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Air Quality Monitoring System Based on IoT using Raspberry PI

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ABSTRACT: Air pollution is the largest environmental and public health challenge in the world today. Air pollution leads to adverse effects on Human health, climate and ecosystem. Air pollution due to vehicular and industrial emission has become menace to the living beings. Due to this menace both indoor and outdoor air quality monitoring in real time has become mandatory. Air is getting polluted because of release of Toxic gases by industries, vehicular emissions and increased concentration of harmful gases and particulate matter in the atmosphere. Internet of Things is nowadays finding profound use in each and every sector, plays a key role in our air quality monitoring system too. Internet of Things converging with cloud computing offers a novel technique for better management of data coming from different sensors, collected and transmitted by low power, low-cost ARM based minicomputer Raspberry pi. An IoT based Air Pollution observing framework incorporates a MQ Series sensor interfaced to a raspberry Pi to send the sensor perusing to a cloud. This prototype can be easily adapted to any monitoring systems with minor changes and can be made scalable fortomorrow.

KEYWORDS: Air Quality Monitoring; IOT; Raspberry Pi; Python; Sensors

I. INTRODUCTION

Air pollution means presence of high concentrations of harmful gases such as dust, smoke. Inhaling these gases can increase the chances of health problem. In fact, dust when inhaled can cause breathing problems, damage lung tissue, and boost up existing health problems. Greenhouse gases trap heat and make the earth warmer. Human activities are responsible for almost all of the increases in greenhouse gases. Therefore, every federal government has stringent regulations which require prevention and reduction of emission levels. In our project, the major air pollutants like CO2, NO2, COis monitored using sensors and values which are obtained from the sensors are processed using Raspberry Pi.
It is essential to track the variation of the environmental parameters to determine the quality of our environment. The most frequently monitored parameters include temperature, humidity, rainfall, atmospheric pressure, light intensity, air quality, and pollutants such as CO2, CO, SOx, volatile organic compounds and many others. One of the immediate benefits brought by the acquisition of such physical proprieties, like soil moisture, temperature, and salinity, can be seen in agriculture, where significant water resource savings can be achieved The collected data encompass important details for a variety of organizations and agencies. With monitoring results, governments can make informed decisions about the impact of the environment on society and how society affects the environment. Wireless sensor networks (WSNs) are becoming a global technology resulting from the development of low cost and low power wireless technology.
WSNs are a group of spatially distributed sensing nodes with low maintenance requirements that can automatically monitor environmental parameters and transfer data to a main database via wireless networking through a gateway. Most monitoring applications rely on WSNs, which have the unquestionable advantages: lower costs due to cable replacement, variable network topologies, scalability and lower maintenance. The WSN consist of small sensors used to monitor or detect data. Because of their small size, power supply is provided by a small battery, which, when deployed in a ‘not-easily reachable’ place, cannot be replaced or recharged frequently. Energy efficiency is therefore one of the principal constraints of the wireless sensor network.

II. RELATED WORK

In [1] authors monitor the toxic gases level in the welding process in SMIs. The case study was done in two car component manufacturer which is a supply for national car. The data from monitoring process was analyzed and compared with the regulation and standards. Furthermore, from the monitoring process, the data will used as a baseline for the further action as a need to comply with the regulation set-up by the government. The monitoring as a key of the

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occupational safety and health (OSH) approach in welding process to improve the quality of work environment has significantly evaluated. In [2] an Environmental Air Pollution Monitoring System (EAPMS) for monitoring the concentrations of major air pollutant gases has been developed, complying with the IEEE 1451.2 standard. This system measures concentrations of gases such as CO, NO_2, SO_2, and O_3 using semiconductor sensors. The smart transducer interface module (STIM) was implemented using the analog devices' ADuC812 micro converter. Network Capable Application Processor (NCAP) was developed using a personal computer and connected to the STIM via the transducer independent interface. Three gas sensors were calibrated using the standard calibration methods. Gas concentration levels and information regarding the STIM can be seen on the graphical user interface of the NCAP. Further, the EAPMS is capable of warning when the pollutant levels exceed predetermined maxima and the system can be developed into a low-cost version for developing countries. In [3] the author focuses on implementation of air pollution monitoring system. First, each sensor was tested after survey about market trends of a variety of sensors for detecting air pollution. Second, wireless communication modules for monitoring system were developed using wireless sensor networks technologies based on ZigBee. And then a performance of modules was estimated in the real-fields. Through software programs written in nesC for efficient routing in wireless networks were simulated using TOSSIM simulator. Finally, integrated wireless sensor board which employs dust, CO_2, temperature/humidity sensor and a ZigBee module was developed. The board is embedded device based on AT91SAM7S64 porting uCOS. This paper accelerates the digital convergence age through continual research and development of technologies related the U-City.

III. PROPOSED SYSTEM

A. *Problem Statement:*

To track the variation of the air quality parameters to determine the quality of air and monitor it effectively.

B. *Methodology:*

Our sensor-based Air quality monitoring system measuring the ambient pollution is highly accurate, affordable, easy to use. DHT11 is a commonly used Temperature and humidity sensor Vcc pin is connected to power supply 3.5V to 5.5V, data pin is used to output the sensed value of Temperature and Humidity through series data, ground pin is connected to the ground of the circuit. MQ135 Air quality Sensor for detecting a wide range of gases, including NH_3, NOx, alcohol, benzene, smoke and CO_2. MQ7CO and MQ5 are gas sensor which with lower conductivity in clean air, it cleans the other gases adsorbed at low temperature and detects different combustible gases. MQ2 sensor is a gas sensor useful for detecting leakages (home and industry). Dust Sensor is a simple air monitoring module with onboard Sharp GP2Y1010AU0F. It is capable of detecting fine particle larger than 0.8µm in diameter, even like the cigarette smoke. Analog voltage output of the sensor is linear with dust density. The module has embedded voltage boost circuit to support wide range of power supply.

C. *System Design*:

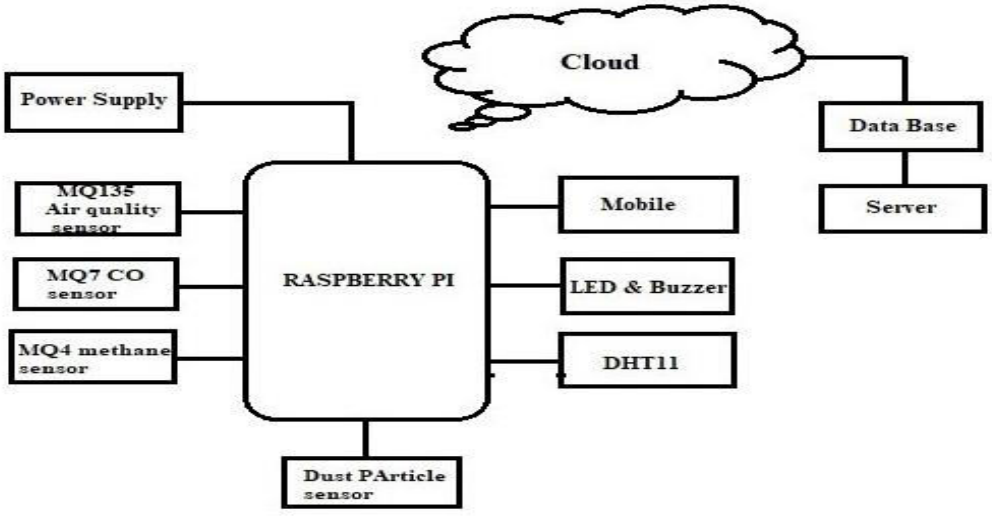

Fig. 1. Block Diagram

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i. Raspberry Pi

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B Specifications.

Processor: Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4GHz

Memory: 1GB LPDDR2 SDRAM

Connectivity:

- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput300Mbps)
- 4 × USB 2.0ports

ii. Altair SmartCore

Altair SmartCore is a cloud-native platform, which offers an integrated set of services and features to help you easily connectyourthingstothedigitalworld.Itprovidesaframework for building powerful industry applications, which optimize efficiency, enable innovative business models, and quickly deliver value. Available as a Platform as a Service (PaaS) or on-premises, Altair SmartCore will help you execute your IoT projects faster in an easy-to-use, reliable, and highly scalable environment. Its Features are:

- Data Collection:

Easily send sensor data and status to Altair SmartCore using multiple protocols (MQTT,REST or custom) and/or communication channels (Sigfox, LoRa,etc.).

- Application Engine:

Write and execute custom code at any complexity level in Altair SmartCore's App Engine to create real time logic for applications.

- Device Management:

Utilize Altair SmartCore's auto-provisioning to quickly onboard devices then remotely maintain, update, control, and interact with devices regardless of location.

- Project Management:

Manage project, device, and user privileges and data visibility with Altair SmartCore's advanced access control features.

iii. Python

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

The project uses SMTP protocol for sending alert mails to user. The Simple Mail Transfer Protocol is an internet standard communication protocol for electronic mail transmissions. It is an application layer protocol. The client who wants to send the mail opens a TCP connection to the STMP server and then sends the mail across the connection. Using a process called "Store and Forward", SMTP moves the email on and across networks. It works closely with something called Mail Transfer Agent (MTA) to send the user's communication to the right device and email inbox.

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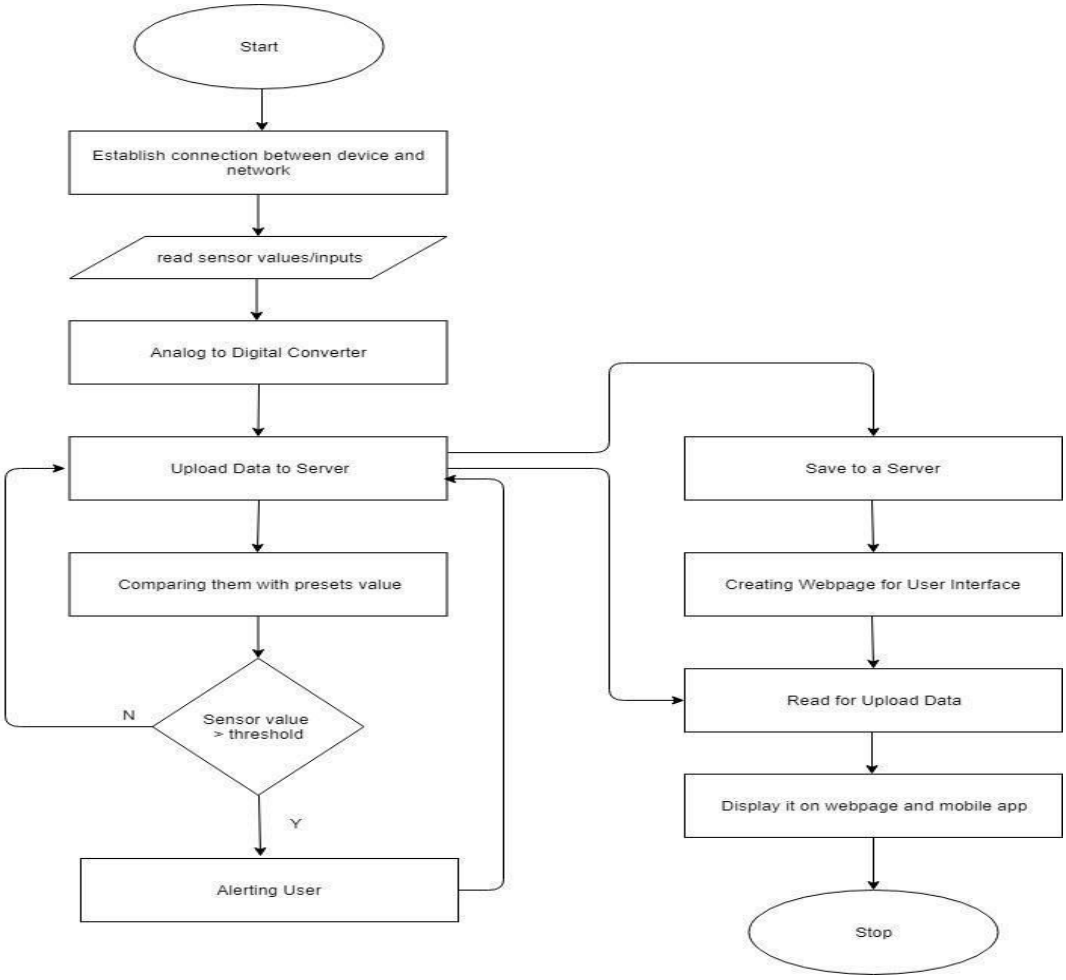
D. *Flowchart:*



IV. COMPARISON

A. *Existing System*

An IOT Based Air Pollution Monitoring System is proposed which will monitor the level of pollution and Air Quality. Sensors can be deployed at various locations which can sense and collect the data. The presence of harmful gases like CO2, Smoke, CO, Butane and LPG above a particular limit may turn fatal which can lead to severe accidents. This type of accidents can be prevented by implementing an effective pollution monitoring system. The air quality can be displayed on the LCD which makes environment monitoringeasy.

An alarm can also be triggered when the air quality goes down beyond a certain level.

B. *Proposed System*

The Proposed model is for detecting harmful toxic gases and shows the real time monitoring of the concentration of the gases in the industrial floor. This concept uses gas sensors and also using the DHT11 (temperature and humidity) sensor. The introduction of flexible, light weight sensors can further boost-up the implementation.

The idea can be realized by introducing Raspberry-pi and IoT shield. The idea of this paper is to sense the level of various gases in the industrial floor and upload these data to the cloud. Also, it provides the warning alarm if the level of gases exceeds the allowable limit. With IoT Shield, device manufacturers, system integrators and IoT network operators can rapidly secure and manage devices, with no need for any security expertise, no costly development and testing resources and no change to the application code or device functionality.

The API (application program interface) can be enabled which works as a medium between the Raspberry-Pi and the server and provides the permission to the sensor to write the readings on the cloud web server by sharing to email id.

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MQ GAS Sensors are the series of semiconductor Gas Sensor that can be employed for detection of gases mainly employed for workshops and commercial buildings. Resistance values of these sensors differ with various concentrations of gases. So, when using these components, sensitivity adjustment is very necessary.

V. RESULTS

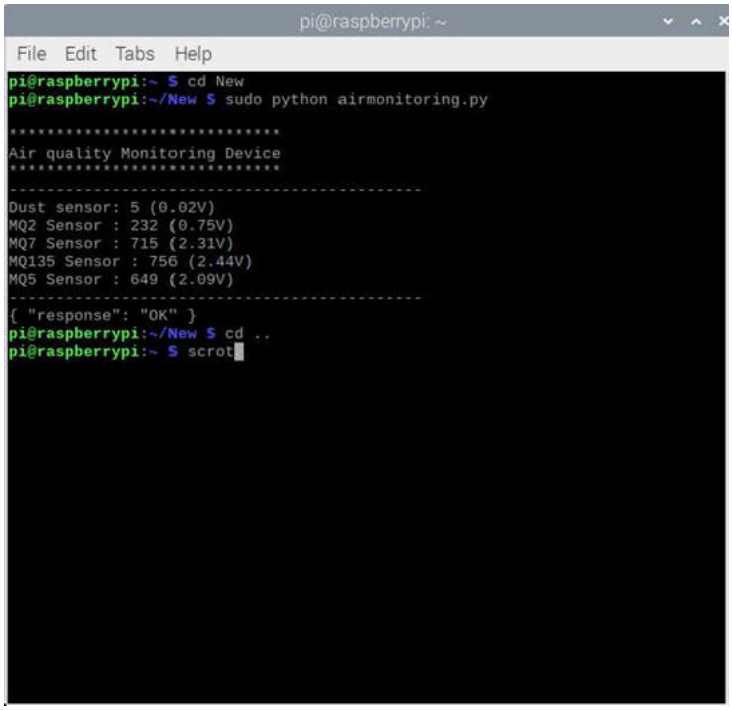
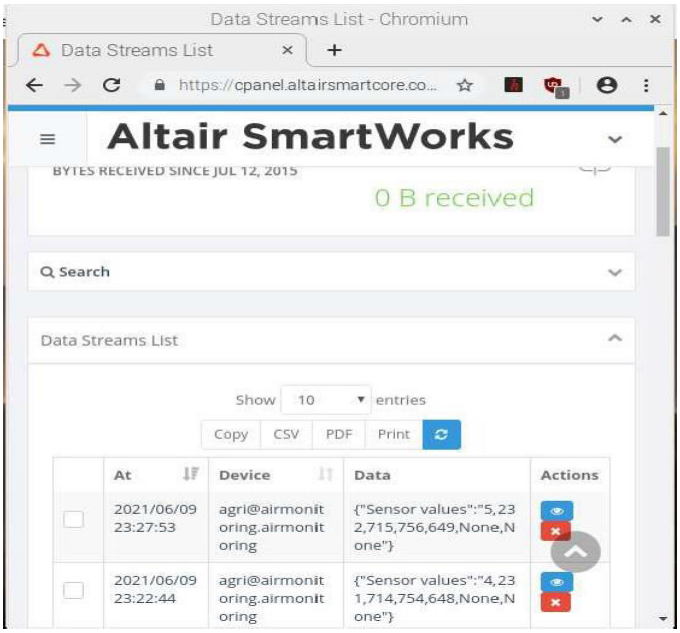


FIG. 2. VALUES READ BY THE SENSORS

FIG. 3. VALUES COLLECTED IN ALTAIR SMARTCORE CLOUD



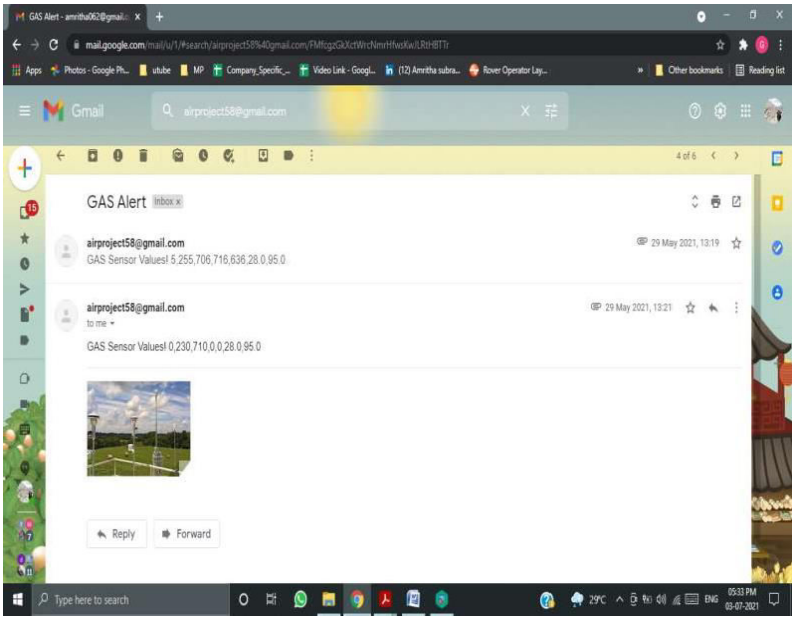


FIG. 4 ALERT MAIL SENT TO THE ADMINISTRATOR

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VI. CONCLUSION AND FUTURE WORK

The smart way to monitor environment and air as well as sound pollution being a low cost but efficient and embedded system is presented in this paper. In the proposed architecture functions of different sensors and their working procedure were discussed. How they work, their functionality, their optimal uses and their data taking procedures and comparison with standard base data arealso discussed here. The noise and air pollution monitoring system were tested for monitoring the gas levels on different parts of the country. It also sent the sensor parameters to the data server. Our project device showed that it is effective and cheap and with some highly working sensors it can really be a reliable one to everybody and its data's will be a key to take some necessary steps for the betterment of the society as it will help to identify the affected area so that we can take early steps to reduce damages for the nextgeneration.

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