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IoT Based Water and Air Quality Monitoring System and Analysis

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Abstract

Air and Water are essential components for living beings. The conventional method of testing water and air quality is to gather samples manually and send to the lab for test and analysis. This method is time-consuming, wastage of manpower, and not economical. Present work describes the design and development of Water and Air Quality Monitoring system. The water and air quality measuring system that we have implemented checks the quality of water and air in real time through various sensors (one for each parameter: pH, TDS, temperature, turbidity, MQ135, Dust sensor) using the IoT concept. The Wi-Fi module in the system transfers data collected by the sensors to the microcontroller and transfers the data to the smartphone/PC using the ThinkSpeak API. In addition, an alert system is deployed to alert PCB officials if water and air quality go down. This system can keep a strict check on the pollution of water and air.

Keywords: IOT, Turbidity, TDS, Temperature, pH, Gas, Dust, ADC, Thinkspeak, Alert system

1. INTRODUCTION

IoT could be a system of reticular computing devices, mechanical and digital machines, objects, animals or folks that or given distinctive identifiers (UIDs) and therefore the ability to transfer knowledge over a network while not requiring human-to-human or human-to-computer interaction. IoT allows objects to be controlled remotely across the existing network infrastructure. IoT is a very good and intelligent technique which reduces human effort as well as easy access to physical devices. This technique also has an autonomous control feature by which any device can control without any human interaction. An article by Ashton printed within the RFID Journal in 1999 same, "If we had computers that knew everything there was to know about things - using data they gathered with none facilitate from North American nation - we'd be ready to track and count everything, and greatly reduce waste, loss, and cost. We need to empower computers with their own suggests that of gathering info, so they can see, hear and smell the world for themselves, in all its random glory." This is precisely what IoT platforms do for us. It allows devices/objects to watch, identify and understand a situation or the surroundings without being dependent on human help. Internet of Things will connect devices embedded in varied systems to the net. When devices/objects will represent themselves digitally, they can be controlled from anywhere. IoT could be a transformational force that may facilitate corporations to improve performance through IoT analytics and IoT Security to deliver higher results. Businesses within the utilities, oil & gas, insurance, producing, transportation, infrastructure, and retail sectors will reap the advantages of IoT by creating additional upon choices, motor-assisted by the torrent of interactional and transactional data at their disposal.

Water pollution is caused due to several reasons. Here are the few major causes of water pollution Sewage and Waste Water, Dumping, Industrial Waste, Oil Pollution, Acid Rain, Global Warming, Eutrophication. Increase in the number of vehicles and a huge number of industries in cities has led to the serious problem of air quality deterioration. Air pollution is the presence of one or more contaminants in the atmosphere such as gases in a quantity that can harm humans, animals and plant. Air pollutants are measured in Parts per Million (ppm). The central pollution control board has been working on reducing the pollution level and ordained the methodology for monitoring the water and air quality. The pollution in water and air are increasing day to day, and many researchers and scientists are trying to solve the problem by checking and maintaining the quality of water and air. This paper focuses mainly on the quality checking of water and air. Analyzing the condition and checking whether the water and air are favorable for living beings and plants is the main target. There are many factors which could be found in water and air, but this paper focuses on checking the TDS, pH value, Turbidity, Temperature in water, gases, and dust in the air which are crucial to determining the quality. It is quite a new step in developing a water and air quality measuring device, which will be helpful for the new researchers to go through the development of a new improved device for the quality check of water and air.

2. LITERATURE SURVEY

Vaishnavi V. Daigavane and Dr. M. A Gaikwad entitled "Water Quality Monitoring System Based on IOT". This system can monitor water quality automatically, and it is low in cost and does not require manual work. This system uses aurdino uno. [1] The Smart Water Quality Monitoring System for Real Time Applications [2] which is efficient and low cost, has been tested after the implementation. A report by Ch.V.Saikumar, P.C.Kishoreraja, M.Reji introduces a Wireless Sensor Network (WSN)-based air quality monitoring system using IOT central server and gases sensors. [3] IOT Based Water Quality Monitoring System through this system,

the officials can keep track of the levels of pollutions occurring in the water bodies and send immediate warnings to the public. [4] A report by Soundarya Pappu, Prathyusha Vudatha, Niharika.A.V [5] this system here receives the input is transmitted serially to Pi3 which is edge level processor where machine learning algorithm employed for predicting the Water Quality based on trained data set. Internet of Things (Iot) Based Smart Water Quality Monitoring System [6] the system is achieved with reliability and feasibility by verifying the four parameters (pH, water level, CO2, Temperature) of water.

3. PROPOSED METHODOLOGY

In this proposed system the complexity reduces, and the performance increases by collecting the data of the water parameters such as temperature, TDS (Total Dissolved Solids), pH, Turbidity and air parameters such as dust and gases concentration in the air. The data collected is updated in the ThinkSpeak server which can be retrieved from anywhere in the world using the channel ID. If the contamination level is high or not suitable for drinking and breathing or other purposes alert will be given to the Pollution Control Board (PCB) officials. This system can be installed in cities and industrial areas like SIPCOT in Perundurai, Tamil Nadu to monitor and control the pollution.

IMPLEMENTATION

Raspberry Pi processor:

Raspberry Pi is a Minicomputer, usually with a Linux OS to run multiple programs. It has inbuilt Ethernet and WLAN port, through which we can connect to the network. Raspberry Pi 3 Model B+ is used in this research.

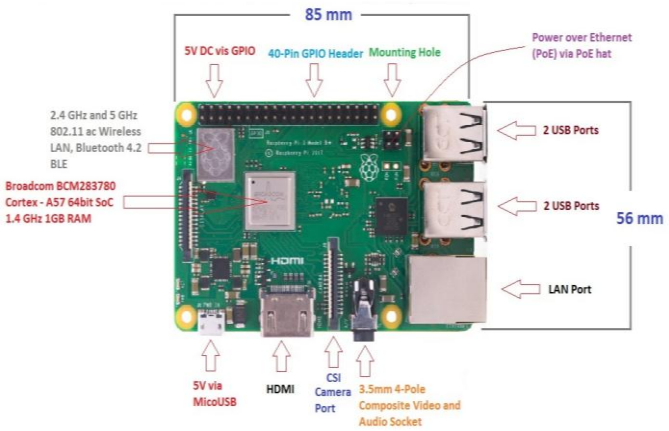


Fig: Raspberry Pi 3 Model B+

MCP3008 ADC:

This is a low-cost Analog to digital convertor. Since raspberry pi do not have analog pins, analog to digital conversion is done. It has 8 channels and so 8 sensors can be interfaced.

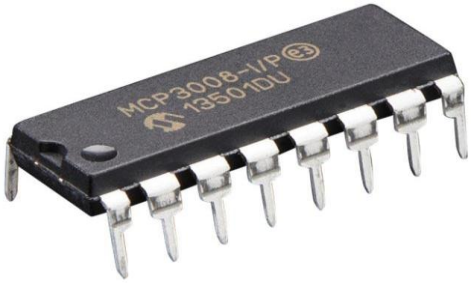


Fig: Analog to Digital Converter

Temperature Sensor

Water Temperature indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digital type which gives accurate reading.

Fig: Temperature sensor

Features

- Power supply range is 3.0V to 5.5V
- Measures temperatures from -55°C to +125°C. Fahrenheit equivalent is -67°F to +257°F
- ±0.5°C accuracy from -10°C to +85°C
- Converts 12-bit temperature to digital word in 750 ms (max.)

Turbidity Sensor

Turbidity sensors measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level (and cloudiness or haziness) increases.

Fig: Turbidity Sensor

Features

- Operating Voltage: 5V DC
- Response Time: <500ms
- Output Method: Analog
- Analog output: 0-4.5V
- Digital Output: High/Low level signal (you can adjust the threshold value by adjusting the potentiometer)
- Operating Temperature: -30 ℃~80 ℃

Total Dissolved Solids (TDS) Sensor

TDS (Total Dissolved Solids) indicates that how many milligrams of soluble solids dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids dissolved in water, and the less clean the water is. The TDS value can be used as one of the references for reflecting the cleanliness of water.

Fig: TDS sensor

Features

- Wide Voltage Input: 3.3~5.5V
- Good Compatibility Output: 0~2.3V analog signal output, compatible with 5V or 3.3V controller
- Waterproof Probe
- TDS Measurement Range: 0 ~ 1000ppm
- TDS Measurement Accuracy: ± 10% F.S. (25 ℃)

pH sensor

Analog pH meter is specifically designed to measure the pH of the solution and reflect the acidity or alkalinity. It is commonly used in various applications such as aquaponics, aquaculture, and environmental water testing.

Fig: pH Sensor

Features

- Hardware filtered output signal, low jitter
- Gravity connector and BNC connector plug and play.
- Uniform size and connector, convenient for the design of mechanical structures.

Signal Conversion Board (Transmitter) V2

- Output Voltage: 0~3.0V
- 3.3~5.5V wide voltage input
- Probe Connector: BNC
- Signal Connector: PH2.0-3P
- Measurement Accuracy: ±0.1@25℃

pH Probe

- Probe Type: Laboratory Grade
- Detection Range: 0~14
- Temperature Range: 5~60°C
- Zero Point: 7±0.5
- Response Time: <2min

Gas sensor (MQ-135)

The MQ-135 Gas sensors are used in air quality control equipment and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller.

Fig: Gas sensor (MQ-135)

Features

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Detect/Measure NH3, NOx, alcohol, Benzene, smoke, CO2, etc.
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

Dust Sensor

Dust Sensor gives a good indication of the air quality in an environment by measuring the dust concentration. The Particulate Matter level (PM level) in the air is measured by counting the Low Pulse Occupancy time (LPO time) in given time unit. LPO time is proportional to PM concentration. This sensor can provide reliable data for air purifier systems; it is responsive to PM of diameter 1µm.

Fig: Dust Sensor

Features

- Grove compatible interface
- Supply voltage range: 5V
- Minimum detect particle: 1um
- PWM output

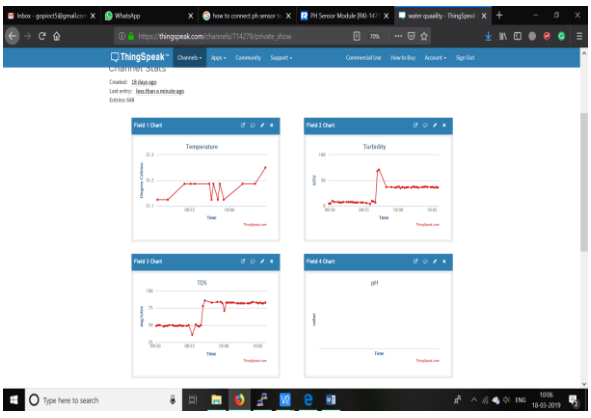
In this system, it makes use of six sensors (Turbidity, temperature, pH, TDS, Gas sensor [MQ135], Dust sensor) and the Raspberry Pi controller connected. The six sensors capture the data in the analog signals. The ADC converter which converts the six-signal information into the digital format. The digital signals are passed to the Raspberry Pi controller which is together with the Wi-Fi. This system employs sensors such as pH, temperature, TDS, and turbidity in the water will analyze the quality of the water resources and the Gas and Dust sensor get data from the atmosphere.

Working with ThingSpeak

Sign-up to create a new account in ThingSpeak Create a new channel to store the data from sensors. ThingSpeak has a 'status update field' to send any additional information required on the page. Give the field names. If you check 'public', other people can access your data. Click on 'Save channel' an API key is created. An application programming interface (API) key is a code passed in by computer programs calling an API to identify the calling program (its developer, or its user to the Web site). If everything is successful, ThingSpeak API status will be '200 OK'. We can keep adding any number of values. We can give other people access to the channel. Data importing from the sensors, and then exporting the data onto the channel, all takes place in real-time basis. Alert system is active to avoid water and air pollution disaster.

5. EXPERIMENTAL RESULTS

The designed sensor node was deployed for monitoring the environmental air and water quality. Obtained sensor data from each node are archived in the corresponding local database and ThingSpeak cloud database. Below figure shows the screen shot on the ThingSpeak cloud channel creation. The local database is for remote monitoring, future retrieving and trend analysis. ThingSpeak cloud services is used for storing the data in the online cloud database mainly for running analytics services. Private and public view for the channel are configured in this cloud service.



The sample data are collected form SIPCOT Industrial area, Perundurai, Tamil Nadu, India. The result obtained shows increase in the pollution at a moderate rate. The Pollution Control Board officials will be alerted when the pollution gone high than the desired level.

6. CONCLUSION

The low cost, efficient, real-time water and air quality monitoring system has been implemented and tested. Through this system, the officials can keep track of the levels of pollutions occurring in the water bodies, atmosphere and send immediate warnings to the public. This can help in preventing diseases caused due to polluted water and air. Quick actions can be taken to curb extreme levels of pollution like in rivers and industrial, city areas. The system can be easily installed, with the base station kept close to the target area, and the task of monitoring can be done by less-trained individuals.

Internet of Things (IoT) and its services have become a part of our lifestyle, ways in which of operating, and business. There is an excellent deal of analysis on developing crucial building blocks and models for following generation web services supported by an inordinateness of connected things.

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