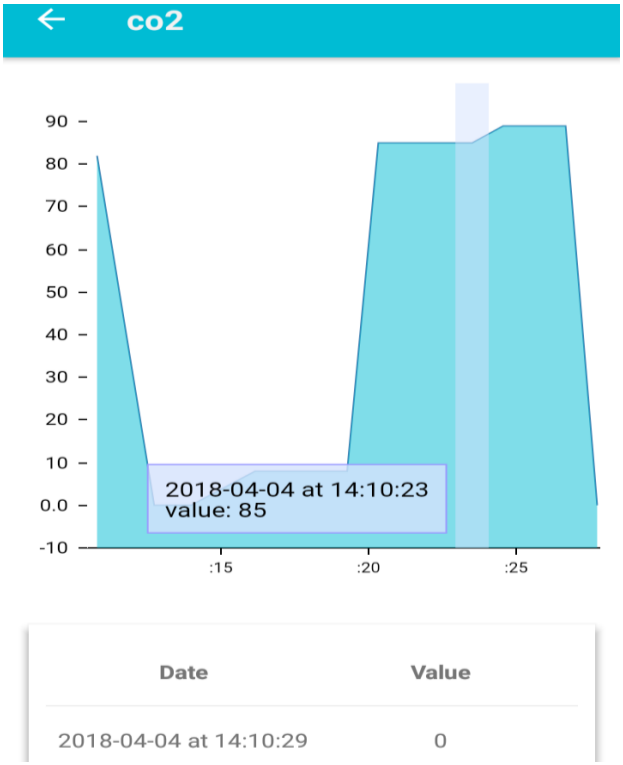

Fig 5. Recorded Values of CO2

V. CONCLUSION AND FUTURE SCOPE

The developed air quality monitoring and visualization system accurately measured the concentration of pollutants carbon monoxide, carbon dioxide, smoke and dust in atmosphere. The sensor has been integrated with IoT framework which has efficiently been used to measure and monitor the pollutants in real–time. This system overcomes the problem of pollution monitoring, health monitoring,

livelihood measurement, sustainability assessments and measurement related fields. The data's are automatically stored in the database; this information can be used by the authorities to take prompt actions. It also helps the normal people to know about the amount of pollutants in their area and to take control measures. This is a robust 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.

This system is monitoring only five parameters and hence can be expanded by considering more parameters that cause the pollution especially by the industries. Many pollutants do not have sensors that sense them if available they are very expensive and hence building sensors for different parameters might be a future and very challenging task. The developed system consumes too much power, so we can use solar power as an external source of energy in future and it will definitely improve the reliability of the system.

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