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Predictive Analytics for Maintenance of Industrial Equipment

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Abstract --- Predictive analytics for the maintenance of Industrial equipment can detect and anticipate the maintenance requirements and equipment's operating power to reveal the maintenance needs before the production is affected. It starts with sensors that monitor and record machine activity and conditions of key components. It observes the sensor data that indicate changes in equipment condition.

As an approach, we are developing a low-cost solution by developing an IoT-based sensor network system that can send the sensor data to the Thing Speak cloud, display the analytics in a dashboard, and gives an alert message through the IFTTT messaging platform by predicting downtime of equipment. Ultimately, predictive analytics can provide machine health transparency besides saving time and costs by scheduling maintenance work whenever it is needed.

Keywords --- Thingspeak, IFTTT, NodeMCU-ESP8266, MQ-02 Gas Sensor, DHT11 Temperature and Humidity Sensor.

I. Introduction

Predictive analytics for the maintenance of Industrial equipment is an equipment health maintenance system that detects the failure of equipment at the earliest possibility. Predicting the failures in advance leads to a decrease in downtime of equipment. The breakdown of one machine might lead to a stoppage for the whole manufacturing process and pose a costly scenario.[1] Thus, maintenance plays a key role in providing profitability and a reliable production process. Recent studies have shown that up to 60 percent of the cost of production can be influenced by efficient maintenance[1].In this project, an IoT system is being developed that contains sensors that generate sensor data including temperature, humidity, and vibrations at every time interval, and send that data to the microcontroller which processes the data, the processed data will be sent to the cloud, there we use IFTTT service to analyze the data in the cloud and sends real-time notifications or alert messages through SMS or email.

These alert messages help manufacturers to predict failures and assist them in maintaining the health of machinery. ThingSpeak cloud platform service is used to aggregate, analyze and visualize the live data stream in the cloud thus helping in the real-time monitoring of industrial equipment.

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II. Related Work

In Previous research work, the IOT design framework of intelligent Industrial monitoring system that can successfully shade the Mechanical floor. A system has been developed using an ARDUINO/IOT module, capable of sensing and measuring the concentration of electrical current, vibrations, and temperature. Continuous information obtained from various sensors has been transferred to the Google spreadsheet. Regardless of the other parameters such as temperature, humidity, and light intensity were estimated. For ease of investigation, the information obtained above has been plotted in a graph. Similar arrangements were made to alert the workers if any crisis arise. The framework provides a solid and accurate investigation to prevent any accident case. This is the framework that uses the ARDUINO/IOT module providing modest security measures. A slight modification of the model allows the client to adapt it to any conditions[2].

A GPRS/ GSM module shown in fig. 1 is used in the above-related work to establish a communication between computing machine and a mobile device[2].

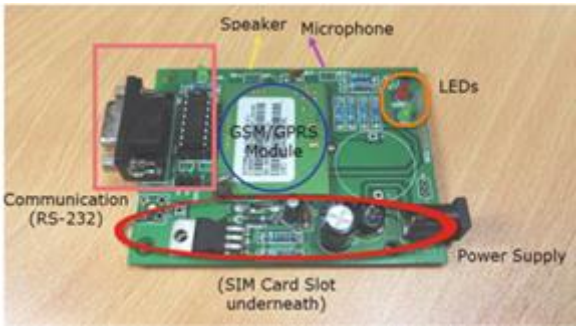

Fig. 1 GSM/GPRS Module[2]

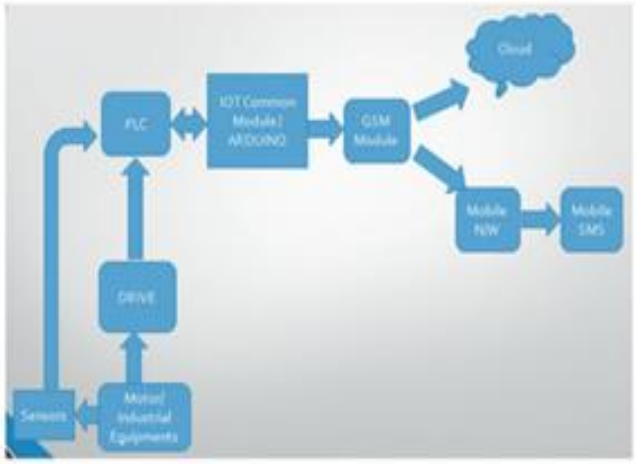

Fig. 2 Concept Block diagram[2]

III. PROPOSED WORK

According to the existing system, our proposed solution could be a solution that reduces cost, downtime, and effort for the maintenance of equipment.

In this design, a prototype contains temperature, humidity, and smoke sensors that detect the equipment's parameters and sends that data to the NodeMCU, the microcontroller which acts as a processor that processes the sensor data. This data will be stored in Mysql Database, and also sends to ThingSpeak Server as well as the IFTTT IoT platform. IFTTT is used for Data Analysis and sends alert messages or notifications through Email or SMS to the owner about the condition of the Equipment. ThingSpeak platform service is used to aggregate, analyze and visualize the live data stream in the cloud(Internet) which provides online monitoring of Equipment conditions. The stored data is further used to generate reports.

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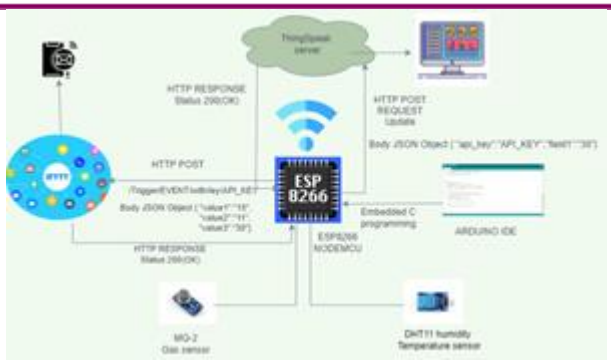

Fig. 3 Architecture diagram

IV. HARDWARE

A. **ESP8266 Microcontroller**: NodeMCU, a microcontroller based on ESP8266, is an open-source platform with a flexible hardware design that can be modified, customized, and built upon. It comprises an ESP8266 chip equipped with WiFi functionality, developed by Espressif Systems, featuring a TCP/IP protocol. This low-cost Wi-Fi chip is integrated into the NodeMCU Dev Kit/board. This controller is used in our project to receive multiple inputs and forward the sensed data to cloud servers.[3]

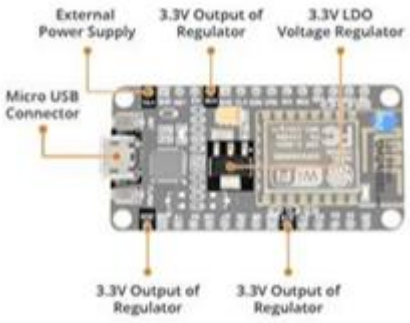

Fig. 4 ESP8266 Micro Controller

B. **MQ-02 Gas Sensor**: MQ2 is a metal oxide semiconductor type sensor that is a powerful device for sensing combustible gas and smoke. The sensor detects the smoke which is in the range of 300 to 10000 ppm. Some of the applications include domestic gas leakage alarms, High sensitivity gas detection. These sensors are termed Chemiresistors as the detection of gas is based on the resistance of the sensing material.[3]

Fig. 5 MQ-02 Gas Sensor[3]

C. **DHT11 Temperature Sensor**: The DHT11 sensor is mostly used for measuring temperature and humidity. This sensor measures the temperature through Negative Temperature Coefficient Thermistor (NTC). This sensor comes with an 8-bit microcontroller that transmits the serial data. It has 3 pins that represent the Ground, Vcc, and Data Input.[3]

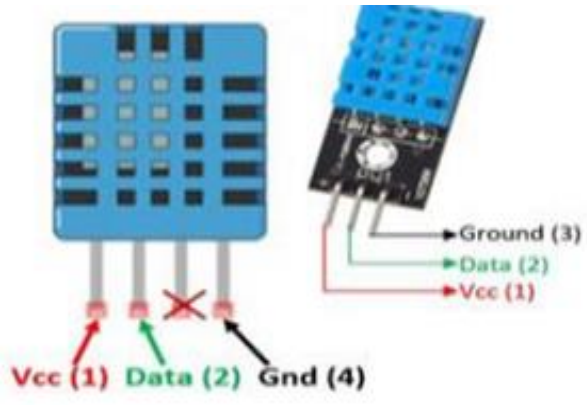

Fig. 6 DHT11 Temperature Sensor[3]

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V. SOFTWARE

A. **Thingspeak Web Server:** Thingspeak web server is used to assemble, visualize and analyze real-time data in the cloud. It is an IoT analytics platform. The data is collected from the sensors and that data is sent to the Thingspeak webserver for instantly visualizing the data. It is an open-source IoT platform that includes libraries and IoT device APIs in addition to a central server that gathers, organizes, and analyses data. The open-source central server can be set up locally or in the cloud with both free and premium payment options. Due to Matlab's support in cloud deployment, which includes graphic output and numerous Matlab toolboxes, ThingSpeak is distinguished by its incredibly user-friendly interface for data processing and display. Access to these toolboxes is provided with a paid subscription in addition to the basic, free Matlab assistance offered by ThingSpeak.

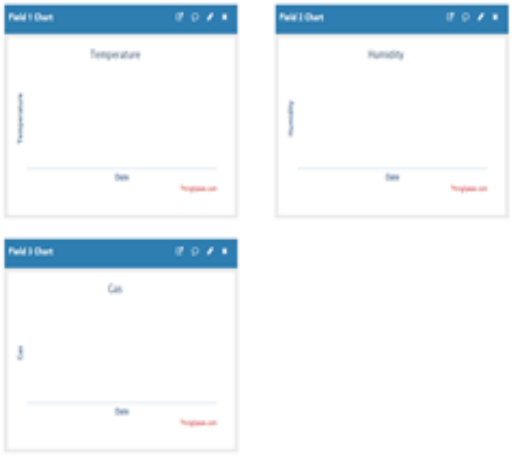

Fig. 7 ThingSpeak Web server Interface

B. **IFTTT platform**: The programmatic conditional command "if this, then that" is whence IFTTT gets its name. To operate one or more automation involving those programs, devices, and services, the company offers a software platform that links products from other developers' websites.

For instance, turn on your Hue lights when you return home.

You may use webhooks to connect other IFTTT services to your DIY projects by making quick web requests. Webhooks use real-time triggers, therefore applets typically launch in a matter of seconds.

C. Dashboard Analytics:

The data collected from the sensors are stored in the MySQL database. The stored data is retrieved from the database and further used to analyze the equipment health management. The dashboard contains the plotted graphs and sensor data. This data is further used to generate a report daily according to the requirement.

VI. RESULTS

The ESP8266 microcontroller is connected to 3 sensors (gas, temperature, humidity) which are again connected to the device or battery to pass current and also connected to WI FI to log data to the Thingspeak web server. From this web server, data is collected and passed to the dashboard.

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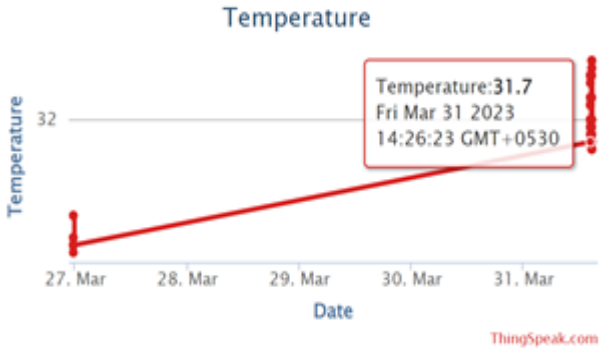
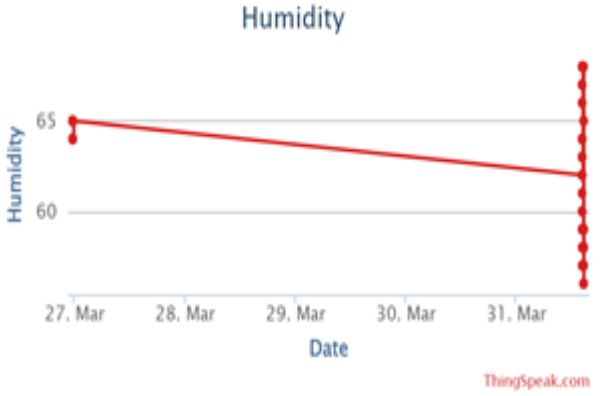
The sensors collect data and display it through the channel on the Thingspeak web server in the form of graphs.





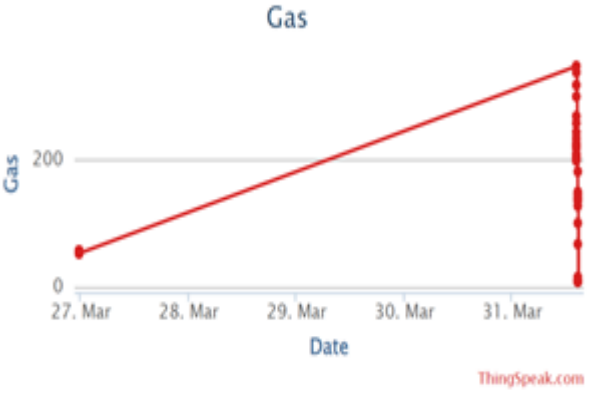


Fig. 8 ThingSpeak Web Server after sensing the objects.

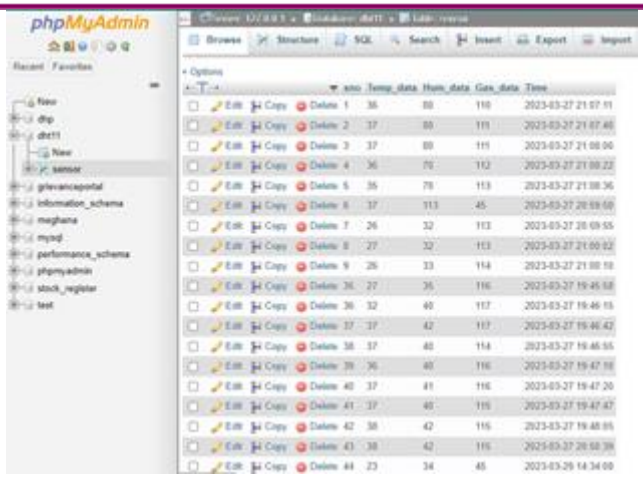


Fig. 9 Mysql database structure

Fig. 10 web dashboard contains Plotting graphs

Fig. 11 Dashboard contains table data stored in the MySQL database.

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VII. CONCLUSION

In this paper, an equipment monitoring system in light of IOT is proposed. Multiple sensors combined with devices that can receive and analyze signals detect numerous parameters of manufacturing equipment. The continuous information acquired from the various sensors has been transferred to IFTTT, Thingspeak, and MySQL databases. For simplicity of investigation, the above information was plotted using Thingspeak. By automating the manual testing process, preventive measures can be taken before the damage.

Arrangements were likewise made to send the alert message using IFTT to the operators if there was an occurrence of any crisis. The introduction of this system of predictive maintenance increases reliability and reduces the cost, equipment downtime, and unscheduled repairs.

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