Data Analysis for Real Time Monitoring of Heat Exchangers

Swetha, Piyush Jain, Juhi Dadhich, Hiya Choudhary

Abstract: ***A Heat Exchanger is a device which is used to exchange heat between two or more fluids with and without a medium and can be used in both heating and cooling processes. There are many industries where these are used such as Space, Chemical, Biogas, Thermal, Sewage treatment, Supply chain, Power stations, Refrigeration, etc. All these industries require real-time monitoring of temperature, humidity, the pressure to ensure the stability and durability of the commodities present in it. The monitoring of these values is obtained by various sensors usually used in IOT. In our paper, an approach towards this situation is dealt where the parameters (temperature, humidity, pressure) are monitored on a real-time basis. The data collected from the IoT devices are continuously sent to the cloud platform. The analysis of this dataset will be done using a machine learning (linear regression) algorithm to predict the future parameter values. The analysis result is visualized as a graphical representation on the monitor which is accessible by the users. This predicted value will be compared with the threshold value set, and an actuator-based response will be generated and an SMS is then sent to the owner. Based on this the owner can take necessary actions. This paper has a greater impact in various industries through which the heat exchangers can be monitored regularly by avoiding major disasters which take away the lives of humans.***

Index terms- Atmospheric parameters, Heat exchangers, Linear regression, Sensors.

I. INTRODUCTION

In today's world, we can find the practical use of heat exchanger's in every nook and corner of the world. Some of the classical examples of that can be the boilers, sewage treatment, space industry, etc. Heat exchangers are being used in these crucial industries for continuous operation and maintaining the efficiency of the overall system. Any kind of malfunctioning of these devices may reduce the standard of production and may force to cease the operation of the entire plant, and in worst cases can even lead to disastrous effect. Therefore, a prior prediction as to what can be the values of the parameters in the future for these devices can aid the industries. The real-time data is analysed in order to monitor various kinds of heat exchangers.

From previous researches, we get to know that data analytics is grasping a lot of spotlight than before. It is expanding its position in all dimensions of companies, including evolving start-ups. The system of data analysis has steadily advanced over the time, and is achieving humongous benefits from growth in computing.

Data analysis is one such process of captivating the data from disparate sources and then analysing the data with the intent of finding useful information.

Internet of Things (IoT) is expected to reform our world by helping us to monitor and control basic development in our environment through the use of devices capable of sensing, processing and wirelessly transmitting data to unknown storage like cloud which stores, analyses and presents the data in useful format.

IoT gives us the chance to associate physical world with machine-based systems. IoT frameworks helps the interaction between "things" most of IoT frameworks seems to target on real-time data solutions.

The main aim of our paper is to prevent the industries from disasters. These disasters are generally caused due to increase in atmosphere conditions. The predictions of these values will prevent such disasters in the industrial environment.

The remaining sections of the paper are formulated as follows. The second section gives an insight about the hardware design used in the paper. The third section describes about the methodology. The fourth section describes the applications and advantages of this paper. The final section concludes this paper.

II. HARDWARE DESIGN

A. DHT11

DHT11 is a simple, basic, low cost sensor using a capacitive humidity sensor, thermistor and an integrated chip on the backside of the sensor. A thermistor is a variable resistor that revises its resistance value with the change in temperature.

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It is incorporated with 8-bit micro-controller. Its technology establishes high reliability which accomplish long-term stability. This is used to gauge the neighboring air discharge out a digital signal on the data pin.

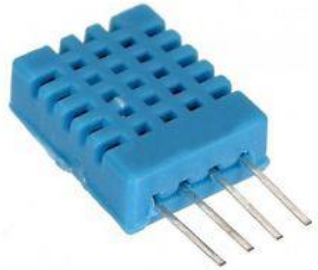

Fig.1 DHT11 composite sensor for temperature and humidity.

B. Pressure Sensor

A pressure sensor senses the surrounding environment to gauge the value of pressure exerted by it. It can be defined as the force required to stop any fluid from expanding.

Fig.2 Pressure sensor to obtain the pressure data

C. Microcontroller

Node MCU is one of the IoT single board microcontroller which is simple low cost, open source IoT platform and development kit having an inbuilt ESP8266 WIFI module. Developed by ESP8266 open source community, having XTOS as operating system, it has only 128K bytes of memory and 4MB of storage capacity. It is WIFI equivalent of ethernet module combining features of WIFI access point and station combined with microcontroller, these features make it extremely useful tool for WIFI networking. In this paper, it is programmed using Arduino IDE.

Fig.3 Node MCU with an ESP8266 built-in module

D. Buzzer

A buzzer is an audio signalling device connected directly to Arduino. These are generally used in timers, alarm devices, and in giving confirmation to the user for his input on the mouse or keyboard. Different types of buzzer are mechanical, electro-chemical or piezoelectric. The one used in this paper is Piezoelectric where one pin is connected to ground and another to digital pin 8. One can change the audio for the buzzer from the Arduino IDE itself.

Fig.4 The Piezoelectric buzzer

E. Fan

Getting a fan working automatically using an IoT requires a relay. A relay is a switch that operates that is open or closes circuit electromechanically or electronically. Relay allow one to control high powered electronics with low power signals emitting from devices such as Raspberry pie or Arduino.

Fig.5 a. Fan

b. Relay

III. METHODOLOGY

A.Design and Implementation

Sensors are connected to the Node MCU microcontroller. Temperature, humidity, pressure and ultrasonic sensors are used in order to collect the data from these sensors. Fan and Buzzer act as actuators. The cloud platform used is Thingspeak. Sensors values are monitored continuously and sent to thingspeak. Later, machine learning analytics is done using the linear regression algorithm. The latest values of temperature data are fetched from thingspeak and analytics is done by using linear regression algorithm. And again, this data is sent back to thingspeak. When temperature crosses the threshold value a prediction is done. After that microcontroller will receive the data, and the actuators will react as the user requirement. The framework configuration handle parcels the necessities to either equipment or programming frameworks. It builds up general framework engineering. Programming configuration includes speaking to the product framework works in a shape that might be changed into at least one executable projects.

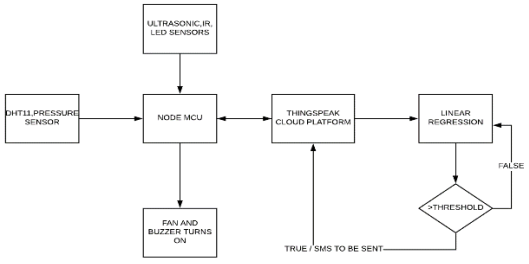

Fig.6 Flow diagram of paper

As shown in the above diagram initially all the data is being collected by the different types of sensors connected to the node MCU. The collected data is stored in the Thing speak cloud platform where a linear regression algorithm is performed and a threshold value is set. Based on this threshold value an SMS is sent to switch on the buzzer and fan or the entire process is repeated again.

B. Collection of data

As the world goes amused by the data, data is now considered to be the new oil and wealth where machine learning is the new engine which harnesses it to predict the valuable information. Going on this track we collect the atmospheric parameters such as humidity, temperature and pressure values in the form of the data generated by the DHT-Digital Humidity and Temperature sensor connected to the NodeMCU board.

Some of the other elements such as Ultrasonic, LED are also attached to the board. The above data collected from the sensors is stored in the form of csv files or text files. The collection of the data takes place in a ceaseless fashion to generate data, which then serves as a training dataset for the machine which can be viewed in matplotlib.

C. Cloud Platform

The data possessed from distinct devices and sensors are to be reserved for necessary subsequent actions. Thus, these data are stored in the cloud. IoT cloud from the Salesforce.com is the platform that is designed to store and process the data. This platform is designed to intake the immense volume of data spawn by various entities and triggers the response. The cloud platform used in this paper is ThingSpeak which is an open source IoT application and application programming interface to store and recollect the data from Things using HTTP protocol over the internet or LAN.

The data in the cloud is structured into different visualization patterns. This grants the entitled person having an account in the cloud for the paper to examine the fluctuations cropping up by the data generated, even though when the person is absent from the workplace. Ergo only the atmospheric parameters data is forwarded to the linear regression algorithm for the purpose of training the machine.

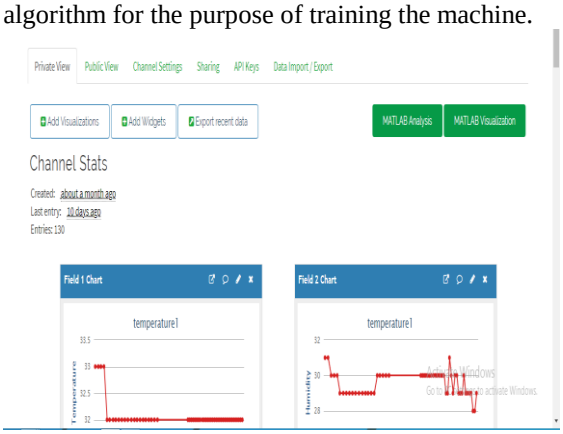

Fig.7 Continual data in ThingsSpeak

D. Visualization of data

The dataset received from the ThingSpeak cloud platform is afresh structured into distinctive visualization patterns by altering the plotting variables. These graphs are produced in matplotlib dynamically and are changing as and when new data is generated. Graphs are uninterruptedly analysed by the co-workers present at the workplace to sense the variations occurring. In the graph plotted the x-axis represents the temperature values against the y-axis which represents the time value. Hence, this temperature versus time graph generates a Histogram. In the similar fashion all the other parameters are considered and the respective graphs are plotted.

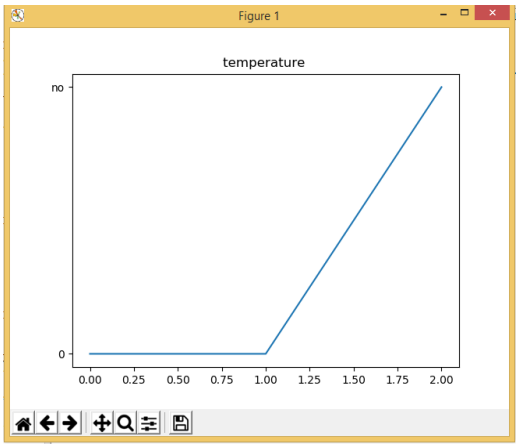

Fig.8 The visual representation of temperature values on matplotlib

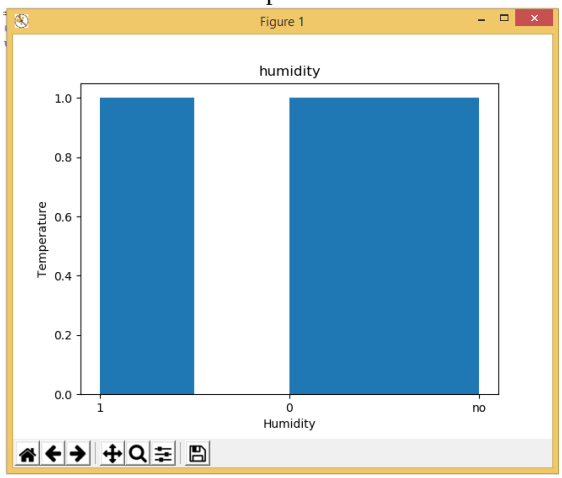

Fig.9 The histogram representation of humidity values with respect to temperature.

E. Prediction

Initially, a set of enormous data is used for training after which the new value generated is used for the prediction of future atmospheric parameter values. The prediction is performed by the linear regression algorithm. According to this algorithm, the datapoints are collected based on the dependent and independent variables that is the training dataset and the testing dataset. The regression algorithm is performed on the newest values automatically.

IV. APPLICATIONS & ADVANTAGES

It is devastating to hear about the horrifying blasts which happen frequently in the various industries in the 21st century even after developing high-end systems to prevent such incidents.

Such events could be avoided by taking actions prior to it. This paper is useful mainly in industries where heat exchangers are present such as Space, Thermal, Chemical, Natural industries. This paper which predicts the future value and takes automatic response when the predicted value is going to cross the threshold value which is set for a device is a boon for the industries. The major application of this paper towards the devices present in the industries is that it allows them to be work in continual due to reduction in downtime, reduce wear and tear thereby increasing its overall efficiency. This timely actions against the incidents can save many lives.

V. RESULT

This paper predicts the value and whenever it crosses the threshold value for the respective parameters an SMS is sent to the owner. If any of the value of the parameters reaches or is above the threshold value an actuator-based response is initiated. As a result of this response, a buzzer is played to alert the people around there and a fan is switched on to reduce the temperature and bring back the device to normalcy. Later on, an SMS is again sent to the owner to inform that the device is operating at normalcy.

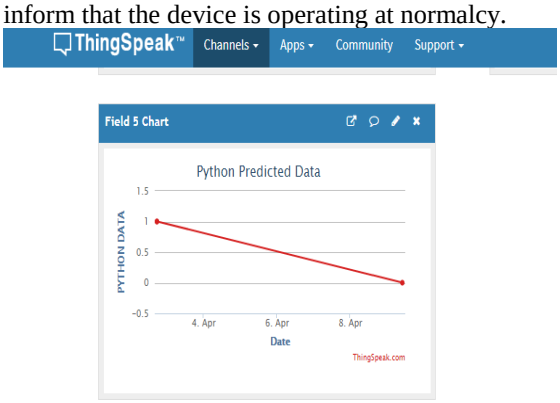

Fig.10 Result display in ThingsSpeak

VI. CONCLUSION

This paper cites an environmental auditing system for real-time monitoring of humidity, temperature and pressure of nearby surrounding. The data which is sensed is sent via the Wi-Fi to the cloud where both real-time data and its graphical analysis can be viewed. This paper has a greater impact in various industries through which the heat exchangers can be monitored regularly by avoiding major disasters which take away the lives of humans. This paper can be extended to provide a web based graphical response and further an encryption feature can be added between the user and the device to communicate securely through authorization process. This system can act as a crucial step in understanding the data analysis in application development and serves as a foundation block for a large number of useful innovations happening in this direction.

REFERENCES

1. "Prediction of temperature using linear regression" Sindhu P. Menon; Ramith Bharadwaj; Pooja Shetty; Prajwal Sanu; Sai Nagendra,2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT) Year: 2017
2. "Prediction of Indoor Temperature and Relative Humidity Based on Cloud Database by Using an Improved BP Neural Network in Chongqing" Xin Shi IEEE Access Year: 2018
3. "A survey on big data analytics" M. D. Anto Praveena; B. Bharathi 2017 Inter-national Conference on Information Communication and Embedded Systems (ICICES).
4. "Internet of things-based approach for open precision farming" C. Kishore Kumar; Mohammed M. Ibrahim; Neerumalla Mani Srikanth; S. Aswin; K. P. Peeyush 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI).
5. "Modeling, identification and detection of faults in industrial boiler" (July2015) Navaseelan Paul David; Bhuvaneswari Swaminathan 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR).
6. "An IoT Based Real Time Environ-mental Monitoring System Using Arduino and Cloud Service" Saima Zafar Dept of Electrical Engineering National University of Computer and Emerging Sciences.
7. "IoT Based Weather Monitoring System using Raspberry Pi" Shubham R. Vilayatkar1, Vaibhav R. Wankhade2, Pranjali G. Wangekar3, Nikhil S. Mundane4 Dept. of Electronics & Tele-communication Engineering.
8. "Environmental Monitoring Using Wireless Sensor Networks (WSN) based on IOT". Aarti Rao Jaladi, Karishma Khithani, Assistant Professor, Dept. of Electronics, Vivekanand Education Society's Institute of Technology, Mumbai, India.
9. "Data Mining and Granular Computing in Big Data and Knowledge Processing", Weiping Ding; Gary G. Yen; Gleb Beliakov; Isaac Triguero; Mahardhika Pratama ; Xiangliang Zhang ; Hongjun Li Year: 2019, Volume: 7.
10. "An efficient linear regression classifier" Hai Wang; Fei Hao 2012 IEEE International Conference on Signal Processing, Computing and Control. Year: 2012.
11. "Novel Instrument for Temperature Measurement Borehole Heat Exchangers", Nordin Aranzabal; Julio Martos; Hagen Steger; Philipp Blum; Jesús Soret
12. IEEE Transactions on Instrumentation and Measurement. Year: 2019.

AUTHORS PROFILE

Mrs Swetha P is an BE, M. Tech graduate from VTU. She is currently pursuing PhD in the domain of Data Analytics from VTU, Karnataka. She is an active member of LMISTE, IEEE, IAENG. She has guided many students' projects and were also funded by IEEE and KSCST. She also received best student project award from IEAE for guiding them. She published many papers in various National and International conferences and journals with Scopus indexing. Currently she is working as an Assistant Professor in Computer Science and engineering department, Rajarajeswari college of engineering, Bangalore, Karnataka.

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