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Air Quality Monitoring in Non-Rural Areas

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Abstract*— Air contamination is one of the major natural issues today. It influences the social existence of the general population, human wellbeing, biological communities and the atmosphere. Air contamination can be caused due to anthropogenic or other sources. Low quality of air particularly in the urban regions prompts real wellbeing dangers, bringing on different illnesses and degrades the standard of living. Researchers have demonstrated that, in Europe around 25% of the air contamination is brought about because of vehicles. With a specific end goal to control the air contamination, steps ought to be taken to monitor the air and perform investigation, which prompts the advancement of air quality checking frameworks. These checking frameworks assume a vital part in observing the air quality and controlling the contamination focus in large portions of the urban zones. In this paper we have presented a framework in which different parameters of the earth, for example, temperature, weight, moistness and dampness are checked along with other gasses shown noticeable all around. In the proposed work, the data collected from the gas sensor, pressure sensor, temperature and humidity sensor and rain sensor is given to the NodeMCU microcontroller which then instructs the LCD to display the data. The data is stored in the Ubidot Cloud and the end user can access this data via his/her PC/Smartphone. The observation of different parameters gives the exact consequences of the grouping of contamination present noticeable all around. This framework can be utilized for the constant checking of indoor as well as outdoor situations.
***Keywords*— Air pollution, Air Quality Monitoring, Environmental Parameter Detection, NodeMCU, Ubidot Cloud.**

I. INTRODUCTION

The nearness of particulates, organic particles, or other destructive materials in the Earth's climate causes air contamination, which prompts ailments, human setbacks, and harm to other living creatures, for example, creatures and sustenance trims, or to the regular or manufactured condition. Air contamination may be caused due to anthropogenic or characteristic sources [1]. It affects the wellbeing of the living beings and leads to many illnesses and diseases [2, 3]. Large scale industries, which are progressively situated outside metropolitan areas and urban zones, is not thought to be the essential hotspot for the air contamination. Recent studies demonstrate that street activity or road traffic is the main reason of urban air contamination. Street transport is considered for 25% of every single destructive discharge in Europe. In numerous EU nations this esteem is higher than 30%. The loss of natural quality, together with the ecological effect of air quality, particularly in expansive urban communities, both on the wellbeing and the welfare of individuals is one of the biggest dangers of this century. As indicated by EU official figures, around 225,000 individuals bite the dust from sicknesses, created via auto discharges in Europe consistently. To battle this risk, the European Union has acquainted stricter laws and means with decrease auto discharges by 20% by 2020 [4].

Wearable sensors have additionally been utilized to screen the air quality, for example in the *CommonSense* [5] and *CitiSense* [6] arrangements. Both depend on small, battery-controlled sensor hubs that measure the convergence of polluting gasses and send the information to clients' cell phones by means of Bluetooth. This information and the GPS directions are then imparted to different clients through a devoted site. The Common Sense [5] framework investigated open air sensors in various settings including sensors appended to road sweeper vehicles, and hand held sensors that could be utilized to test the outside areas. The use of road sweeper mounted sensors is intended to broaden the current sensor framework in the city. The CitiSense [6] framework gives desktop based, reflection supporting perceptions and "real-time" representations that bolster on-going investigation. A comparable approach is additionally taken after where, a little and versatile ozone estimation framework *GasMobile* [7] is proposed. It utilizes a specific sensor outfitted with a transmitter board that enables simple association of the sensor to the client's cell phone through the USB port. The framework is to a great degree minimized and utilizes an Android application to align the sensor and transfer the gained information to a server. Be that as it may, the readings are extremely constrained and allude just to a solitary gas.

II. PROPOSED WORK

The proposed approach is an extension of OutSense [8]. This framework is utilized for measuring air quality parameters using NodeMCU [9] microcontroller. It permits correspondence with the sensors, readout of parameters and their stockpiling on an outside memory. The electronic module is equipped for measuring a few principle air pollutants and parameters. The Wi-Fi

association utilizes a module in view of the ESP8266 chipset which is inbuilt inside the NodeMCU. It is a simple arrangement, with great affectability and low utilization in transmission mode – 140mA. All the firmware is composed using Arduino programming language. The proposed framework is produced to monitor air quality which is cost efficient. It utilizes the following sensors: alcohol gas sensor, DHT11 sensor (measures humidity & temperature), rain sensor and pressure sensor. The readings of these sensors are shown on the LCD at transmitter side and the framework notifies this by turning on the buzzer.
The system architecture of the proposed framework is shown in Fig.1. It incorporates the fundamental segments: sensor hubs, Ubidot cloud and end devices such as PC/Smartphone. The sensors are installed in different sites or locations. The data collected from these sensors is transmitted and stored in the web server. The transmission of data requires an internet connection. The stored data can be accessed by the end user in their smart phone or PC.

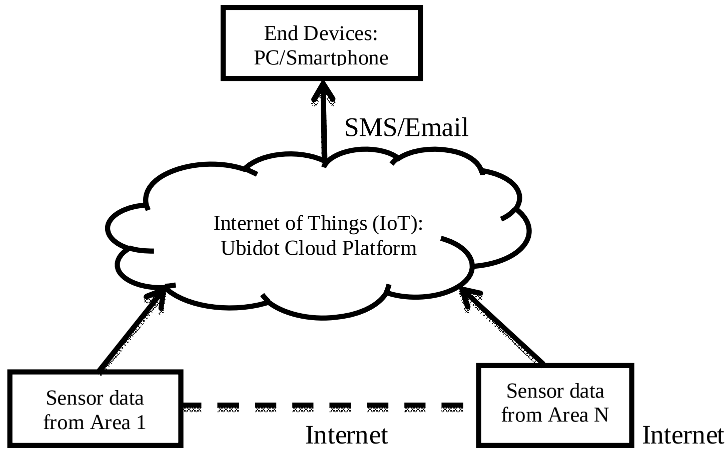

Fig.1 System Architecture

Block diagram of the air quality monitoring system is shown in Fig. 2. It consists of the NODEMCU microcontroller [9] and different sensors such as humidity sensor, temperature sensor, pressure sensor, moisture sensor and alcohol gas sensor. A buzzer is used to indicate the detection of gas and rain. All the data is stored in data base (IoT). Message is sent through GSM using mobile phone. The LCD is initialized and all the sensor values are displayed on the LCD.

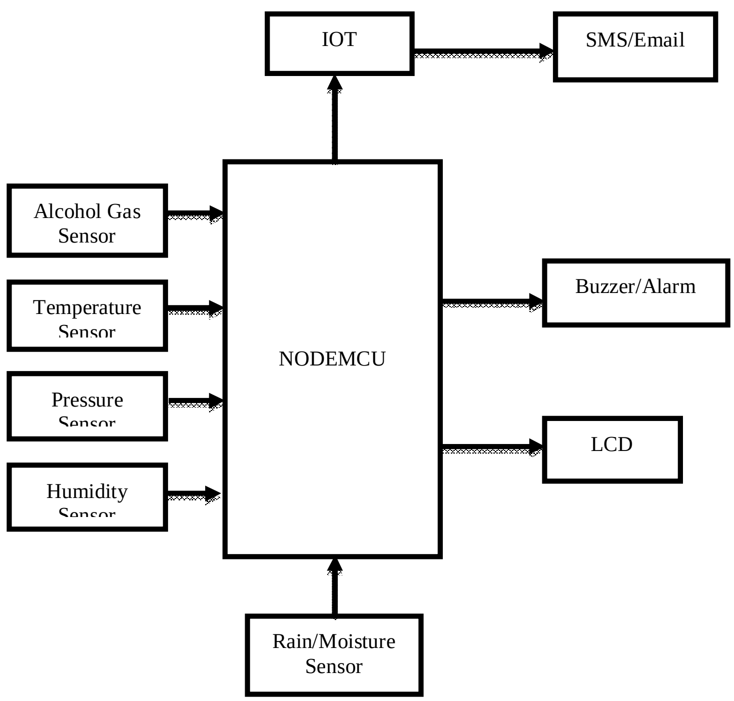

Fig.2 Block Diagram of Air Quality Monitoring System

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III. IMPLEMENTATION

A. Sensors Used

The main required parameter to be sensed is the gas (Alcohol gas) present in the atmosphere. Along with this, other quantities such as temperature, pressure, humidity and moisture are also considered for measurement, since knowing the presence of these quantities adds precision to the measured data. In this paper, the detection of an alcohol gas using the alcohol gas sensor i.e. MQ2 gas sensor is considered. Other gases such as CO_2, CO, NO_2, etc. can also be detected simultaneously in order to improve the precision of the data. The DHT11 sensor is used to detect the humidity and temperature. The MPS-2000 sensor is used to detect the atmospheric pressure. A rain sensor detects the presence of rain in the environment. All the sensors require a 5V power supply and their sensitivity can be varied accordingly by varying the potentiometer.

The detecting concentration scope of MQ2 gas sensor is 100ppm-2000ppm.When the gas sensor senses the presence of gas, it sends a signal to the NodeMCU. On receiving this signal, the NodeMCU instructs the buzzer to turn on indicating the presence of gas. The LCD displays a message indicating that the gas is detected. The measurement range for humidity at 25°C is 20%RH to 90%RH and the response time is 6s-15s. The measurement range for temperature lies between 0°C-50°C with a response time of 6s-30s. The range of the pressure sensor is 5.8 per square inch gauge. The DHT11 sensor senses both temperature and humidity of the atmosphere and the pressure sensor senses the atmospheric pressure and sends a signal to the NodeMCU which instructs the LCD to display the corresponding values on the display. The rain sensor consists of two parts: induction unit and a control unit. The LED on the control unit will turn on whenever the induction unit detects a rain drop and turns off when the water droplet is brushed off. The corresponding signal is sent to the NodeMCU which turns on the buzzer on detection of rain and displays a message on the LCD.

B. NodeMCU Board

The NodeMCU Board [9] is an open-source IoT platform which is developed by the Espressif Systems. The Espressif Systems had initially designed an individual Wi-Fi module called as ESP-8266 which was later incorporated within the NodeMCU. The NodeMCU unit has hardware similar to that of Arduino and Application Program Interface (API) which is event-driven for network applications. It uses Lua scripting language for programming. It is a low-cost, simple, programmable and interactive microcontroller unit that requires 5V power supply to operate. It also incorporates the functionality of Pulse Width Modulation (PWM). Both the analog and digital data obtained by the sensors are sent to the Ubidot cloud via the in-built Wi-Fi module in the NodeMCU. The data obtained from these sensors is displayed on the LCD and a buzzer is also used to indicate the presence of gas and rain.

C. Internet of Things

Internet of Things or generally called as IoT is the interconnection of installed frameworks inside the current web foundation. It can be figured as the Future of Internet, where all of the objects are interconnected with each other. IoT enables the objects to communicate with each other, access data over the Internet, and interact with clients making inescapable, savvy and constantly associated environment. Likewise, machine to machine (M2M) correspondence is empowered by the IoT, which enables machines to be controlled by the Internet and different machines. This can change the way innovation is utilized to make a machine take control of different machines which avoids the trouble that individuals confront while taking care of the computerized frameworks. Machines can watch the sensors everywhere throughout the world to create extensive amount of important data which is difficult to accomplish in a human years.

D. Software Implementation

The NodeMCU unit receives the data from all the sensors via the in-built analog and digital pins. The program is designed on the Arduino IDE to display the data on the LCD and also to upload it to the Ubidot [10] cloud so that it can be accessed anytime, anywhere by the end user. In the Ubidot cloud, a token is generated through an Application Program Interface (API) by making a request in the Ubidot Cloud. This token acts as an id for the connection of the Wi-Fi module to the Ubidot cloud. To store the data of each sensor within the created account profile, sub-tokens are created and referenced in the developed code. This data can be accessed by the end user on the smartphone or PC by logging in that particular account. The data obtained by the gas and rain sensor is displayed in the Ubidot cloud as digital values (0 and 1). The values of the pressure, temperature and humidity are also displayed. A graphical representation of these values is also available. An Email is also sent to the end user when these parameters are detected.

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IV. RESULTS AND DISCUSSION

Fig. 3 shows the hardware module of the proposed work and Fig. 4 shows the data displayed on the Ubidot Cloud which is accessible by the end user. The Ubidot Cloud stores the data obtained from the sensors. The data obtained is real-time and is available to the end user anytime and anywhere. Both graphical representation and digital values of the parameters are displayed in the Ubidot.

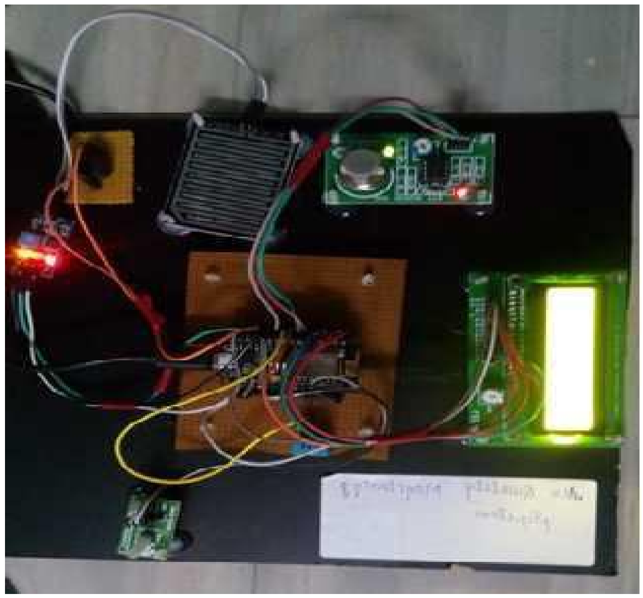

Fig. 3 Hardware Module

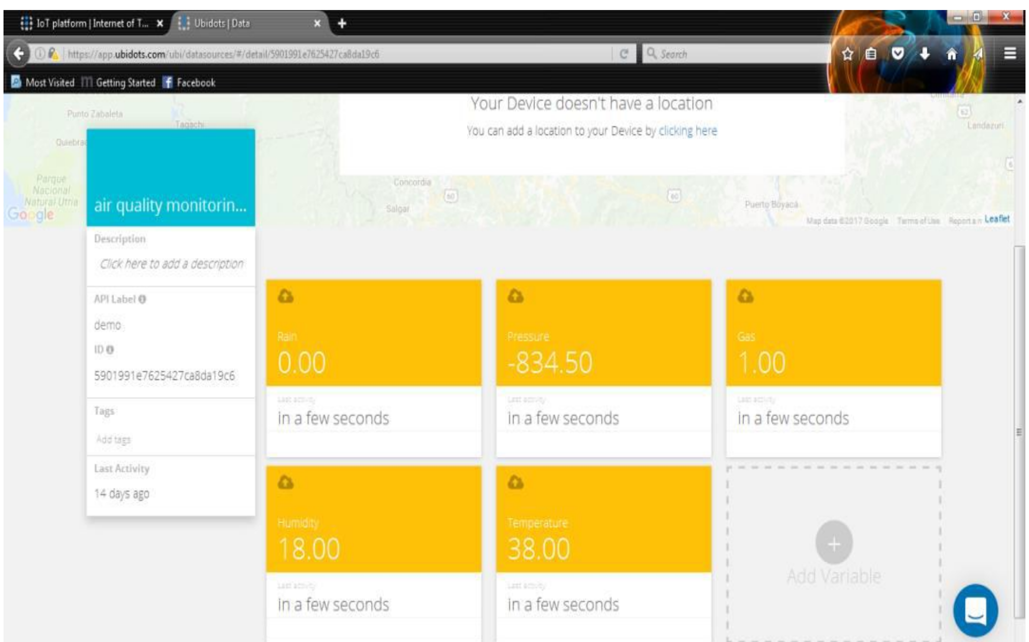

Fig. 4 Data display in Ubidot Cloud

V. CONCLUSION

This paper introduces the preparatory outcomes about the nature of the information obtained by low cost sensors. The estimations acquired from these sensors can give helpful signs of air quality in a particular area. The quality of information given by the sensor hubs depends altogether on the precision of the utilized low cost sensors. The combination of gas sensors for detecting different gases with sensors for exact estimation of essential physical parameters, for example, barometrical weight, temperature and humidity make it conceivable to perform higher precise estimations of the obtained data. The sensors used here are of domestic purpose. Industrial level sensors can be utilized to get more accurate and precise values. Estimations obtained in this paper are with respect to only one area and the same hardware can be implemented in different areas and the results can be compared.

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