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Atmospheric Environment Monitoring System Based on Wireless Sensor Prototype to Prevent Data Centers

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Abstract- **- Environmental monitoring is fundamental to understanding our ecosystem to prevent adverse effects on human health and the data environment. According to the World Health Organization, with the rapid increase in polluting gases and particles, the world is now in need of automation that can only achieve through the development of a system that controls the hazards of the environment. In this research, we are developing a system named 'Atmospheric Environment Monitoring System Based on Wireless Sensor Prototype to Save Data Centers' that is capable to record data in real-time and keep us updated about the abnormalities of the environment to keep the system safe and secure. Data centers are responsible for the process of patching, updating, and reporting. It is important to protect them from any kind of harm so that they can perform efficiently. The goal of this research is to protect data centers from any type of damage that can cause delay or latency to businesses and to ensure the safety of the electronic devices that are present in the data centers. Another objective is to monitor remotely to meet demand, data centers are facing the need for physical expansion of their proficiencies, such as the addition of new server racks, greater capacity systems, and more.**

Index Terms— Pollution, Particles; Automation; Wireless Sensor Network; Data Center; Abnormalities; Data Center.

I. INTRODUCTION

Data centers are a fundamental portion of the enterprise, designed to support business applications and provide numerous services such as data storage, administration, backup, and recovery. It is important to make sure that data centers are safe and secure.

Automation in the data center is extremely valuable because it frees up human computing time and automates routine procedures such as patching, updating, and reporting. To meet demand, data centers are facing the need for physical expansion of their proficiencies, such as the addition of new server racks, greater capacity HVAC systems, and more. A lot of people would be facing a problem if they want to make a physical change because of the long distance.

Although this problem has been deciphered and a solution has been brought up which is that if we combine traditional data center infrastructure management (DCIM) with the Internet of Things (IoT) application it will minimize the need for on-site interventions, reducing costs and improving data collection. Data center automation will not only enhance operational efficiency but also agility.

For maximum protection, a comprehensive safety system is needed to ensure business continuity, personal safety, and damage mitigation in case of any emergency. The cornerstones of such a system are to provide an automated solution that guarantees the earliest and most reliable detection in highly sensitive areas and then generates the alarm.

Automation in the data center is extremely valuable because it frees up human computing time and automates routine procedures such as patching, updating, and reporting.

The purpose of this system is to ensure the safety of the electronic devices installed in the room specifically computers, for instance, if the temperature gets too high and seems unsafe then the system generates an alert which helps the people on the spot to take adequate measures to counter the situation in this way, a lot of damage to the systems and lives can be avoided.

a. Real-time data monitoring of critical parameters.
b. Data storage on a server in real-time.
c. Data analysis by Plotting graphs on the dashboard.

d. Generate daily log files to track and monitor daily updates.
e. Implementing a process for backup to avoid data loss Sound an alarm if abnormalities are spotted.
f. It includes a camera for remote viewing of the data center.
g. Desktop Application
h. Mobile Application for Administration access only.

II. LITERATURE REVIEW

A literature review is used to acquire information from many research articles to get an understanding of a project that we wish to begin. We read some of them in detail, and all of them are relevant to the foundation of our idea.

Currently "Environmental Monitoring System Using IoT and Cloud Service at Real-Time" in which the author proposes an internet of Things (IoT) based on a real-time environmental checking framework. The framework uses sensors to monitor and oversee vital natural parameters such as temperature, humidity, and carbon oxide (CO) level, and after that sends the information to the cloud. The information is available over the web from any place, and the sensor information then appears as graphical measurements in a portable application. The data can be utilized to control the circumstances from a remote place. Notices can too be sent utilizing this strategy. The collected information is transferred to the cloud, where it is gotten to by an Android application that shows the results to the end-users. The framework incorporates an Arduino UNO board, a DHT11 sensor, and an ESP8266 Wi-Fi module that employments MQTT to send information to AWS IoT Center cloud administrations. The result is an Android application that gets cloud information and shows the results to the clients [1].

"IoT Based Model for Monitoring Datacenters Systems" in [2] introduced a prototype model for observing framework based on the Internet of Things (IoT). The concept was to arrange that included equipment and a set of sensors. Those devices are associated with the main monitoring framework through Ethernet or the Global System for Mobile Monitoring (GSM). The objective of this paper is to ensure information centers against natural turbulence. The framework communicated environmental recordings to a centralized framework that analyzed the information and suggested or took essential activities utilizing an undertaking arrangement with different Internet of Things (IoT). The centralized framework has a portal with real-time information and protected records from the past. The data was displayed in a graphical dashboard with real-time charts.

"IoT Based Weather Monitoring System for Effective Analytics" [3] article demonstrated the use of a Raspberry Pi to create a weather monitoring system. Access to the information is provided on the network at this time's extent of performance, and it may be made public after the information is kept in cloud storage or other web sources. The smallest unit for analyzing meteorological parameters in locations where pollution is generated by Particulates with a diameter of fewer than 2.5 micrometers is this proposed system (PM 2.5). This device consists of several nodes that may interconnect from various study sites. The Raspberry Pi relates to sensors and other components as well as the software that manages the data acquired by the sensors.

In [4] Data about humidity, temperature, leakage of gas, light intensity, sea level, and water level are collected and wirelessly uploaded to ThingSpeak through Arduino UNO. The focus of this work is on MATLAB visualization and analysis of records.

The author of "Real-Time Environment Monitoring System Using IoT" keeps track of humidity, ambient light, and temperature. He creates an operational prototype based on IoT concepts for real-time monitoring of various environmental conditions utilizing readily available and low-cost sensors [5]. With the help of separate sensors, an Arduino board continuously checks, processes, and limits various environmental variables such as temperature, air pollution, sunshine intensity, and rain. With the help of an ESP8266 Wi-Fi module, this data is distributed over the internet. It exhibits dependability, and the system is in good working order. The purpose of this prototype is to monitor real-time data that is utilized to generate graphical information about the environment.

Environmental Internet of Things [6] is the deep integration of Internet of Things technology and the environmental protection industry. The environmental Internet of Things has a wide range of applications in environmental monitoring systems, including pollution source location, vehicle emission monitoring, and environmental quality assessment.

On the one hand, thermal dissatisfaction seriously affects people's health, while on the other hand, artificial air conditioning for space cooling in buildings represents a significant challenge in terms of energy efficiency [7, 8].

Moreover, in these zones, due to population growth along with the temperature effects caused by climate change, electricity energy used in social housing is expected to have a growing influence on both local and global energy consumption rates [9, 10].

IoT has been successfully used to continuously monitor diverse processes. This approach has shown broad application potential in the agricultural sector to report in real-time to farmers the comfort level of comfort in crops (temperature, humidity, pH, etc.) [11, 12]. It has also been quickly adapted to the medical field for the storage and remote visualization of a patient's vital signs (heart rate, oxygen saturation, blood glucose level, etc.) [13, 14]. In the energy sector, this approach has proven to be one of the main trends to reduce instrumentation costs and streamline the decision-making process to improve the performance of large photovoltaic installations [15, 16], the real-time monitoring of offshore wind farms [17, 18], and the automation of households to integrate them into smart grids [19, 20].

Another important factor in analyzing from the perspective of thermal comfort is the validation of IoT systems for measuring indoor conditions in inhabited buildings. Most of the reported systems are validated under laboratory conditions [21-25].

For this purpose, the Raspberry Pi was used; it is a cheap and low-power reduced board computer that operates under a distribution of the open-source Linux operating system [26]. Into the Raspberry Pi board were implemented different APIs intended to perform specific operation processes on data.

Mosquito API [27] is used for assigning tags to RSN and enabling communication.

The energy consumption during the cluster head selection phase in a hierarchal and dynamic cluster-based wireless sensor network had been considered insignificant in the previous research works [28].

The recent advancements open up many significant energy optimization techniques in the Internet of Things. Smart systems can now achieve a paramount level of control of user comfort while reducing the use of energy. Our main purpose is to construct a smart environment monitoring and surveillance system using a wireless sensor network (WSN) mainly focused on the plantation, bridge monitoring, and industrial products [29].

Energy constrained nature of WSNs necessitates that their architecture and communication protocols be designed in an energy-aware manner. Sensor data collection through clustering mechanisms has become a common strategy in WSN [30].

The said automation technology i.e. IoT (Internet of Things), has taken us to a new world of automation. This new era of the Internet Revolution, where we tend to discover approaches to make things inside the range of our fingertips, prompted the advancement of office Automation Systems [31].

We studied several research articles that discussed the same technology or module, but for our research, we sorted and reviewed only a few research papers to support our research. This research has been the subject of extensive investigation, and the researcher employs these modules by following the appropriate scenario.

It has been evaluated and studied for many years, allowing us to conclude each of our project components.

III. PROBLEM STATEMENT

Data centers are a fundamental portion of the enterprise, designed to support business applications and provide various services such as data storage, administration, backup, and recovery. It is critical to ensure the safety and security of data centers. Maintaining uptime is a top priority for data centers. Protecting these mission-critical facilities against any abnormal things is vital but detecting the early signs of such things as (Fire, Smoke detection, and Water leakage) can be a real challenge. The foundations of such a device are an automated solution that ensures the earliest and most accurate detection in highly sensitive locations, followed by the generation of an alarm. Automation within the data center is amazingly profitable since it liberates up human computing time and mechanizes schedule strategies such as fixing, upgrading, and announcing.

In the light of the problem here we are developing an 'Atmospheric Environment Monitoring System Based on Wireless Sensor Prototype to Save Data Centers' which will be able to acquire data in real-time and keep you informed about all levels of the environment to maintain the systems safe. Because these data centers will speed up the process of patching, updating, and reporting, and will also reduce human computing time. This will make it possible to handle more data efficiently and that too without errors, and surely it is the need of the hour.

The purpose of this system is to ensure the safety of the electronic devices installed in the room specifically computers, for instance, if the temperature gets too high and seems unsafe then the device will generate an alert which will help the people on the spot to take adequate measures to counter the situation. In this way, a lot of damage to the systems and lives can be avoided.

This product is one of its kind and can be used for multiple purposes, it is not confined to data centers only, but can as well be used for small businesses and even normal households, as this device is easy to install and use. The benefits of this system are somewhat never-ending that is why it is always going to be the first choice of many users around the world.

Datacenters play a vital part for any company as they are responsible to store and protect their data. It is important to follow all the precautions to make sure that the data center is safe and secure. Our goal is to develop a system that will help the company in protecting its data from any kind of abnormality.

IV. HARDWARE AND SOFTWARE DESIGN

A. HARDWARE USED

The proposed system's most important component is a Raspberry Pi (Version 4) module, which serves as the system's main processing unit. It connects to the input sensors to receive temperature and humidity, water level, smoke, sound, and touch data, and then sends the information to the cloud over the Internet. The microcontroller polls the sensor for data and sends it to the cloud for processing over the Internet.

1. RASPBERRY PI

The Raspberry Pi, which interfaces with other components of the system, is the most important hardware component of the proposed system. FIGUREure 1 depicts a Raspberry Pi model that we used in our project. The Raspberry Pi has 40 pins, with 26 of them being GPIO pins and the rest being power or ground pins. It is programmed in Python using the VNC viewer IDE.

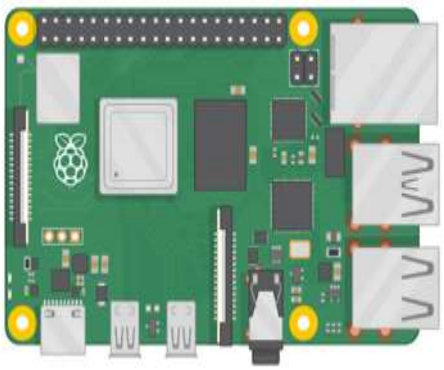

FIGURE 1. Raspberry Pi

2. DH11 SENSOR

The temperature and humidity sensor is also known as the DHT11 sensor. This sensor detects the temperature and humidity and the changes that occur in the environment. FIGUREure 2 shows the picture of the DHT11 sensor which we have used in our project.

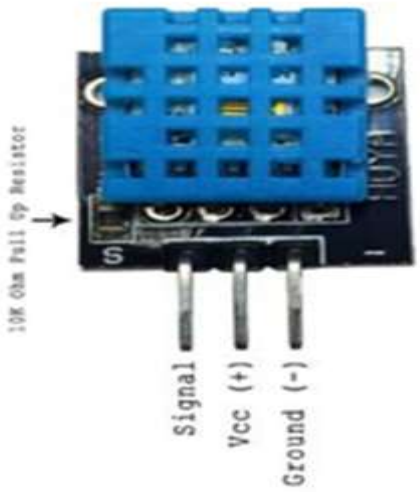

FIGURE 2. DHT11 Sensor for Temperature and Humidity.

3. MQ2 SENSOR

It is also known as MQ2 sensor. It detects the presence of gases in the atmosphere. This sensor is used in factories and manufacturing facilities to identify gas leaks. FIGUREure 3 shows the gas sensor.

FIGURE 3. MQ2 Sensor for Gas and smoke

4. GROOVE SENSOR

The sound intensity of the environment will be detected by the groove sensor. The main component of this module is a simple microphone, which is based on the L358 amplifier and an electric microphone. FIGUREure 4 shows the picture of the Groove sensor.

FIGURE 4. Groove Sensor

5. WATER LEVEL SENSOR

Water level sensors are used to detect the substance that can flow. The purpose of this sensor is to determine the presence of the liquid at any moment. FIGUREure 5 shows the picture of the sensor.

FIGURE 5. Water Level Sensor

6. TOUCH SENSOR

A capacitive touch sensor detects the touch and then an onboard LED gives a visual indication when the sensor is triggered.

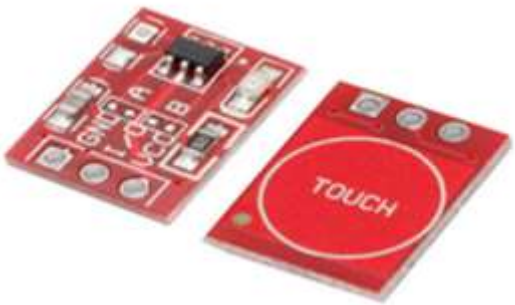

FIGURE 6. Touch Sensor

7 Pi Camera

Pi Camera module takes pictures and captures high-definition video. Raspberry Pi Board has Camera Serial Interface to which we can attach the pi camera module directly using a 15-pin ribbon cable.

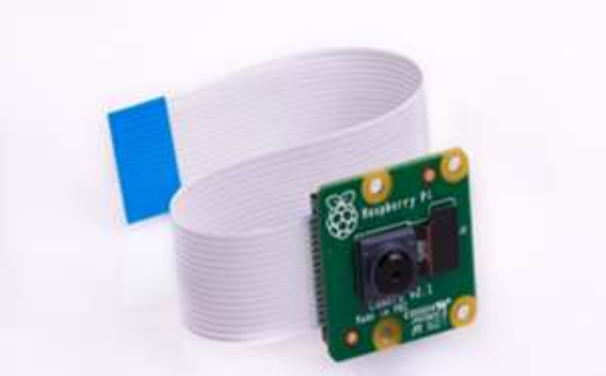

FIGURE.7. Pi Camera

B. SOFTWARE DESIGN

1. MQTT

MQTT CLOUD is a standard messaging protocol for the Internet of Things (IoT). The MQTT is Message Queuing Telemetry Transport, and it is designed for lightweight to publish/subscribe messaging transport for connecting remote devices [32].

We are using MQ Telemetry Transport (MQTT) to get our values of the sensor from Raspberry pi. After getting the values, they will be displayed on our desktop application to help us monitor the values digitally [33].

2 THINGSPEAK

Thing Speak is an IoT analytics stage service. It permits you to aggregate, visualize and analyze live information streams within the cloud. It gives instant visualizations of information posted by your devices to ThingSpeak. ThingSpeak is an IoT Cloud stage where you will send sensor information to the cloud.

We are using ThingSpeak to display our graph. It relates to raspberry pi where we get the values from our sensors which is later displed on our screen through graphs. ThingSpeak is a cloud platform and our main purpose for using is to access it globally.

3. DESKTOP APPLICATION

Java Graphical User Interface is used for the desktop application. The desktop app will display the splash screen after the screen login page will be displayed. After logging in, the dashboard will display the values of the sensor. MySQL is used for the database of Java [34].

4. MOBILE APPLICATION

Android mobile application interface is also developed for administration. It will only be accessible by the administrator of the company. It will show them the values of the sensor. SQLite database is used in the android mobile application [31].

V. METHODOLOGY

To protect the premises from any form of mishap, we devised a hybrid approach in which all vital sensors are installed and connected via Raspberry Pi. The Raspberry Pi is also connected to a desktop and mobile application using the MQTT cloud protocol. The sensor values are displayed on both the desktop and mobile applications. If an irregularity occurs because of this, the sensors detect it and notify the Raspberry Pi. At the same moment, the Desktop Application and Mobile Application sound the alarm and notify the team and supervising authorities, while Thingspeak, on which the graph is displayed, indicates that the reading has exceeded the set threshold. We also have a camera that allows us to view the data center, as well as collect and record footage.

Staff and admins can use the desktop application, whereas the mobile app is only for admin use. In the case of the Desktop Application, the administrator registers the employees who work in the datacenters, after which the employees enter their credentials and log in. Only show readings and the daily log file are accessible to employees. When the administrator logs in, he has access to the show readings, the daily log file, and the employee registration. Every entry, along with the date and time, is saved in the daily log file of the desktop application. To evaluate the readings, staff or admin can also sort the records by date. No one can use the mobile application unless the admin authorizes them. Restraints have been put in place. In Thingspeak, however, all the sensor graphs are plotted.

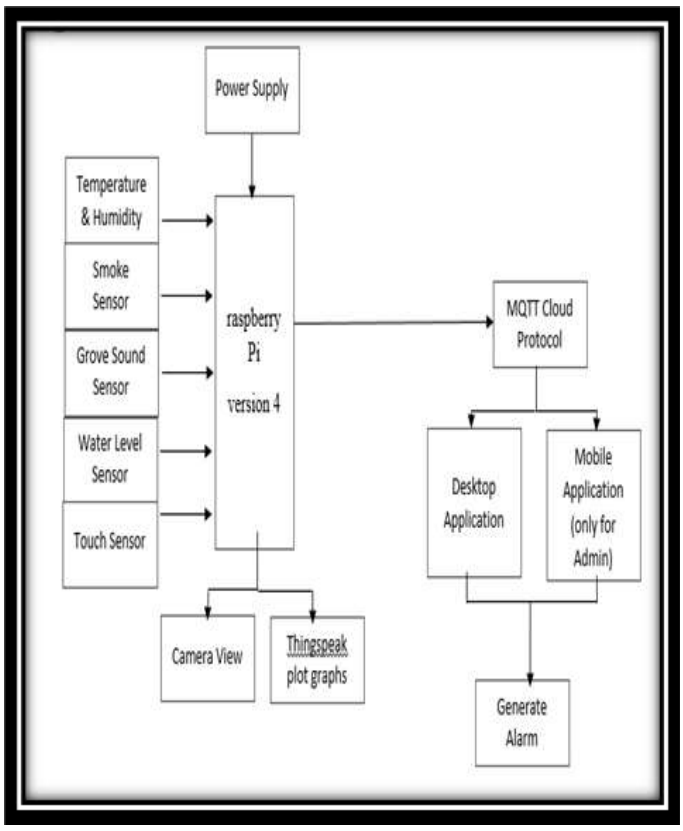

FIGURE 8. System Block Diagram

VI. EXPERIMENTS AND RESULTS

Desktop Application and Mobile Application both displays the records related to the parameter that is captured by the corresponding sensors and a daily log file is generated by Desktop Application to view and analyze the daily readings of the sensors and filter them by date. The outcomes are displayed by our criteria.

Table 1: Values detected in sensors

DHT11	Grove sensor	Touch sensor	Gass sensor	water level sensor
25	detected	detected	1	1
30	Not detected	detected	0	0
35	detected	Not detected	0	0

Table 2: Values above of threshold level

DHT11	Grove sensor	Touch sensor	Gass sensor	water level sensor
55	Sound detected	detected	1	1
50	Not detected	detected	1	0
49	Sound detected	Not detected	0	0

A. DESKTOP APPLICATION VIEW

The desktop application shows the data related to the temperature and humidity, water level, gas, sound, and touch record captured by the corresponding sensors and also generate the daily log file.

FIGURE 9. Data received by the desktop application

B. MOBILE APPLICATION VIEW

The mobile application shows the data related to the temperature and humidity, water level, gas, sound, and touch records captured by the corresponding sensors.

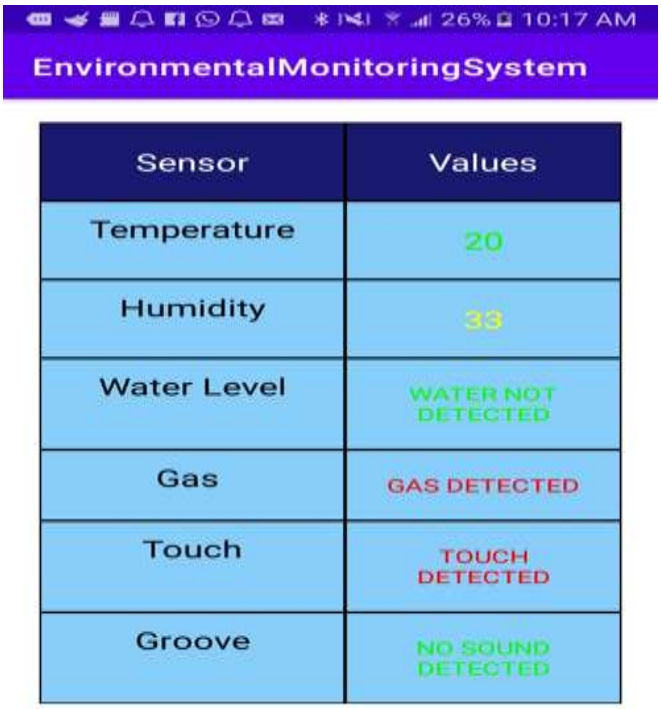

FIGURE 10. Data received by the Mobile application

C. GRAPHICAL RECORD

Figure 11, 12, and 13 depict the data as a graph on thingSpeak to analyze the record.

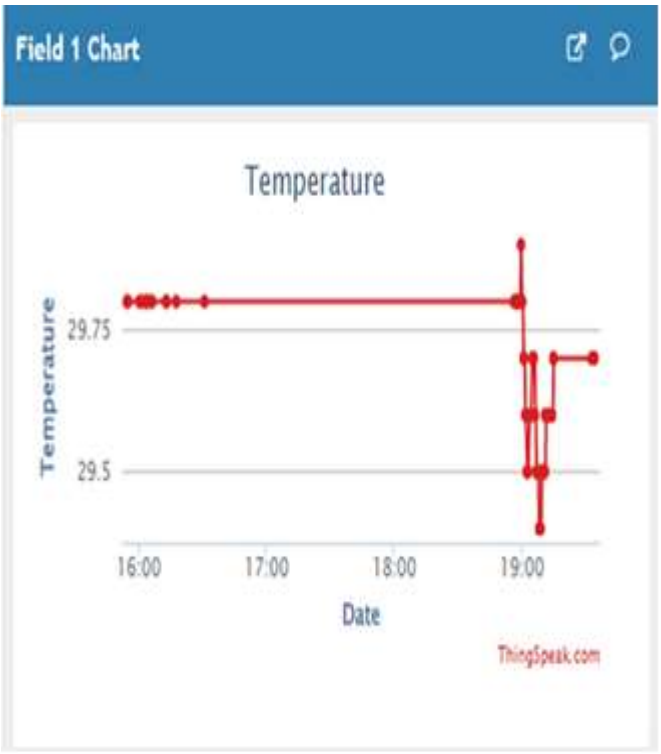

FIGURE 11. Temperature Monitoring Record

FIGURE 12. Humidity Monitoring Record

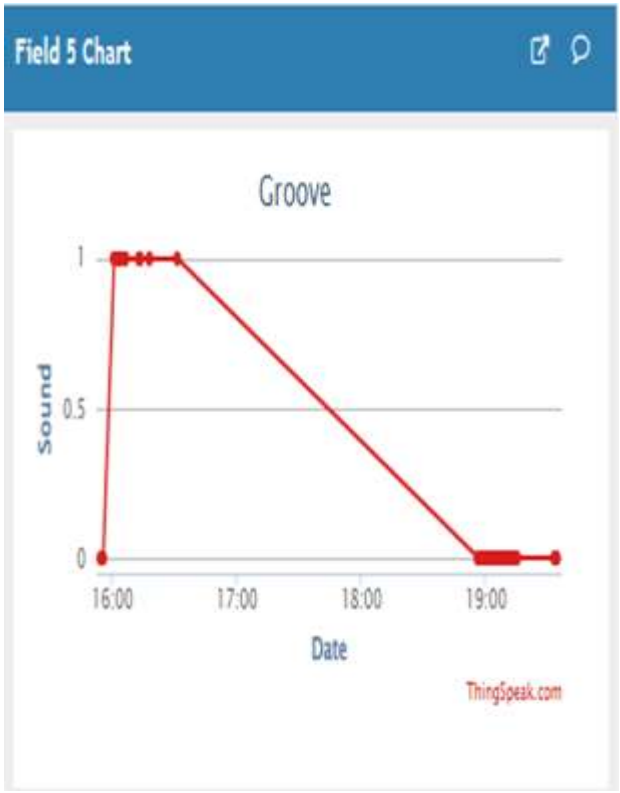

FIGURE 13. Sound Monitoring Record

VII. CONCLUSION AND FUTURE ENHANCEMENT

By integrating real-time data monitoring, generating alarms if any irregularity occurs, and plotting graphs through sensors, desktop, and mobile applications, and cameras, we accomplish our goals of protecting data centers from massive damage, data loss, and human lives. We utilized a Raspberry Pi to contain all of the sensors, as well as an MQTT cloud to connect the Raspberry Pi to Desktop and Mobile Application and Thingspeak to display graphs. To safeguard the data center's data from loss, we employed a MySQL database in which all records are kept.

• Machine learning will be used in the future to decide if an alert notification should be sent to a lower, intermediate, or higher authority depending on the situation. These authorities will also be alert through a call on cell phones.

• In the future, if any irregularity occurs, such as if the temperature rises, the system will automatically make a decision and turn on the air conditioner to balance the temperature and handle the situation.

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