Implementation of an IoT Based Environmental Monitoring System

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ABSTRACT

This IoT-based environmental monitoring system leverages ThingSpeak to enable seamless data acquisition, storage, and analysis of environmental parameters. Through an array of sensors, the system monitors variables like temperature, humidity, and air quality in real-time. The integration with ThingSpeak provides a robust cloud platform for data management, facilitating remote access and visualization. This system proffers a reliable and efficient solution for environmental monitoring, encouraging informed decision-making and contributing to the broader goal of sustainable environmental resource

Keywords: IoT, Environment, Monitoring System, Thingspeak, Visualization, Data

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1. BACKGROUND TO THE STUDY

Environmental effect has been one of the leading factors adopted in making sure that the Earth keeps some of the planet's heat that is liable to escape to space from the atmosphere. The earth's mild global temperature will be much colder and living could have been impossible for living things without the greenhouse effect. Most environmental effect parameters include CO2, Methan, Water Vapor, Nitrous Oxide, temperature, humidity and many more. The major effect of the greenhouse parameter is that there is stable heating of the atmosphere, surface and global warming (Darkwah W et al, 2017).

In this century, it is as if everything could be monitored and controlled remotely but meanwhile in some ssectors like the agriculture sector, the automatic monitoring and controlling of the environmental effects has not been fully utilized, the traditional way is still adopted mostly when it comes to farming on a small-scale business. Some of the major factors why automation of environmental effects has not been fully adopted are high cost of implementation, few technical know-hows and it requires high maintenance. Environmental effect monitoring is an important part of agriculture because it could be used to grow plants under a controlled climatic condition for plant produce. It is also useful by providing shields to plants from weather by controlling the environment (Jeyashree et al, 2016).

Those who study about climate believe that an increase in atmospheric concentration of some environmental effect released by human activities like the deforestation and burning of fossil fuels warms the whole earth. This environmental effect makes the earth possible to live in.
In recent years, there has been numerous developments of systems and methodss to control environmental effects. Systems have been developed for monitoring and managing environmental effects where various sensors capable of performing different functions have been used as a way of getting data for management. Traditional methods were deployed for monitoring the environment by the use of a wiring method. Nevertheless, the installation of this traditional method was relatively easier but there is an increase in the maintenance costs of wiring (Lafont et al, 2002).

One of the various technologies used nowadays is the Internet of Things (IoT). IoT makes the utilization of other technologies possible, it facilitates interoperability of devices to either work, communicate together and also provide data from sensors in real-time. It is also used to control motors and actuators from a long-range distance. This technology has helped invent a lot of ideas in various economic sectors including agriculture, climate monitoring. It is widely used in smart cities, robotics, automations and agriculture (Kaushik S. et al, 2020). A typical system for monitoring environmental effects captures data of some elements such as temperature and humidity using sensors because these two elements contribute majorly to the development and growth of plants and human being

2. REVIEW OF RELATED WORKS

Ibrahim. A. et al. (2012) proposed a system to control and monitor the environment inside the greenhouse. The system includes local stations and a central station. The local stations measure the environmental parameters and to control the operation of controlled actuators to maintain climate parameters at predefined set points. The system uses the ZigBee wireless module servers as the communication link between the local stations and the central station. Mohammed et al in the year 2012, published a paper titled "Synopsis on the Effects of Anthropogenic Greenhouse Gases Emissions from Power Generation and Energy Consumption". The paper gives information that there is a global change in the environment which results from various power generation. Various environmental activists and stakeholders have been promoting the acceptability of procedures to limit the effect of these greenhouse factors. An overview of the effect of anthropogenic energy generation and consumption practices to reduce the emissions of greenhouse gasses was presented.

Dhumal et al in the year 2013, published a paper titled "Greenhouse Automation using Zigbee and Smartphone". The research discussed the monitoring of Greenhouse gasses and control with the use of Zigbee wireless sensor network (WSN) by using ARM controllers over the internet where the monitoring and control is accessible to the user from anywhere in the world. Prof K. Patil et al (2016), proposed a model for smart agriculture using IoT. They argued that changes in climate and rainfall have been alarming over the decades, causing researchers and innovators to come up with new methods of improving agricultural products. In the traditional system, farmers have to plant their crops for years without monitoring it.

During this period weather and soil conditions, pests and diseases would have affected the growth and productivity of the crop. By using the proposed system approach, which senses the local agricultural parameters, identifies the location of sensors, transfers the data crop fields and crop monitoring. The Received updated information allows the farmers to cope with and even benefit from these changes. Complete real-time and historical environmental information is expected to help to achieve efficient management/monitoring and utilization of resources. Amandeep et al, (2016), proposed a work on smart farming with the aid of automation and internet of things (IoT) technology.

They aimed at implementing a smart GPS based remote controlled vehicle that performs various tasks like monitoring fields to prevent thefts, scaring birds and animals, sensing soil moisture content, spraying fertilizers and pesticides, weeding, sensing soil moisture, etc. Smart irrigation, by usage of optimum amounts of water, depending on the requirement of each crop type and the soil will be executed. Finally, they plan on enforcing smart warehouse management, with temperature and humidity sensing for the benefit of the products being stored, and detection of presence of any invader who tries to steal from the warehouse.

Controlling and monitoring of all these operations will be through a remote smart device with Internet connectivity and the operations will be performed by interfacing sensors, ZigBee modules, with microcontroller. Ramya V. et al (2017), proposed a system that monitors the agricultural field automatically and also performs real time video stream of the farmland using raspberry pi camera. Various environmental parameters are measured such as temperature, humidity and soil moisture level. Internet of Things and wireless sensor networks are used to reduce the human physical efforts in monitoring the farmland. IoT is used to prevent loss of database which keeps the record of the parameters measured on the farmland.

3. THE SYSTEM ARCHITECTURE

The backbone of the proposed system is the microcontroller, ATMEGA 328P-PU that receives analogue signal from the sensors and send it to the thinkspeak sever using ESP8266 Internet module. Three sensors are used in this model, namely the temperature and humidity sensor, CO2 sensor and benzene sensor. Figure 1. shows the architecture of the proposed system. The weather monitoring system using IoT for Smart Agriculture will sense and monitor weather parameter in real time with the help of sensors. Three different sensors namely the humidity sensor, temperature sensor, rain fall sensors are arranged in different form in the proposed system The model described how the sensors are connected to the micro-controller unit in the architecture.

The system is decided into two main sections namely the hardware section and software section. The hardware section consists of the hardware components; the power supply section, the sensor sensing section and micro-controller section which is responsible for signal manipulation and conversion, data transfer and visualization. Software section consist of the Arduino programs are written in the Arduino Integrated Development Environment (IDE). Arduino IDE is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino boards.

The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution.

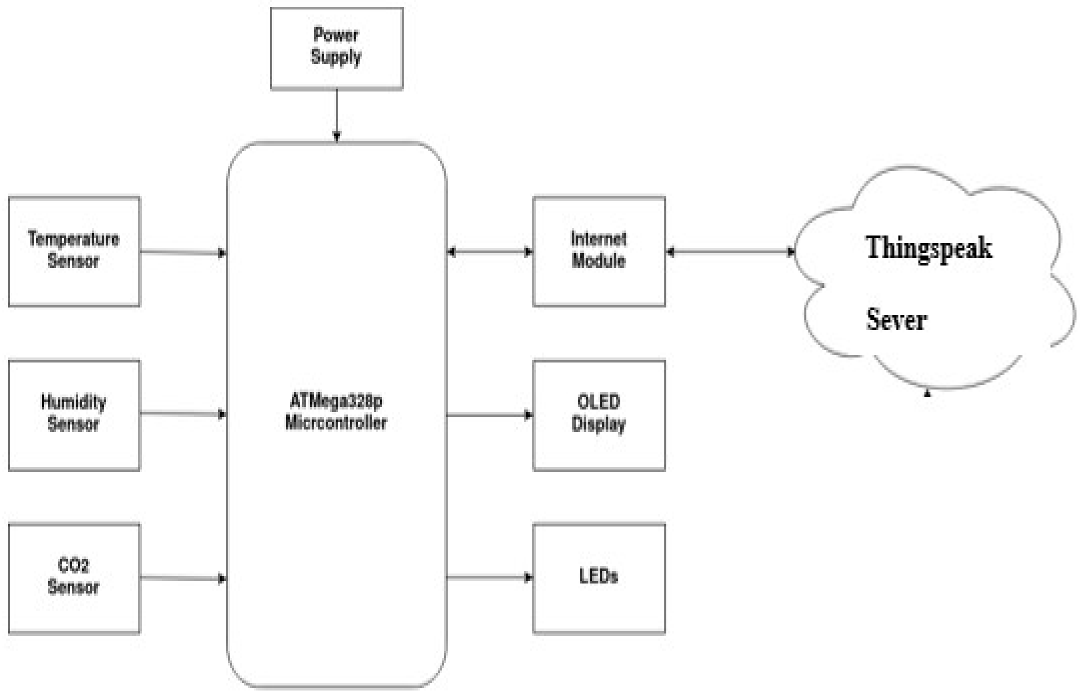

Figure .1: Block diagram of the environmental monitoring system showing the sensors are connected to the microcontroller

3.1 Power Supply Section

There is a need for uninterrupted power supply section because the data collection is real time. The power supply system is a 20W solar power system is considered to charge 12 A, 30AH deep cycle battery whose output is regulated to produce 5V.

3.2 Micro-controller Section

This section uses ATMEGA328P which is a high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards. The ATMEGA328P-PN is the 8-bit RISC heart of the Arduino Uno, with a maximum clock frequency of 20MHz, 32KB program FLASH, and 2KB of RAM.

The ATMEGA328P-PN contains many on-board peripherals, including UART, SPI, timers, ADC, comparators, and a watchdog, and is housed in a 28-DIP package which enables designers to easily prototype their designs before committing to surface mount technology.

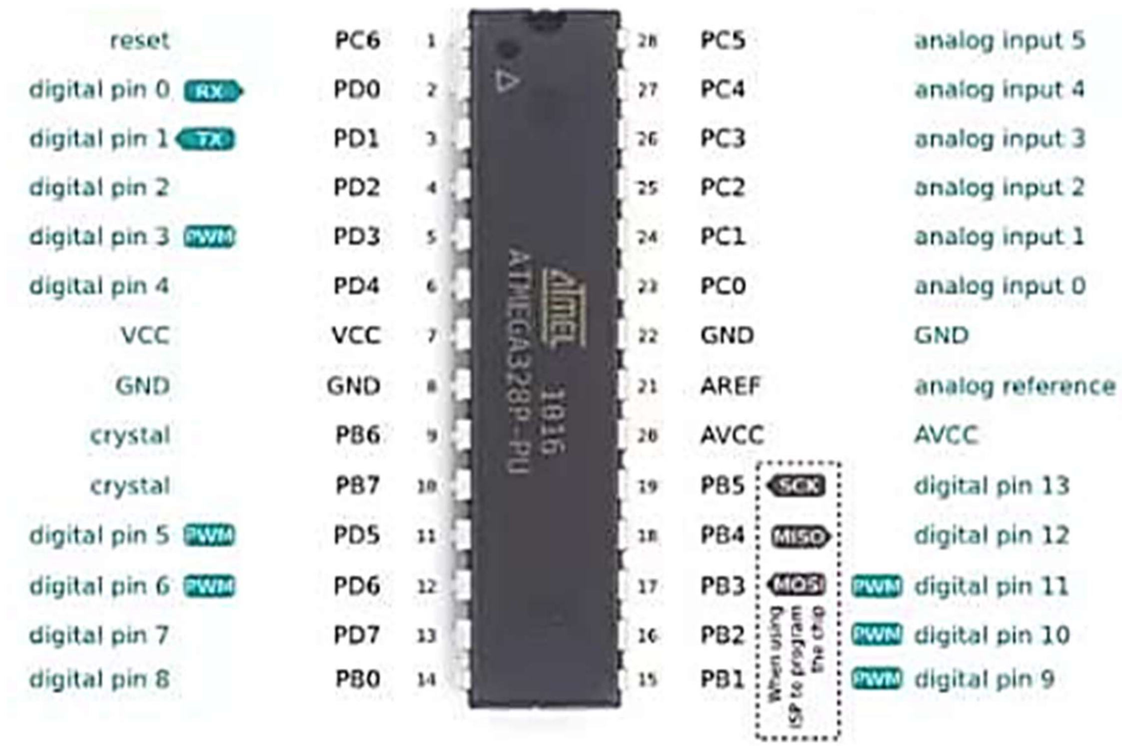

Figure 2: ATMega328p Microcontroller

3.3 Digital Temperature and Humidity Sensor

The AM2302 is a wired version of the DHT22, in a large plastic body. It is a basic, efficient digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analogue input pins needed). It's fairly simple to use but requires careful timing to grab data. It is a little more accurate and good over a slightly larger range. Both use a single digital pin and are 'sluggish' in that you can't query them more than once every second or two. In this project, it is used to capture the environmental temperature and humidity.

Figure 3: Industrial Temperature and Humidity Sensor

3.4 Carbon dioxide Sensor (CO2)

A carbon dioxide (CO2) sensor is a device used to measure the concentration of carbon dioxide gas in the atmosphere. It is measured using "parts per million" (ppm) and typically has a presence of around 400 ppm. In this project, it is used to capture the presence and the level of the gas in the environment.

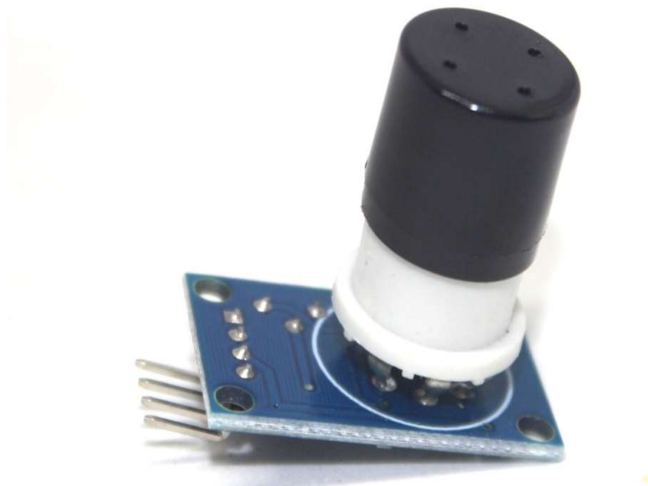

Figure 4: CO2 Sensor

3.5 Benzene Gas Sensor

It is mainly used to detect formaldehyde, toluene, benzene and other VOC gasses, is a semiconductor-type sensor product, and is widely used in ventilation equipment, ventilation fans, air filters, hoods, hoods and other equipment. With high sensitivity and stability, it can detect gas over 0.1ppm, suitable for the detection of formaldehyde in the air, benzene, xylene and other organic volatile components. This project is used to capture the concentration of benzene gas in the environment.

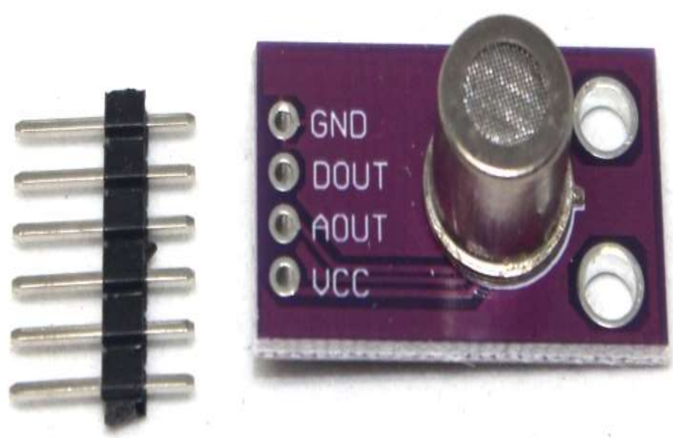

Figure 5: Benzene Gas Sensor Module

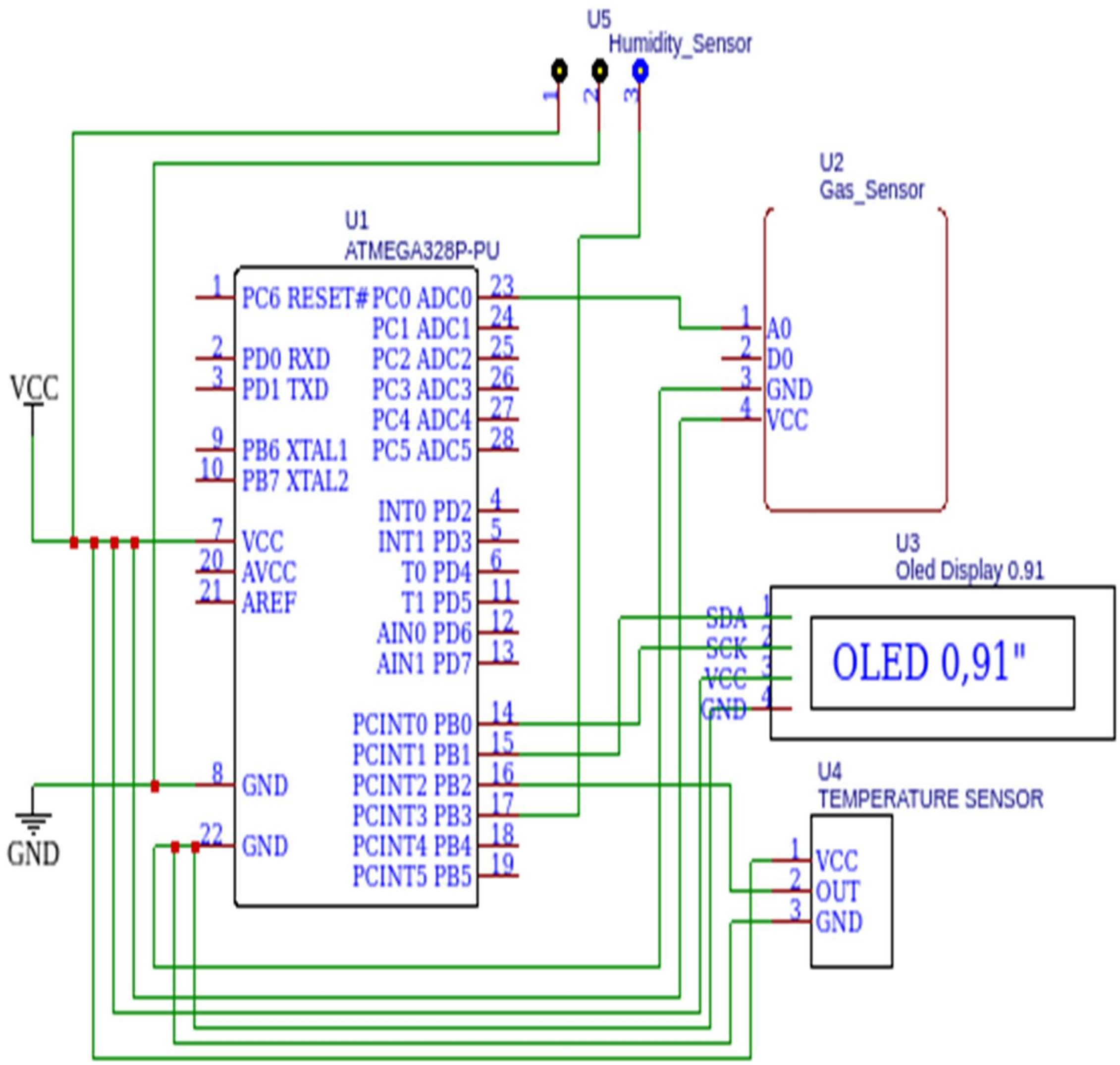

Figure 6: Design Circuit Diagram

4. TESTING, RESULT AND DISCUSSION

All sensors and other components were tested individually to ascertain their compatibility with the micro-controller. The operating voltages of the humidity, temperature, CO_2 and benzene sensors are is between 5V -12V. The micro-controller can only accept voltages between 0-5 V into the programmable input pin. It is therefore important that any output voltage from the sensors fed into the micro-controller must be within this range. The data from the sensors are transmitted to the Thingspeak cloud IoT platform with the help of the ESP8266 Internet module every 5 seconds. Upon implementation, the snapshot of the collected real time data chart displayed in the thinkspeak IOT cloud sever is shown in figure 7 to figure 10.

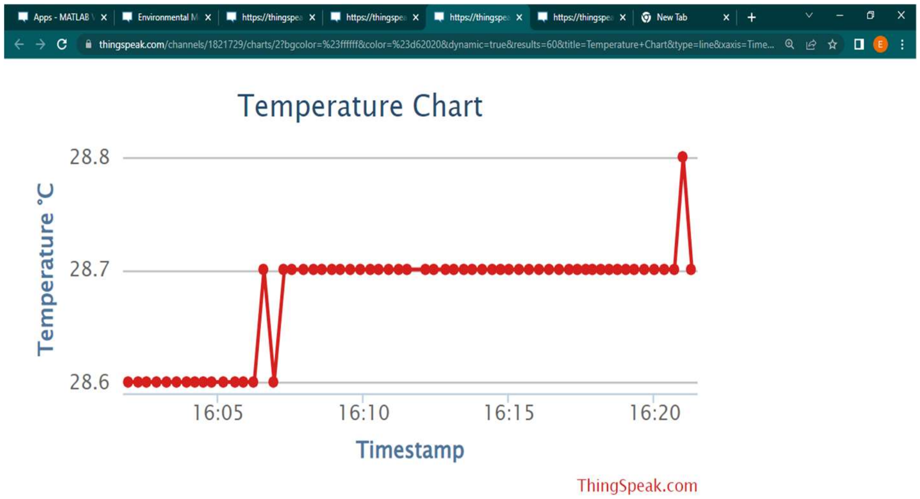

Figure 7: Graphical Representation of Temperature Measurement

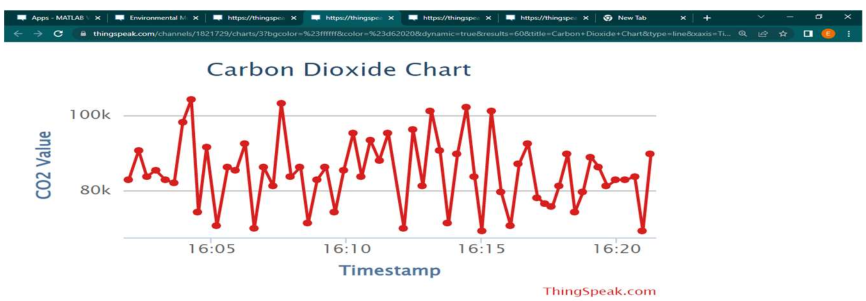

Figure 8: Graphical Representation of Carbon Dioxide Measurement

Figure 9: Graphical Representation of Humidity Measurement

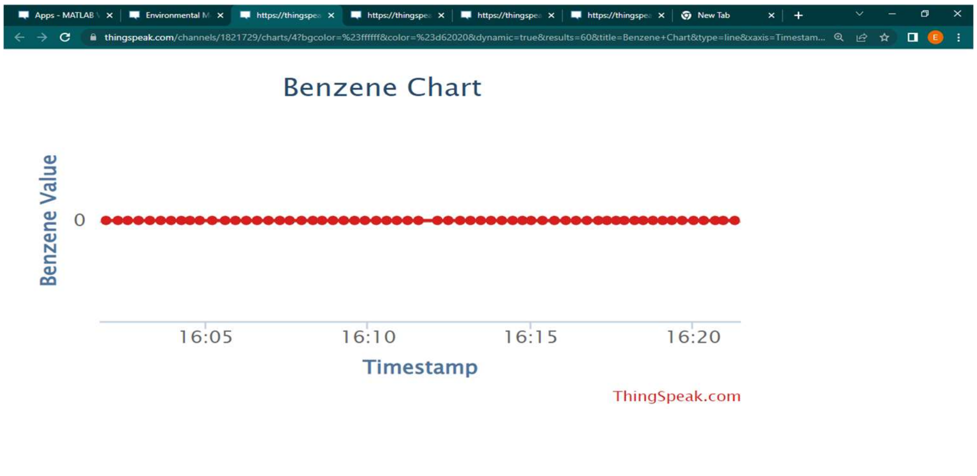

Figure 10: Graphical Representation of Benzene Measurement

5. CONCLUSION

The IoT based environmental monitoring system using Thingspeak was successfully developed using temperature and humidity, CO2 benzene sensors. The sensors were interface with the micro-controller ATMEGA328P. The internet module ESP8266 is responsible for the fast transmission of collated data to the Thingspeak IOT cloud platform for visualization and analysis. This system collects data in real time and can compare favorably with existing system.

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