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Cloud based Wireless Sensor Network for Industrial Parameter Monitoring, Fault Detection and Alert System

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Abstract: A remote monitoring, control and intelligent are one of the most important criteria for maximizing process plant availability production. With the development of modern industry the requirement for industrial monitoring system is getting higher. A system is required to be able to acquire and process real time data. It is also required to control related instruments to change those environmental factors and monitoring in long distance so that it realizes modern, intelligent and accurate control. The main aim of the project is to develop an embedded web system using ARM11 processor and real time operating system, which enables data acquisition and status monitoring with the help of any standard web browser. Determining the dynamic behavior of Industrial parameters require dense development of sensor. The wired Industrial parameters monitoring system of highly expansive and always needs large installation space to deploy. This project describes wireless sensor network which consume low power and less space. The wireless sensor network developed to detect physical parameters of industry continuously and send the sensor information to internet cloud server via TCP/IP protocol. The user can access graphical view of various sensor from cloud server .The cloud server utilizes MATLAB program to give graphical representation of WSN data. On cloud server, user with server account can access real time WSN data and view graphically using MATLAB. In this project an email alert also developed .When WSN detect critical values of sensor data to predict upcoming accident and fault at machineries in industry .The user can also access WSN for announcement when damage and upcoming accidents predicted.

Index Terms **- Raspberry Pi, fault detection, TCP/IP protocol, WSN, Dynamic, IOT.**

I. INTRODUCTION

Large industries such as steel plant and coal industries are the backbone of our society and are critical to its daily operation. Inspectors typically assess them manually, but a networked computer system that could automatically assess industrial integrity and pinpoint the existence and location of any machineries fault and damage could measurably lengthen a industries lifetime, reduce its operational cost, and improve overall public safety. Industrial Parameter Monitoring strategies measure industrial response and aim to effectively detect, locate, and assess damage produced by severe loading events and by progressive environmental deterioration. A wireless sensor network-based data acquisition system, delivers time synchronized industrial-response data reliably from several locations over multiple hops to a base station. It supports flexible self-organizing sensor-network deployments of up to several tens of unmetered wireless nodes and avoids the high cabling, installation, and maintenance costs incurred by traditional wired data-acquisition systems. WSN provides a programmable sensor actuator network system that engineers can use to implement algorithms in a higher-level language such as Mat lab or C. It uses a two-tier hierarchy with resource-constrained sensor nodes in the lower tier and more endowed gateway nodes in the upper tier; theoretically, it can scale to hundreds of nodes. Industrial parameters monitoring calls for sensors that are low-cost, low-profile, and power-constraint. It also requires the sensors to form a network to accurately monitor the low-frequency response that often occurs in many civil industries such as long-span bridges. To monitor a industry (e.g. power plants, projects), we measure behavior (e.g. acceleration, vibration, displacement) of industry, and analyze parameters of the industry based on measured data. However, the existing sensors are either not practice wireless implementation, does not have enough accuracy, or are not cost-effective.

II. LITERATURE SURVEY

The main aim behind the system is as per the proposed system of CSUXu.et.al [1], it is unable to provide the Parameters monitoring of industries for long distance because of ZigBee technology. As per the proposed system of G.Feltrin H. [2] it is also unable to provide the Parameters monitoring of industries when the host is at remote place. As per the proposed system of J.Salmenen, [3] it is limited up to several meters. The system requires more effective device in this case and the data rates are also very low. These are the main drawbacks of these existing systems. So we need better system to provide the civil industry parameters monitoring information to the remote unit. The proposed system fulfils these requirements. Only within the past century have scientists used electronic devices to verify the behaviour of materials used to construct our society's infra industry. As electronics

technology has evolved, it has become more commonly available, and useful, to industrial engineers in both the research and professional arenas.

Today, it would be almost impossible to find a consultant who does not use computers as a design aide. Increasingly, monitoring the parameters of industries will not be solely a function of an annual physical, or visual, inspection by industrial engineers. Engineers now, and in the future, will need to use technology in the field to help them verify the behaviour of that which they have learned to analyse and design. As more industries are instrumented, we will learn more about their behaviour and this can lead to more economical ways to build and maintain them. As an outcome of the combination of computer technology, communication technology and sensor network technology, it is regarded as the first of 21st century top 10 new technologies that changed world. With strong data capture and process abilities, it has very expansive application foreground in the fields of military, environment monitoring, disaster prevention and biomedicine, especially in some special fields such as environment monitoring and disaster rescue with nobody on duty, it has advantages that traditional technologies could never compare.

III. BLOCK DIAGRAM

The System architecture of Industrial Parameters Monitoring System is shown in the figure 1. Raspberry Pi, Power supply forms the entire security system to be installed at the required place An efficient and accurate embedded access control system to be installed at the required place .In these sensors are to be connected with GPIO pins of Raspberry pi, in our project used sensors are digital in nature. So, there is no external ADC convertor is required .These sensors are directly send the digital information to the raspberry pi and it can process the information and it can be sent to the web page via Ethernet. Web page is open platform for IOT applications. These can be used to access and store the data and these can be visualized by Graphical user interface (GUI) by the laptop, pc, smart mobile and give email alert when any parameters cross the threshold values. And it can be helpful to predict the future hazards. Industrial parameters monitoring consist two blocks. They are:

Part1. Industrial monitoring system is a block, which is established in our building where monitoring system is implemented.

Part2. Remote control unit is a frame work implemented by the user where we can display the graph and gives alert to the people

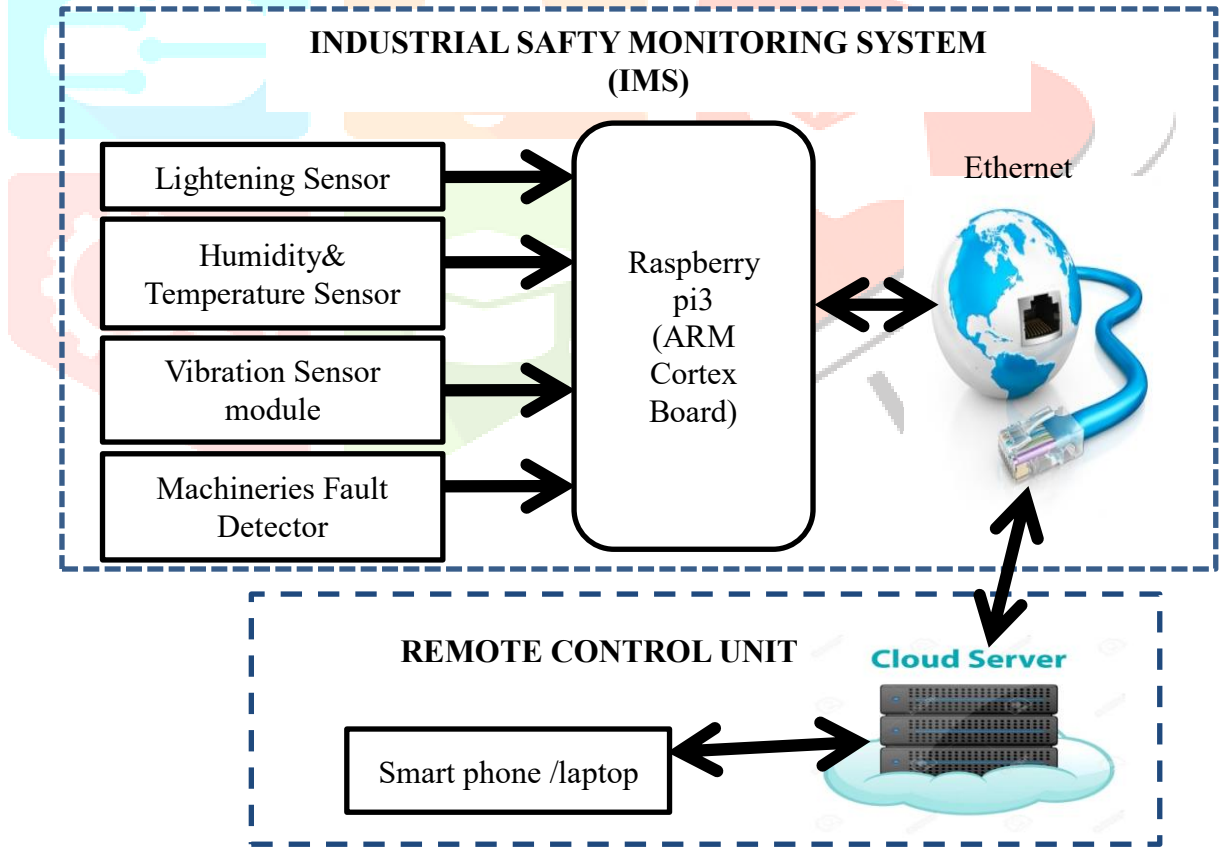

Figure: 1 Block diagram

IV. SYSTEM ARCHITECTURE

Cloud (IOT) based industrial Parameters monitoring system consists of two components, industrial monitoring System (IMS) is part of industry where monitoring system implemented and Remote Control Unit (RCU) is a framework implemented on Users Personal computer or laptop or smart phone.

INDUSTRIAL PARAMETER MONITORING SYSTEM (IMS)

IMS is efficient, low power consumption, low cost WSN system for civil structural health monitoring and allows the user to remote monitoring and controlling. IMS have a Raspberry Pi setup with Raspbian jessi operating system installed on SD card. Our sensors are interfaced with Raspberry pi to detect the temperature, humidity, vibration and light values respectively. These graphs with respect to time and date are saved to ThingSpeak webpage. Generally, our data is saved in the form of entities via TCP/IP protocol.

- **Raspberry pi3**

The Raspberry Pi is a single computer board — developed to encourage and aid the teaching of programming and computing. It is also a fantastic starting point for the development of the Internet of Things (IOT) projects. Pi is the perfect experimental tool, whether you want to use it as a desktop computer, media center, server or monitoring/security device within your home. It has no limits. Linux-based operating systems run on the Pi with plenty of access to free software and download. The new Pi 3 brings more processing power and on-board connectivity, saving you time with the development of your application.

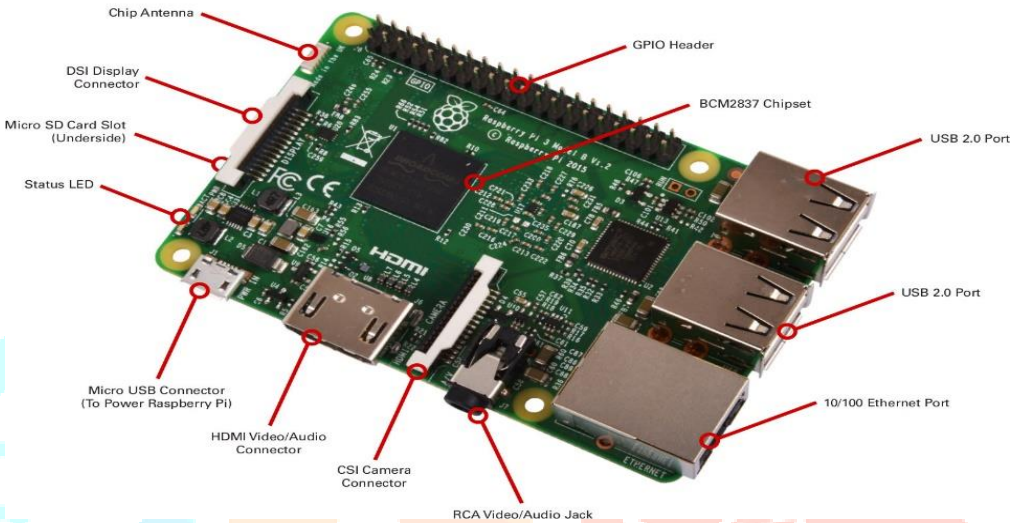

Figure 2: Raspberry Pi3

- **Light Sensor (LDR):**

An LDR is a component that has variable resistance changes with light intensity that falls upon it. These allow them to use in light sensing circuits. When the light intensity is low, then the resistance of the LDR is high. This stops the current flow to the base terminal of the transistor. So, the LED does not light. However, when the light intensity onto the LDR is high, then the resistance of the LDR is low. So current flows onto the base of the first transistor and then the second transistor. Consequently the LED lights. Here, a preset resistor is used to turn up or down to increase or decrease the resistance. The circuit diagram of a LDR is shown below

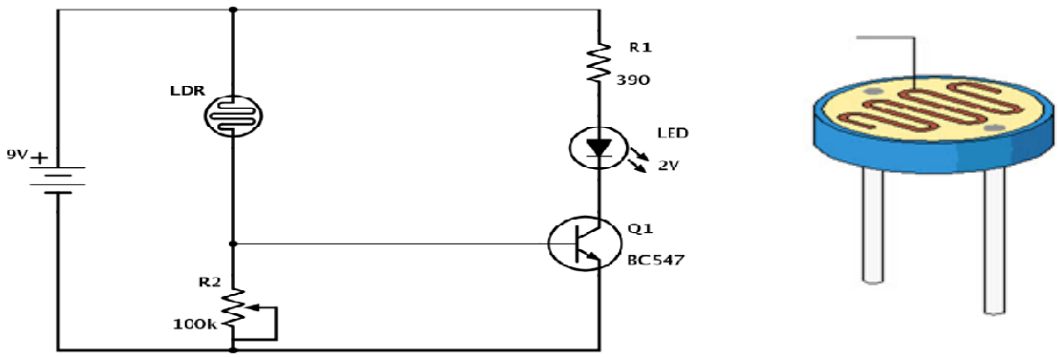

Figure 3: circuit diagram of LDR

- **Vibration Sensor (SW420)**

The Vibration module based on the vibration sensor SW-420 and Comparator LM393 to detect if there is any vibration that beyond the threshold. The threshold can be adjusted by the on-board potentiometer. The Vibration module based on the vibration sensor SW-420 and Comparator LM393 to detect if there is any vibration that beyond the threshold. The threshold can be adjusted by the on-board potentiometer.SW-420 Vibration Sensor is a one of the most commonly used module for vibration or tilt detection above a particular threshold. This module consists of vibration sensor SW-420 switch and comparator LM393. The comparator converts signals from switch to Digital Output. The module outputs logic LOW when there is no vibration. Compatible with Arduino, Raspberry Pi, PIC, Atmel, and 8051 Microcontrollers.

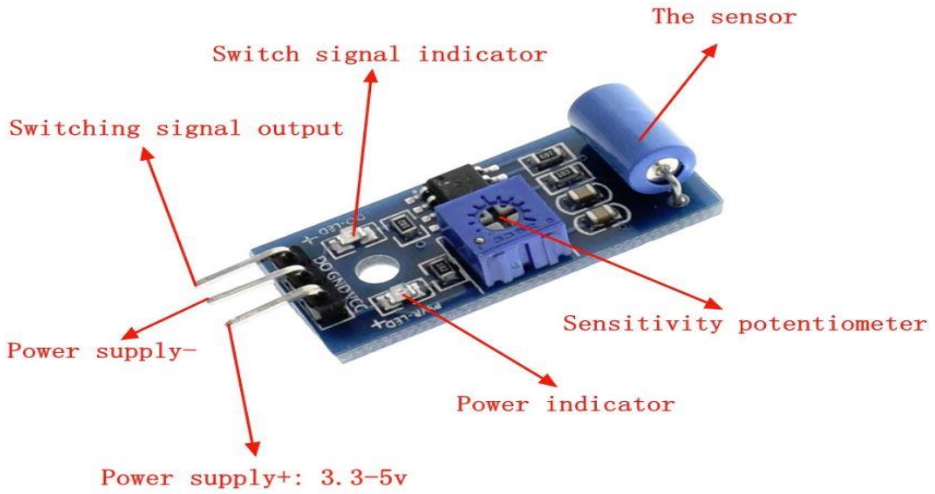

Figure 4: SW420 Vibration Sensor pin diagram

- **Ethernet**

Ethernet is a network protocol that controls how data is transmitted over a LAN. Technically it is referred to as the IEEE 802.3 protocol. The protocol has evolved and improved over time and can now deliver at the speed of a gigabit per second. An Ethernet cable is the most common type of network cable used on a wired network whether at home or in any other business establishment. This cable connects wired devices together to the local network for file sharing and Internet access.

- **Temperature & Humidity Sensor(DHT11)**

DHT11 digital temperature and humidity sensor is a composite Sensor contain a calibrated digital signal output of the temperature and humidity. The DHT11 is a 4-pin (one pin is unused) temperature and humidity sensor capable of measuring 20% - 90% relative humidity and 0 to 50 ℃ .Communicates using its own proprietary One Wire protocol.

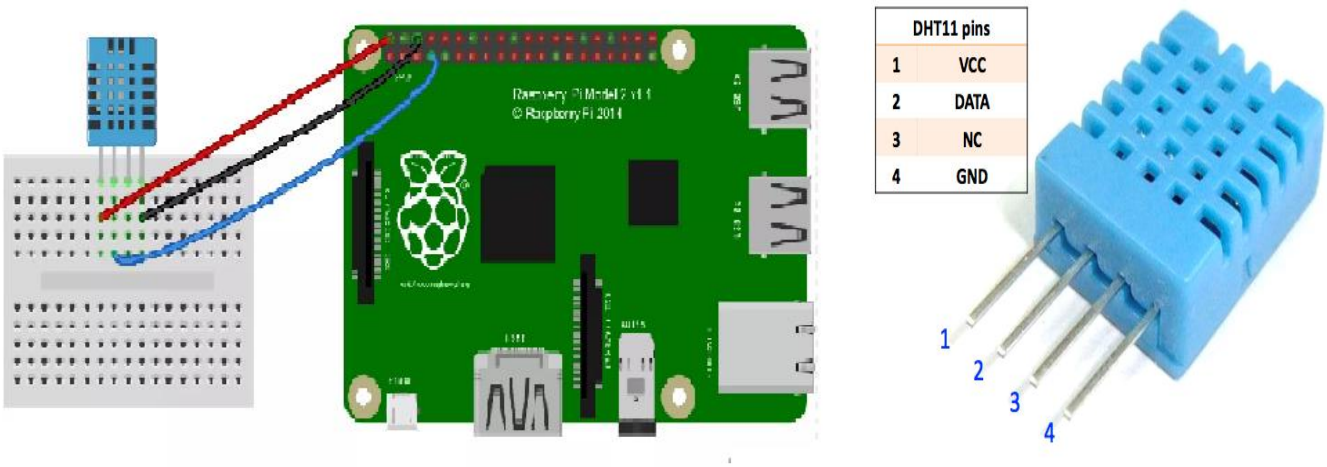

Figure 5: DHT11 with raspberry pi

V. REMOTE CONTROL UNIT (RCU)

RCU is a software tool implemented on Users Smart Phone. Provide GUI (Graphical User Interface) to send predefined Linux Terminal Commands via SSH to IMS... SSH are a secure protocol and the most commonly used to administrate and communicate with Linux servers. RCU is implemented on android platform using python Script on PDK (Python Development Kit) and Eclipse IDE An efficient and accurate embedded access control system based on vibration, temperature, humidity and lightning detection is wide range of commercial and security application .Many countries are doing research for adopting the civil industrial Parameters Monitoring.

- **Cloud Server**

  A cloud server is a logical server that is built, hosted and delivered through a cloud computing platform over the Internet. Cloud servers possess and exhibit similar capabilities and functionality to a typical server but are accessed remotely from a cloud service provider.

- **PC/Laptop/Smart Phone**

  It acts as a graphical user interface (GUI).Which can be used to visualize the output.

VI. OPERATING PRINCIPLES OF IOT CLOUD SERVER

For the purpose of connecting an object to the IOT, we focus on the Thing speak API. The interface provides simple communication capabilities to objects within the IOT environment. Moreover, Things peak allows you to build applications around data collected by sensors. It offers near real-time data collection, data processing, and also simple visualizations for its users. Data is stored in so-called channels, which provides the user with a list of features. Each channel allows you to store up to 8 fields of data, using maximum of 255 alphanumeric characters each. There are also 4 dedicated fields for positional data, consisting of Description, Latitude, Longitude, and Elevation. All incoming data is time and date stamped and receives a sequential ID. Once a channel has been created, data can be published by accessing the Thing Speak API with a 'write key', a randomly created unique alphanumeric string used for authentication. Consequently, a 'read key' is used to access channel data in case it is set to keep its data private (the default setting). Channels can also be made public in which case no read key is required.

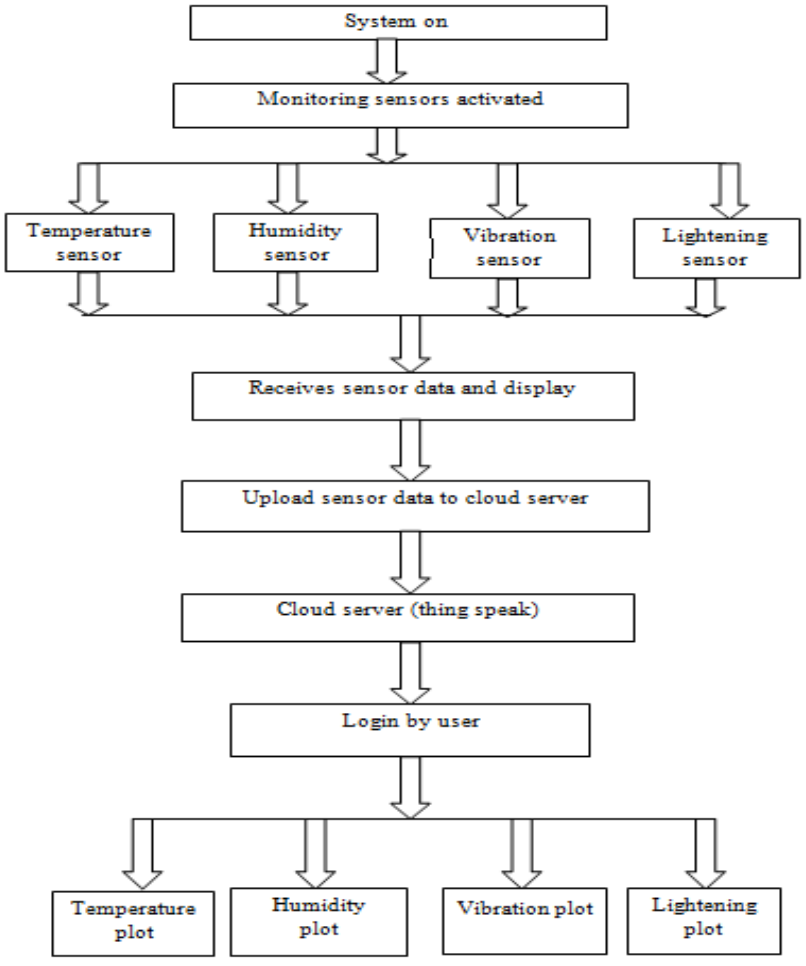

Figure 7: Flowcharts for Design Procedure

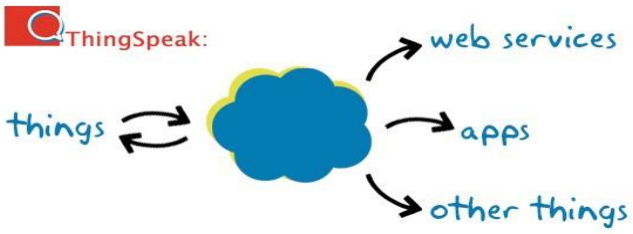

Figure 6: IOT 'cloud' interface

A deeper level of what occurs, especially on the server side. When a device sends data through a HTTP request (communication), it is processed by the IOT service (in this case Thing speak), which communicates with a virtual server. Both the server and the IOT service communicate directly with the application. Finally, at all levels of communication from the device to the application there is both requirements regarding security and management of the data transfer.

VII. RESULT ANALYSIS

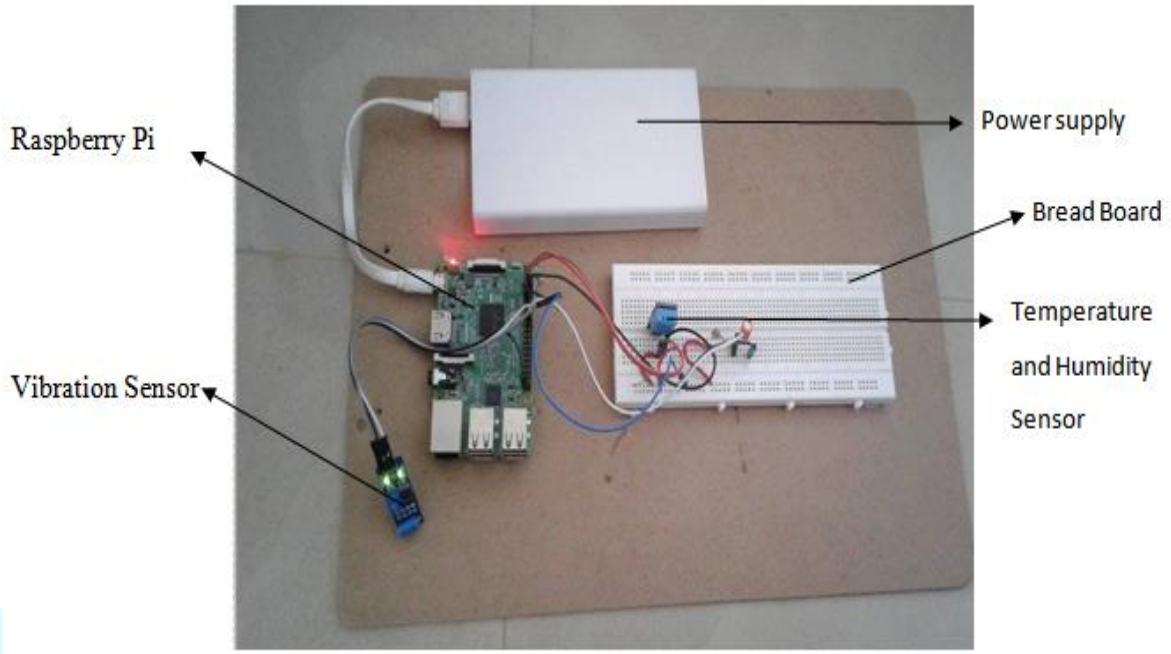

Figure 8: Working Experimental setup for WSN

The results produced by the system of IOT based civil structure health monitoring system and alerting through Raspberry Pi. In such ways, Observations were made here by taking various constraints into account. The experimental setup shown in Figure 5 is monitoring the Industrial Parameter with wireless sensor network. The IMS sends the Email alert indicating the update status to the authorized users and the user then sent the command using SSH Client over the Internet to RCU for controlling action. Based on command RCU run the Python script and activate respective devices.

The Fig.8 screenshot tells about our project setup connection i.e. Industrial Parameter monitoring system The Fig.14 screenshot tells that after installation of putty software we can see the real time data detection of sensors. i.e., vibration sensor, humidity sensor, LDR

Eg; 30.0 58.0 62.0 10 where

- 30.0 indicates that the atmospheric temperature in Celsius.
- 58.0 indicates that the atmospheric temperature in Fareinnheat.
- 62.0 indicates that the atmospheric humidity in ppm.
- 10 in which 1 indicates the light and 0 indicates the vibration.

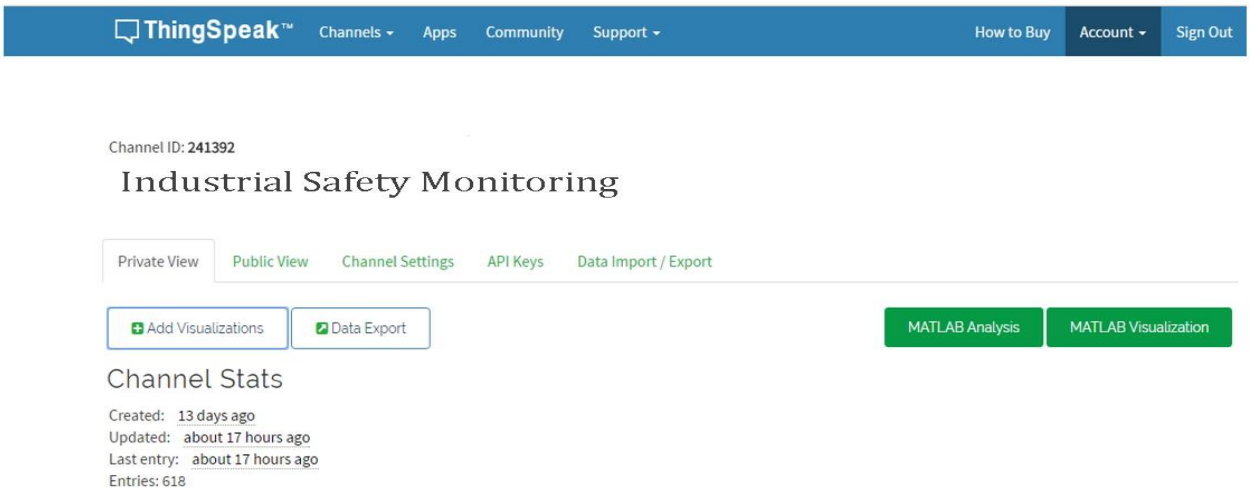

Figure 9: IOT Channel view

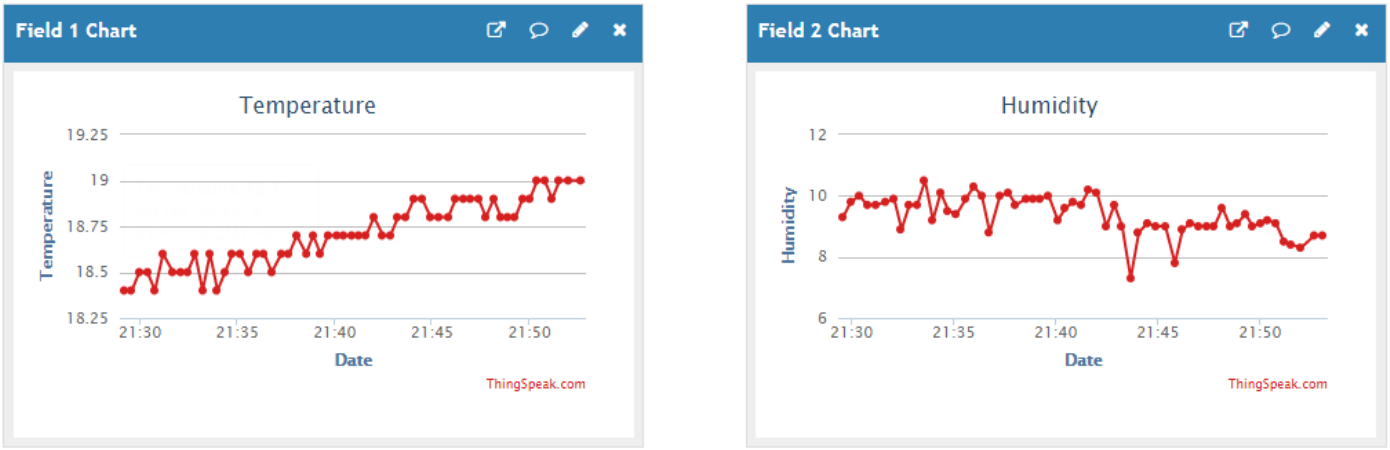

Figure 10: Temperature and Humidity plot view

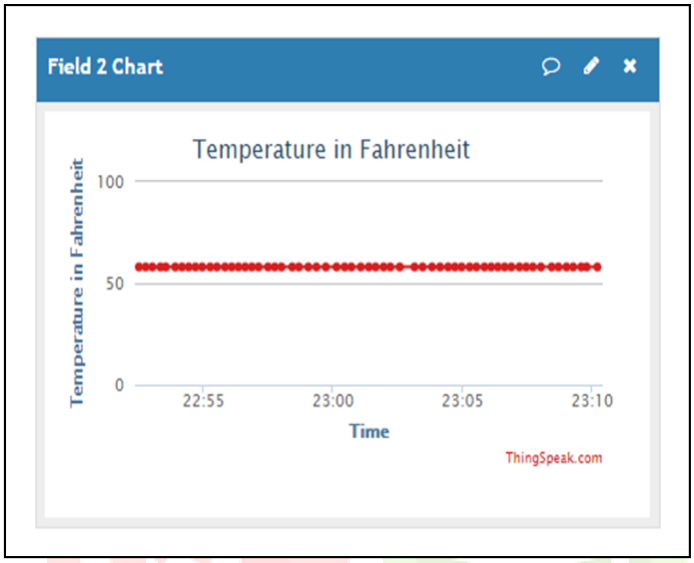

Figure 11: Temperature in Fahrenheit plot

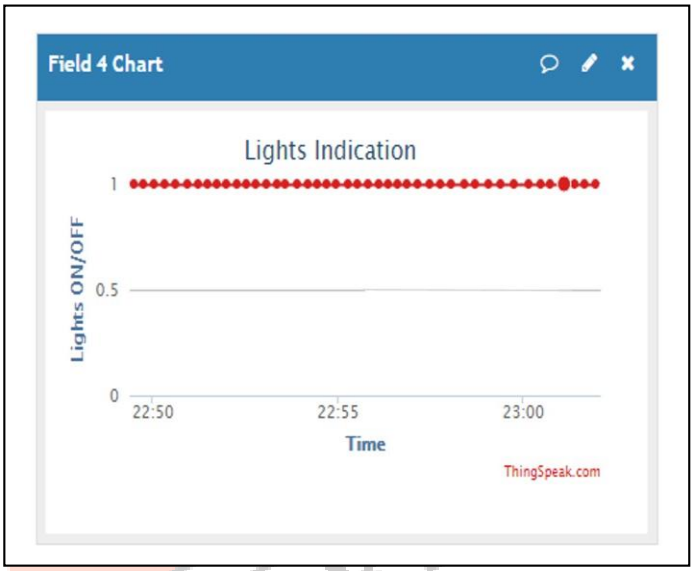

Figure 12: Light plot

The above figure shows the Industrial Parameters monitoring channel. Click on that channel. Then we will see our output waveforms.

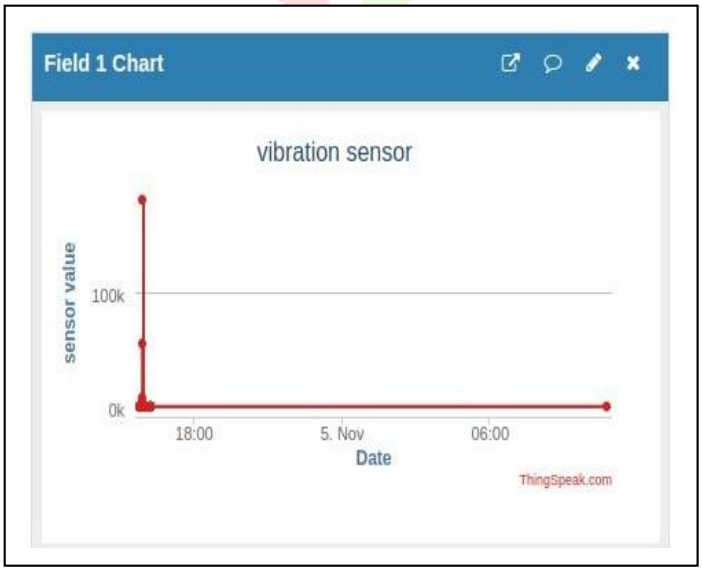

Figure 15: Vibration plot

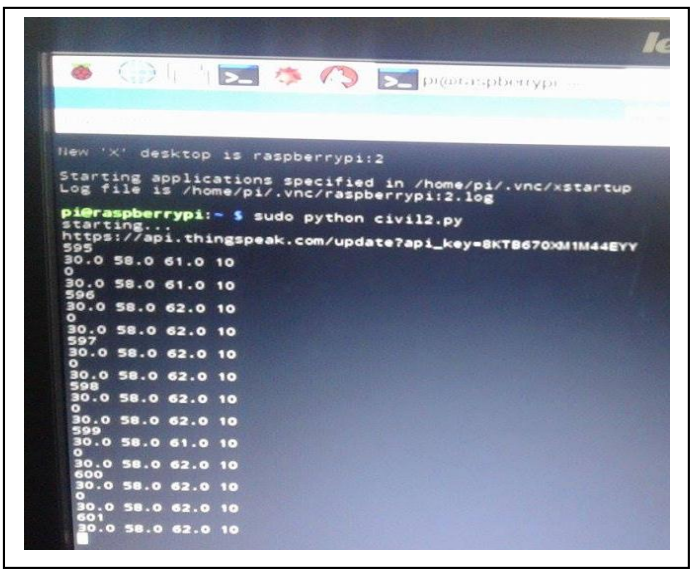

Figure 15: Display of Sensors Data

VIII. CONCLUSION

This project presents the design and the implementation of a industrial parameter monitoring with smart wireless sensor network using IOT platform. Web based monitor and automatic control of equipment are forming a trend in industrial field. Replacing PC with low-cost single chip processor which can make administrators to get parameters of different remote devices and send control information to field equipment's at any time through Internet**.** The Smart mobile Phone based monitor and automatic control of equipment are forming a trend in structures field. Replacing PC with low-cost single chip processor which can make administrators to get parameters of different remote devices and send control information to field equipment at any time through Internet. The IOT is an excellent choice for this due to its extensive coverage. The complete system is secured through a login E-mail and Webpage. The design is completely wireless and integrated with the software to form a low cost, robust and easily operable system. The E-mail and Web based controlled duplex communication system provide a powerful decision making device concept for adaptation to several civil structures scenarios.

IX. FUTURE SCOPE

- In order to monitor industries at different sites, future works can be focused on establishing a system with more sensor nodes and more base stations.
- We can also use our system to monitor Bridges, dam road tunnels, Aircraft parameter continuously.
- Industrial parameters monitoring (IPM) will be an important component of the next generation satellites and space transportation vehicles.
- We can also use solar panel instead of battery operated power supply.

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