Traffic Management by Monitoring Weather Parameters and Pollutants Remote system based on IoT using Raspberry Pi

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Abstract:

Clean and fresh air is a basic need for any creature on this planet. The increasing count of motor vehicles mainly in urban areas have become prominent reason for unhealthy environment and causing illness due to pollution. Systematic flow of vehicles will help in reduction of pollution. Use of technology is a solution in handling traffic, sensing pollutants like carbon dioxide and carbon monoxide in the pathway of transit will help in decision making for the traffic authorities as well as to the commuters. The proposed method is a stand-alone IoT system to measure few weather parameters at a dense location with heavy traffic and provide the corresponding live data. The system uses a low-power mini-computer Raspberry Pi fourth generation. The various sensors are used to sense different parameters like temperature, light intensity, carbon dioxide, carbon monoxide and humidity. The data collected by the Raspberry Pi is sent to the cloud and stored which can be viewed by anyone and anywhere at any time. Future measures can be taken using available recorded-data if there are unhealthy readings measured by the system set up at a location.

Keywords: *Air pollution, Thing speaks, Raspberry Pi, Sensors, Traffic management.*

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1. Introdction

Around 1.4 billion people in urban areas are living with air pollution above recommended air quality. According to the reports of the World Health Organization (WHO) and about 7 million people die due to air pollution every year. The uneven rise and fall in weather parameters and pollutants is affecting climatic seasons. This has made people more cautious about air pollution in and around them. The exposure of living creatures to polluted air could cause cardiovascular diseases [1-2]. And could also cause irritation and infection in

respiratory track, bronchitis, lung diseases, asthama. This would result in short life of living beings with painful deaths. The pollution is increasing to the danger level affecting the lifestyle of the people. The mankind across the world is worried about the sudden changes in the climate. To control air pollution first step is to monitor it well. Exponential increase in number of motor vehicles on road is leading to air pollution, contaminating the environment because of harmful gases, particles emitted during combustion [3-5]. In urban cities there is problem of heavy traffic due to poor management of traffic which results in release of more pollutants and making the air toxic at many locations. Such locations with heavy traffic movement should be on the observatory radar. Meteorological Department has setup various high-cost weather and air quality monitoring units all over India to measure various weather parameters and pollutants, but each unit is separated by hundreds of kilometres. The existing approach use Arduino along with different set of sensors where a separate component for internet connection is necessary for data transfer to the cloud [6-9]. The proposed approach is used for Traffic management and also helps is easy traffic movement and keeping the environment clean by less combustion of fuel. The proposed system is used to measures various parameters like temperature, Light intensity, carbon monoxide, carbon dioxide and humidity at selected locations. If the measured values are above safe level, then authorities can take required steps in diverting the traffic through other routes. This helps in traffic management and allows the rider to take the safe healthy route and diverting the traffic results in stabilizing and reversing the various parameters back to safe level. The system helps in having a reasonably good quality of air for the people on the streets and around. Internet of Things and cloud computing are the most emerging technologies. Internet of Things is a concept or a paradigm in which without human interruption devices sense, identify, process and communicate with each other [10-12]. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house. Internet of Things becomes very powerful when converges with Cloud computing. IoT cloud system provides a view on accessing IoT resources and capabilities in defined API, configuring and operating it on cloud. The data stored at the cloud can be retrieved any time and the scenarios can be analyzed in a better way leading to the solutions for controlling air pollution to some extent [13-18].

2. Literature Review

An air quality monitoring system which is based on the IEEE/ISO/IEC 21451 standard. Concentrations of CO, CO2, SO2 and NO2, were measured using electrochemical and infrared sensors [19-24]. Results are saved in the data server. The authors have also explained the definition and concepts of IoT in various different ways. The differences and similarities between the smart objects, smart things in IoT are presented in tabular form. Monitors environmental parameters with amperometric sensors and gas sensors (infrared) using the PIC18F87K22 microcontroller [25-31]. Sensor nodes are set up in different areas for real time monitoring of environment. The results are displayed on the city map. A business intelligence engine (APA). The system is designed to aware the public about the quality of air being affected by different factors like pollutants, toxic gases etc. Analysis of air pollution from different perspectives like meteorological data, pollutants and traffic data using APA is done. The system helps the people to realize their activities impact on deteriorating air quality [32-39].

A system for monitoring the environmental parameters, modelling and manipulating microclimate of urban areas. The system is implemented for the adaption of efficient urban infrastructure after analyzing the urban micro-climate, provides the framework for monitoring the city environment. Low cost Raspberry pi is used for implanting the system. Parameters like carbon monoxide, carbon dioxide, temperature and pressure are measured but no emphasis is given on particulate matter which left the environment monitoring incomplete. The presented a system for measurement and acquisition of data of water and air quality parameters and results are shown on IBM Watson IoT platform [40-45]. The system is battery powered with solar panel based charger unit. Collected air quality data from different cities of South Africa. Machine learning technique was applied to the data and prediction models were generated for ground level ozone.

Air quality assurance is a very big concern for humanity, especially for people living in urban areas. A custom extensible Air Quality Internet of Things device platform is capable of making measurements and stores all collected data in the cloud [46-51]. The components used in the first version of the device cost around US$900 dollars and are based on a Raspberry Pi3 Model B. This version was tested with six devices in Southampton in the UK.

LoRaWAN is also used in a Romanian solution named uRADMonitor. It equips smart city projects with sensors for various pollutants. This solution was used in Alba Iulia, with 15

sensors installed on 15 buses. This novelty of this approach is in the way the sensors work and the platform's ability to render maps using the measurements' decks and dashboards. Samples of the collected data can be accessed [52-59].

Another pragmatic project is Radon Air, which was developed by the Dositracker start-up. It aims to reduce the concentration of radon in dwellings and buildings. Another research that analyzed smart buildings, in which the authors proposed a system that, focuses on efficient energy use for data collection [60-66].

As people spend 90% of their time indoors, home air quality is also very important. The iAir system is used for collecting data about ammonia, carbon monoxide, nitrogen dioxide, propane, butane, methane, hydrogen, and ethanol. The Air provides real-time alerts when the concentration of one of these gazes is excessive. The system uses an ESP8266 as a microcontroller and an MICS-6814 sensor for measurements. The collected data is stored in Thing Speak, which allows data analysis on the time series. The micro computing unit (MCU ESP8266) is also part of another solution is presented [67-73].

Internet for Things technology is used for the monitoring of both air and water pollution. Another IoT project with (Supervisory Control and Data Acquisition (SCADA) technology for water quality monitoring is presented. The security of these systems is an important aspect and several studies, such focus on its implementation in data integration and air quality monitoring [74-79].

The second version of the solution aims to use the IoT-NB 5G GSM (NarowBand IoT) network in a hybrid approach with Wi-Fi, SigFox, and LoRaWAN and to enhance security by using the Java Card secure element in within an industrial IoT gateway [80-82]. This uses at least an IP of 67 because of the outdoor exposure of the station. Development boards, such as Raspberry Pi 3 and Nitrogen iMX6, are suitable candidates for proof of the concepts and fast prototyping, but in real solutions they are not reliable.

3. Overview of Proposed Scheme

3.1 Hardware Architecture

Raspberry Pi is the brain of the system which is called as minicomputer. The sensors DHT11, MQ2, and MQ135 are used to measure weather parameters temperature and humidity, light intensity and carbon dioxide. These sensors are connected to the Raspberry Pi through GPIO pins available on the Pi.

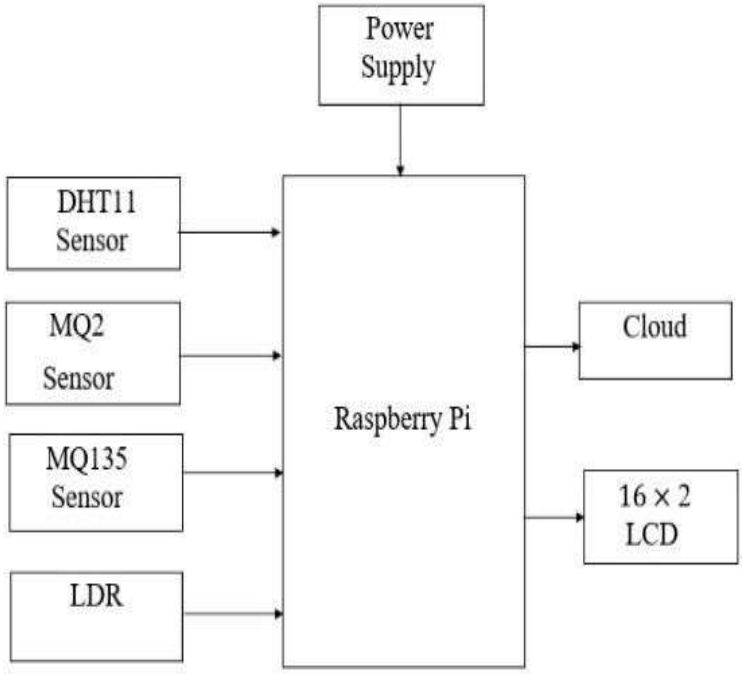

Fig.1: Block diagram

Raspberry Pi: This Raspberry Pi 4 is integrated with a 64-bit quad core cortex- A72 ARM v8, Broadcom BCM2711 and runs at a speed of 1.5GHz. Form Factor: Nano-ITX. The new Raspberry Pi product is equipped with Bluetooth 5.0, BLE, gigabit ethernet and has 802.11ac wireless at 2.4GHz and 5GHz. It provides faster data transfer with two USB 3.0 ports, two USB 2.0 ports, micro-SD slot for data storage and loading operating systems. The Raspberry Pi 4 has 2 micro-HDMI ports (supports 4k@60p), 2 lane MIPI DSI display port, 2 lane MIPI CSI camera port and 4-pole stereo audio and composite video port.

Sensors: In proposed system four Sensors are used of which two are air quality sensors, MQ2 and MQ135. Tin dioxide is used as sensing material in these semiconductor sensors. When monitoring gas comes in contact with the sensor then there occurs a chemical reaction which changes the electrical resistance of the semiconductor. The change in resistance is the proportional to the gas concentration. MQ2 sensor can detect and measure carbon monoxide gas present in the atmosphere. MQ135 sensor detects NH3, NOx, alcohol, benzene, smoke, carbon dioxide. Libraries of these sensors have to be installed onto the Pi. DHT11 is a Temperature and humidity sensor. It uses thermistor and capacitive type humidity sensor. LDR sensor module is a low-cost digital sensor as well as analog sensor module, which is capable to measure and detect light intensity. This sensor also is known as the Photoresistor sensor. This sensor has an onboard LDR (Light Dependent Resistor), that helps it to detect

light. The measured digital atmospheric pressure value is sent to Pi through GPIO pin. The sensors used are of low-cost, easy to use and small in size which makes the system size compact.

3.2 Software Requirement

The Raspberry Pi needs to be booted with an operating system to make it a stand-alone device. There are many OS available on internet such as NOOBS, Raspbian, Ubuntu, Windows10 IoT core and many others that can be downloaded and installed. The Pi used in the system is installed with Raspbian OS. It is required to download the system updates, library files to use available components on Pi and externally connected components. Python or C programming languages can be used to write the code. The code and the supporting libraries should be placed in a same location.

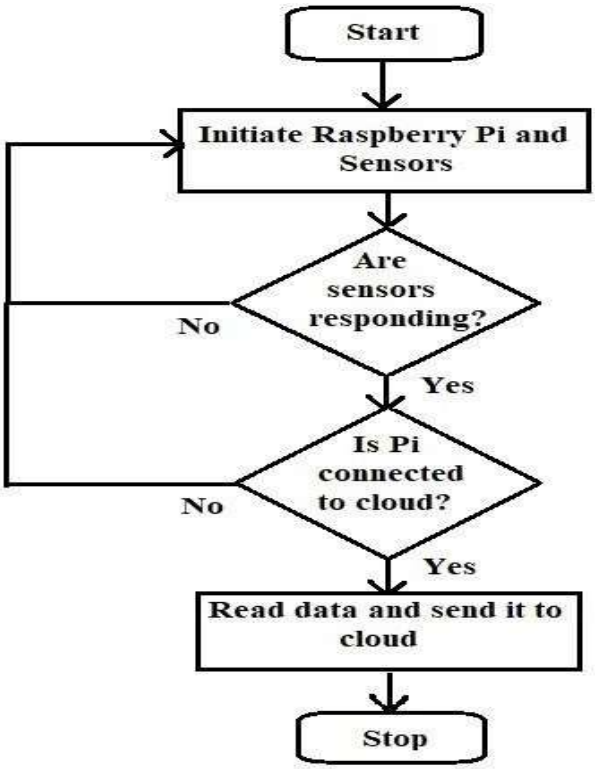

Fig.2: Flow Chart

Cloud: Thing speak is used as cloud for experimental purpose. It is an IoT platform that serves you to pile up, envision and analyze the real-time data streaming in the cloud. It facilitates to have separate channels to store data received from systems placed in different locations. Each channel has a unique Read and Write Application Program Interface key abbreviated as API key, which are used to fetch and upload data to the channel respectively. The data stored in the cloud can be fetched anytimeanywhere on any device shown in Fig.2.

4. Performance Evaluation

Fig.3 shows the proposed system. The Raspberry Pi and other components are rigged up using connecting-wires and are powered with compatible external power supply. A display unit is connected to Pi temporarily for programming. Pi is connected to wireless local area network (WLAN) so that it can upload data to the cloud. While writing the code it is necessary to install libraries of all the components onto the Pi. The complete setup without the display unit can be placed in any location, because of its compact size, whenever the experiment has to be carried out. When the system is powered and execution of the program begins, expecting no errors in connection, the sensors start reading the values of parameters which they are meant to and send it to the Pi.

Proposed system helps

- In measuring weather parameters and pollutants remotely at locations with heavy traffic.
- Commuters to take safe, healthy, lesscongested routes.
- In managing and routing the traffic flow in systematic way which saves fuel and helps in reduced emission of pollutants.
- Development authorities to look for long term and permanent solution.

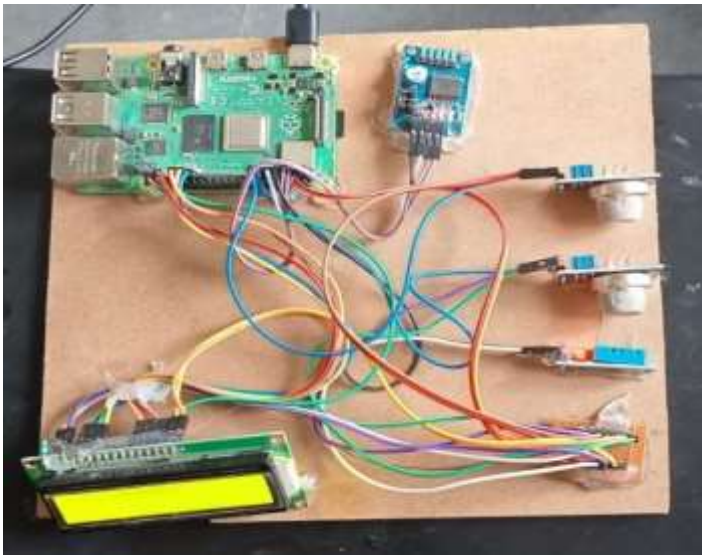

Fig.3: Proposed System

5. Results and Discussion

Fig.4. shows the real-time recorded results of temperature, humidity, carbon dioxide, carbon monoxide and light intensity, The recorded readings vary timely depending on the weather and on the number of pollutantsthat are produced during combustion in movingvehicles.

If there is stillness or slowness in the flow of vehicles due to traffic then this causes more emission of pollutants causing readings go high which is evident by the graphs. Same procedure is repeated for different locations to know the number of pollutants emitted during other time intervals in day, as density of vehicles vary from time to time in a day. So the concentration of carbon particles would increase if there is heavy slow-moving traffic, causing health issues for people travelling regularly by this route.

It was also observed that increase in pollutants was analogous to the weather parameters like temperature and humidity. The measured values of carbon dioxide and carbon monoxide, on an average from the graphs, show that they are within the safe levels. But there are many other locations with heavy traffic the concentration of pollutants, on an average, may go above safe level mark for which the system developed will help to have a clean, fresh and decent air. the template. Duplicate the template file by using the Save As command, and use the naming convention. The system will help in managing traffic. When the values go beyond safe level mark the authorities could come into action fuel too. After the text edit has been completed, the paper is ready for Weather Parameters and Weather Parameters and Pollutants in Location 2.


Field 1 Chart
weather parameters monitoring using pi
Temperature
Date
Field 2 Chart
weather parameters monitoring using pi
Humidity
Date
Field 3 Chart
weather parameters monitoring using pi
Date
Field 4 Chart
weather parameters monitoring using pi
Date
Field 5 Chart
weather parameters monitoring using pi
Light intensity
227.5
225
19:20
19:25
19:30
19:35
Date

Fig.(a)

Fig. (b).

Fig.4 (a) & (b): Real-time recordedresults of temperature, humidity, carbon dioxide, carbon monoxide and light intensity.

6. Conclusion

A low-cost, reliable, compact, low maintenance system is designed to monitor the various weather parameters and pollutants remotely. The system helps in improving the quality of lives of living creatures and will be a support for 2-tier and 3-tier cities to make them smart in managing the pollution and traffic which are very concerning. The proposed kind is need of an hour. When such systems are setup around the city then it could be easy to know the safe routes for the movement of public and to cut down the carbon particles in the affected area so that as soon as the values become normal the traffic movement could be restored.

7. Future Scope

IOT weather reporting system has an application to farmers as well. The weather forecasting plays a very important role in the field of agriculture. Global Journal of Engineering and Technology Advances. IoT weather monitoring project proves helpful for monitoring weather at places like a volcano, rain forests. It is quite difficult for a human being to stay for a longer time at such places. Or even areas that are exposed to radioactive leakage. IoT weather monitoring system project using IoT supporting controller is fully automated. It does not require any human attention. You can get a prior alert of the weather conditions. Suppose you are planning to visit a place and you want to know the weather parameters over that place, then you can just visit a website IoT portal.

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