International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 07 | July - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Electrical Fault Predictor System Using BOLT IoT and Machine Learning

Arundhati Sahu, Apurva Nigam

Undergraduate student, Dept of Electronics and communication engineering, Bharati Vidyapeeth College of Engineering, Pune

Undergraduate student, Dept of Electronics and communication engineering, Bharati Vidyapeeth College of Engineering, Pune

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Abstract - With the advent of technology, such as the Internet of Things (IoT), it is now possible to integrate billions of virtual machines around the world through the Internet, collecting and sharing data. Connecting all these different devices and attaching the sensors to them, adds a level of intelligence to these devices that would be mute, enabling them to communicate with real-time data without involving anyone. Electrical / energy appliances, with their various assets, must face the critical task of monitoring and maintaining their assets while operating with increasing efficiency and reliability levels. In this paper, we have combined the two technologies that come with Machine Learning and IoT to create an analytical model for detecting unfavorable events (for example - machine errors, malfunctioning assets, etc.) and making it easier for working employees to find rewarding features. in irregular processes, and appropriately organize maintenance activities. This early detection of any unwanted functionality allows the electricity utility industry to use the most cost-effective repair services available and improve quality and delivery processes, ultimately improving the economic status of services, product value, and leading to increased customer satisfaction.

The project is subject to constant temperature monitoring using the LM35 and BoltIoT Wi-Fi module.

1.Putting a prediction graph developed with a polynomial regression ML algorithm to predict future temperature and width changes to take early action when the temperature is maintained within a given distance of more than 20 minutes.

2. Emailing using Mailgun and SMS services using Twilio services where the temperature is not within the specified range for early action and when the refrigerator is opened (Using Z-score Analysis i.e. when an unusual graph is detected) and an alarm through the buzzer and LED light.

Key words: IoT, Machine Learning, Bolt IoT, polynomial regression, fault detection

1.INTRODUCTION

The Internet of Things (IoT) has the power to change the way people interact with the world around them. IoT Systems, which we describe as sensors and actuators connected to software networks, can monitor and control connected objects, equipment, and even living things. These rapidly evolving technologies make it possible to implement data-driven decisions in new areas of human activity. From factory-level monitoring equipment to tracking the progress of ships at sea, sensing changes in the physical environment to closely monitoring important human features, IoT systems can enable companies to find out more about their physical assets, changing the way we operate our system. cities and homes, improve health outcomes, and save lives.IoT is defined as the "network of physical objects empowered with limited computation, storage and communication capabilities and embedded with electronics, software and network connectivity". Here we have made use of Bolt IoT , which is an innovative platform giving us the ability to control and collect data from our IoT devices, safely and securely no matter where we are. We can get useful insights by deploying machine learning algorithms that enables us to detect anomalies and predict future sensor values.

Internet of Things (IoT) has started as a niche market for hobbyists and has become a major industry. This IoT is a combination of many technologies, real-time analysis, machine learning and artificial intelligence. It has spawned many consumer needs such as home automation, pre-device error detection, electronic health equipment and remote monitoring apps.

Systematic recognition and determination of various types of mechanical frustrations is an exciting process in modern operating systems. Different types of sensors are used to screen vibration sensor errors, sound sensors, warm sensors, infrared cameras, light cameras, and many other sensors. Modern technology is widespread and widespread in everyday life.

This device requires reliable algorithms and forecasting. This article emphasizes the prediction of errors in real-life applications that make our daily lives easier. Here, the device website compiles the previous errors returned online using cloud computing technology. This will assist in predicting machine repair errors. The proposed model for this article involves monitoring each household item online and thus errors are detected without much human intervention.

The project is a temperature monitor and Predictive Fault Alert system that continuously monitors the temperature of the equipment (transformer oil, winding for motors) and provides a telegram alert, email in case of an error. The project also provides on-site LED lighting provision as well as a site Buzzer alarm recovery program and prompt action for repair personnel. Finally, the project sends Android Push alerts as soon as possible in the event of a fixed temperature violation.

With the help of predictable statistics and forecasting technology, electronic services can better detect inefficient goods and make warnings easier for working employees. With the advent of IoT or Internet of Things, it is now possible to transfer data directly to Cloud, With the help of the Bolt IoT WIFI module, temperatures can be monitored and analyzed in remote locations. Bolt Cloud, also directly with the API, allows you to store data, perform calculations on it, and visualize data

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in the form of graphs. It also allows you to use Machine Learning Algorithms to predict your IoT Data and be confused.

Electrical machinery must meet the critical responsibility of monitoring and maintaining property while operating with increasing efficiency and reliability standards. This early detection of any unwanted performance makes electrical appliances use limited repair functions. This early detection of any unwanted performance makes electrical appliances use limited repair functions. One of the key factors that hinders credibility and stops the occurrence of errors in distribution networks. Therefore, accurate and fast and accurate forecasts and local forecasts for distribution networks are essential for increasing reliability, speed recovery, total power consumption, and customer satisfaction.

2. Body of Paper

➢ The BOLT Platform

BOLT is a fully integrated platform. Bolt IoT platform gives us the capability to control our devices and collect data from IoT devices safely and securely no matter where we are. Get actionable insights by deploying machine learning algorithms with just a few clicks to detect anomalies as well as predict sensor values.The Bolt app detects the chip when it is turned on and connects it to a fixed internet connection. This platform has its own cloud dashboard that allows you to transfer data directly to the cloud, making it easily accessible anywhere in the world with official login details.

With Bolt Cloud you can control and monitor them online, create personalized dashboards to visualize data, monitor device life, use machine learning algorithms and much more. The forum also has its own open API (Application programming interface), which allows you to add your own tools to the platform and connect them to different programs to make your projects different. Bolt is an IoT platform that helps businesses and manufacturers connect their devices to the Internet. Bolt comes with a WiFi / GSM Chip to connect your sensors to the internet.We can install this program on the Bolt cloud to receive, store and visualize data.

With the help of this Bolt Wi-Fi module, we can monitor and monitor temperatures in remote locations. Therefore, we do not need serial or Ethernet-based technology connections to transfer data between devices. The cloud gives us access to many services and let us be informed of important events at the same time. The Wi-Fi module is able to integrate with major industries and heavy equipment. Depending on the Bolt IoT usage, whether using a custom website or application, or a virtual private server, or even a charger in the cloud, we can connect any device to the Internet and manage or analyze data.

Aim Of the Project

The project is to monitor temperature and the Predictive Fault Alert system which regularly monitors various industrial equipment (transformer oil, winding for motors) temperature and provide an sms, email warning in the event of an error. (Error, depending on its intensity can significantly increase local temperature, and as a result, temperature is one of the most important parameters for error detection). The project also provides on-site LED brightness provision and site Buzzer system restore alarm and prompt action for repair personnel. Finally, the project sends Android Push notifications immediately in case of a violation of the fixed temperature.

Majorly, this project builds a module that detects temperature and any confusion in temperature reading which is undesirable to the machinery with respected to the external as well as internal environment. Further it sends the required information selected in user-friendly manner via email, SMS, alarm via buzzer and LED light.

➢ Technical Specifications of Wi-Fi enabled microcontroller module.

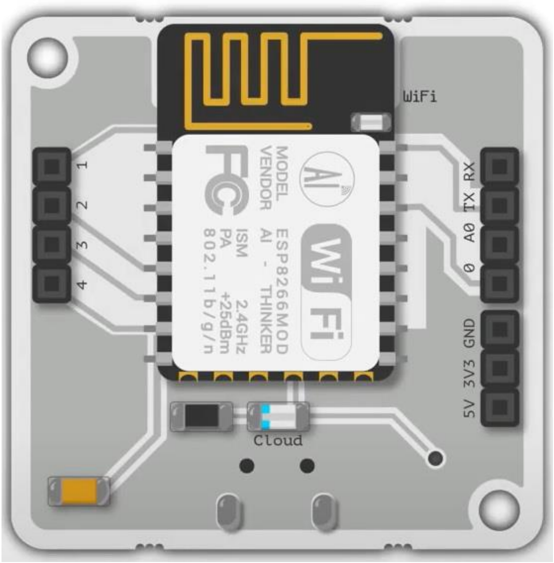


Fig -1: Bolt Wi-Fi module

- ➢ Contains an ESP8266 wi-fi module developed by the company Expressive
- ➢ ESP8266 can connect to all home / office wi-fi networks operating at 2.4Ghz frequencies.
- ➢ Module also works as a Wi-Fi hotspot, so it can handle its Wi-Fi hotspot
- ➢ Inbuilt processor operates at 80Mhz frequency
- ➢ ESP8266 chip operates at 3.3V voltage
- ➢ The Bolt Wi-fi module has 5 digital GPIO's (standard target input pins) operating at 0-3V voltages
- ➢ 1 pin analog pin with ADC-built converter operating at 0-1V voltages
- ➢ LED indicators show communication

➢ IOT CLOUD ARCHITECTURE

One component that enhances Internet of Things is Cloud Computing. Cloud computing allows users to perform computer tasks using the services provided over the Internet. The use of Internet of Things in conjunction with cloud technology has become a form of catalyst: Internet of Things and cloud computing are now linked. This is the true technology of the future that will bring many benefits.

Due to the rapid growth of technology, the problem of storage, processing, and access to large amounts of data has arisen. Good innovation is related to the interaction of the Internet of Things and cloud technology. Collectively, it will be able to utilize the powerful processing of sensory data streaming and new monitoring services. For example, sensor data can be downloaded and stored using cloud computing for later use as intelligent monitoring and activation using other devices. The goal is to convert data into information and thus promote less costly and productive action.

It is important to note that IOT cloud formation must be carefully designed as reliability, security, economy, and efficiency depend on it. The use of well-designed CI / CD pipelines, organized resources, and sandbox facilities results in a safer environment and faster development.

Bolt Cloud is one of the major components in providing IoT power to the Bolt device. All Bolt devices connect to Bolt Cloud outside the box. Bolt devices are shipped with firmware that helps them understand how to connect to Bolt Cloud via the internet.

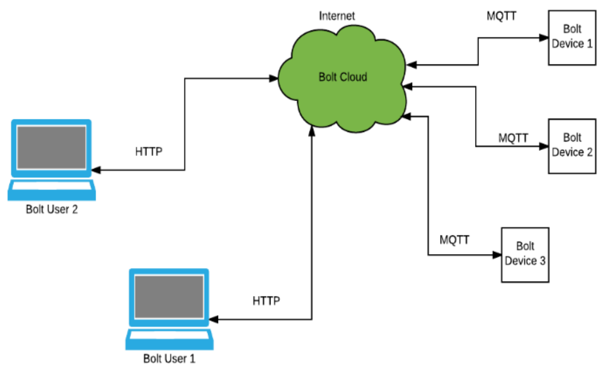


Fig -2: IoT cloud architecture

Bolt Device communication via Bolt Cloud occurs via MQTT communication protocol. MQTT stands for Message Queue Telemetry Transport.
MQTT is a pub-sub messaging protocol. Pub means publish and sub means subscription. There is a central organization, for us Bolt Cloud. All Bolt devices connect to Bolt Cloud and send data to various channels by publishing data to their respective channels. Bolt machines also subscribe to channels to receive instructions from Bolt users.
Bolt Cloud users communicate with Bolt Cloud using HTTPS communication protocol. Bolt Cloud Dashboard may be used to control and monitor our Bolt devices or to use Bolt Cloud APIs in case we want to skip the dashboard and access our Bolt devices with the programs we have listed. Bolt Cloud receives all the commands to control or request sensory data on Bolt devices, and sends commands to the Bolt device. The Bolt device executes commands, and sends a response to Bolt Cloud which then relays it to the user who initiated the command.

- **MACHINE LEARNING ALGORITHM**

Polynomial Regression:

It is defined as the relationship between independent and dependent variables where dependent variables are related to independent variations with the degree of nth. The Polynomial Regression equation is given below:

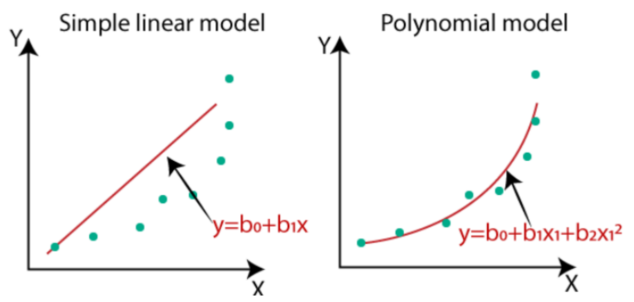
$$y = b0 + b1x1 + b2x12 + b2x13 + \ldots\ldots bnx1n$$

Polynomial Regression is a type of linear regression known as a special Multiple linear regression that measures relationships as nth degree polynomial. Polynomial Regression is sensitive to outsiders so the presence of one or two products may also adversely affect performance.

Polynomial Regression Requirements for this project:

If we use a line model on line dataset, then it provides us with the best result as we have seen in Simple Linear Regression, but if we use the same model without modification of any offline database conversion, it will be much more productive. output. Because the loss function will increase, the error rate will be higher, and the accuracy will be reduced.

So in such cases, when the data points are randomly sorted, we need a Polynomial Regression model. We can better understand you using the comparison diagram of linear data and indirect data.



Non-linear data if it covers it with a line model, then we can clearly see that it does not cover any point of data. On the other hand, the curve should cover most data points, which is typical of the Polynomial model.

Therefore, if data sets are randomly programmed, we should use the Polynomial Regression model instead of Simple Linear Regression.

Steps for Polynomial Regression:
The main steps involved in Polynomial Regression are given below:

- **Data Pre-processing**

In the Polynomial Regression model, we will not use feature scaling, and also we will not split our dataset into training and test set. It has two reasons:
The dataset contains very less information which is not suitable to divide it into a test and training set, else our model will not be able to find the correlations between the salaries and levels.
Secondly, In this model, we want very accurate predictions for salary, so the model should have enough information.

- **Build a Polynomial Regression model and fit it to the dataset**

Now we will build the Polynomial Regression model, but it will be a little different from the Simple Linear model. Because here we will use the **PolynomialFeatures** class of **preprocessing** library. We are using this class to add some extra features to our dataset.
Visualize the result for Polynomial Regression model.
Here we will visualize the result of Polynomial regression model. The plot will vary as we will change the degree such as degree 1, degree 2 etc.

- **Predicting the output.**

Now, we will predict the final output using the Polynomial Regression model to predict the future temperature change and ranges

In this way, the procedure of this project takes place starting from Data pre-processing and then building a Polynomial Regression model and give in n number of dataset values and later it will predict the required output.

- **MACHINE LEARNING FOR IoT**

The Internet of Things produces huge amounts of data from millions of devices. Machine learning empowers data and generates comprehension in it. Machine learning uses previous behaviors to identify patterns and build models that help predict future behaviors and events.

IoT and machine learning bring hidden information alternately to data for faster, automated responses and improved decision-making. IoT machine learning can be used to visualize future styles, discover complexity, and increase intelligence by importing image, video and audio.

Machine learning can help reduce hidden patterns in IoT data by analyzing large amounts of data using complex algorithms. The concept of machine learning can add to or replace manual processes by automated systems using mathematical actions in key processes.

Using IoT machine learning to create predictive capabilities in multiple application environments that allow the business to discover new information and improved automation capabilities.

With IoT machine learning, we can:

- Import and convert data into the same format
- Build a machine learning model
- Use this machine learning model in the clouds, edges and device

- **MACHINE LEARNING Apply to IoT Data**

With powerful AI capabilities, IoT data can be converted, analyzed, visualized and embedded throughout the ecosystem - peripheral devices, gates and data centers, fog or cloud.

IoT or internet of things is a subset of modern ingenuity. The smart IoT system contains the following important components:

- Mechanical and electrical components
- Sensors, processors, storage and software
- Ports, sticks and protocols
- Internal analysis of training and application of AI models at the edges

Building a successful IoT solution depends on tens of billions of devices sitting on the edge, in houses and offices, in factories and oil fields and agricultural fields, on airplanes and ships, and in cars - everywhere.
Today, IoT and machine learning are used in a variety of fields, including manufacturing, agriculture, health care, etc. Whenever the IoT system brings dependence on people, it fails. Therefore, it becomes necessary to support machine learning in order to avoid errors and smooth the process. authenticity, data analysis, alarm warnings, and online attack detection.

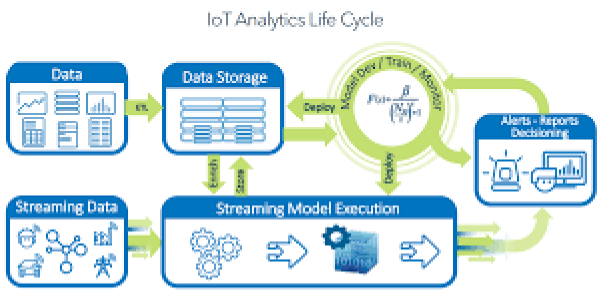
IoT data includes:

- **Metadata**: Device ID, Class or type, Model, Production Date, Hardware serial number etc.

For example, data from a room temperature sensor .

- **Regional information**: data that describes the current state of the device, not the environment. This information can be read or written.

- **Telemetry**: This is the only readable data on the environment, usually collected by nerves. Each source of telemetry exits the station. This data is stored as official variables on the device or cloud.
- **Instructions**: This information contains device actions.
- **Operating Information:** Data such as computer operating temperature falls under this category. It is appropriate as a person should respond when broken and repair software malfunctions after the update.



- **Hardware Components Used-**

COMPONENTS	QUANTITY
1) Bolt Wi-fi module	1
2) LM 35 temperature sensor	1
3) Piezo Buzzer	1

4) Resistor 330 ohm	1
5) 5mm LED: Yellow	1
6) Breadboard(generic)	1
7) Male/Female jumper wires	1

➢ Software apps and online services-

1) Bolt IoT android app
2) Bolt IoT Cloud
3) Digital ocean cloud server
4) Mailgun
5) Twilio

➢ Hardware Connections-

STEP 1- The LM35 sensor is connected to the bolt wifi as follows using Male-Female jumping cables

- GND (LM35) -GND (Bolt IoT WIFI Module)
- VCC (LM35) -5V (Bolt IoT WIFI Module)
- Output (LM35) -A0 (Bolt IoT WIFI Module)

STEP 2- We take one resistor leg (330 Ohms) and wrap it in a long LED leg i.e. a straight leg. Then we inserted the negative LED leg into the ground bolt of the Bolt. Finally, we insert another resistor leg into the Bolt 0 digital code. We deliberately use the Yellow LED to indicate the urgency of the situation in the event of an error.

STEP 3- Piezo Buzzer Connections are the same as the LED. But, unlike the LED there is no need to challenge the series with a buzzer. The long PIN is a positive pin and the short one is negative.

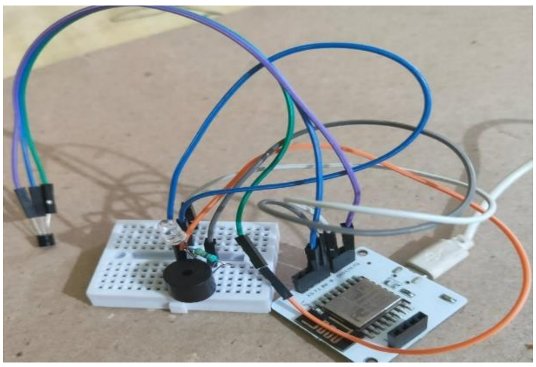


Fig -3: Circuit Connections

➢ Software setup:

Step 1: Register / Sign in to Bolt Cloud

Step 2: Connect your Bolt device to Bolt Cloud using the Bolt App.

Step 3: Create a product in Bolt Cloud for GPIO Input type.

Step 4: Prepare the hardware to monitor the A0 PIN, and give it a flexible name for it.

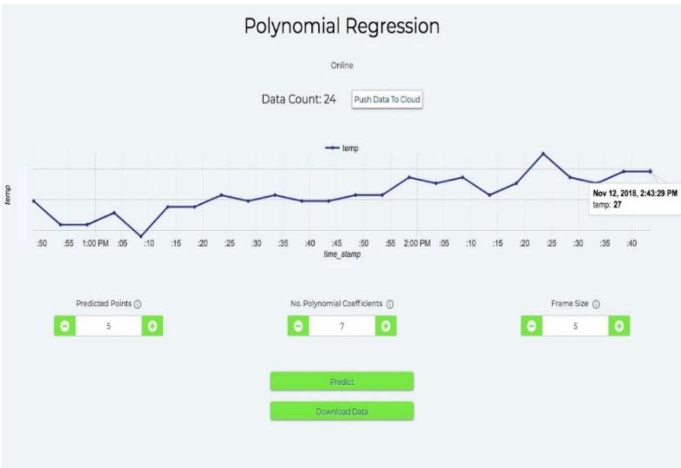
Step 5: In the code setting, type the data view code (JavaScript Code) attached to this project.

Step 6: Save and Exit product configuration.

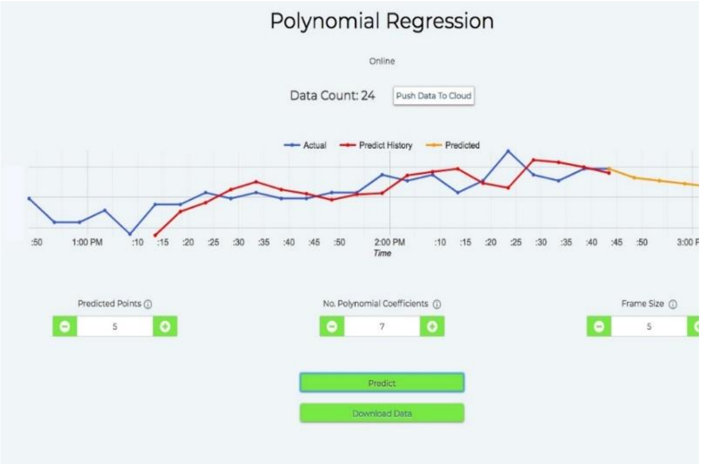
Step 7: Connect the Bolt Module to the newly built product.

➢ Data Visualization and Analytics

STEP 1: Previously, we made the required circuit connections, and created and deployed a Bolt Cloud product to monitor the temperature of an electrical equipment.



STEP 2: Then, we used the monitored data to predict future values in the machine and accordingly perform maintenance for predicted fault or damage.



➢ Various Parameters in the Graph (Plot)

Prediction points: This number tells the Visualizer how many future data points need to be predicted. By default, the Visualizer spaces the points with the data collection time in the hardware configuration of the product. So, if you set the product to collect data every 5 minutes, and select 6 prediction points, the Visualizer will predict the trend and show 6 points up to 30 minutes into the future.

No. Polynomial coefficients: Polynomial Visualizer processes the given input time-dependent data, and outputs the coefficients of the function of the form:

$$data(t) = (C_n{*}t^n) + (C_{n-1}{*}t^{n-1}) + (C_{n-2}{*}t^{n-2}) + \ldots\ldots + (C_1{*}t^1)$$

which most closely resembles the trend in the input data. This number tells the Visualizer how many elements should be present in the function i.e., the value of n.

Frame Size: These are the number of previous data points the Visualizer will use to predict the trend of the data. For example, if you set this value to 5, the Visualizer will use the previous 5 points to predict the trend.

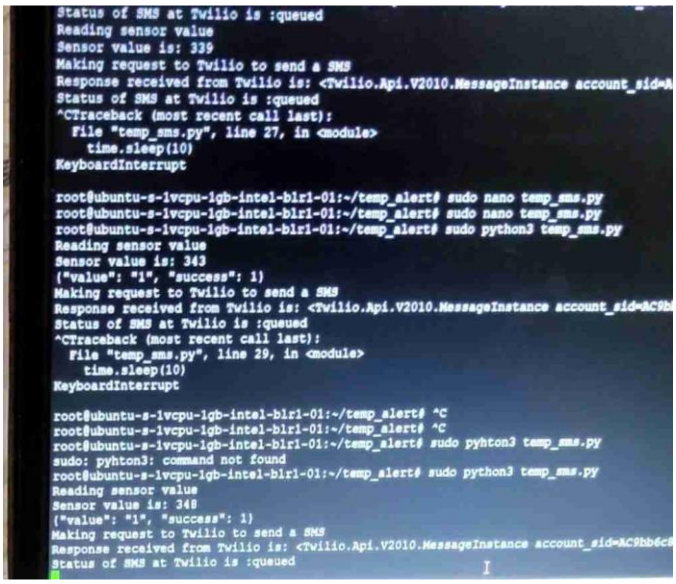


Fig -3: Temperature data getting printed on the terminal

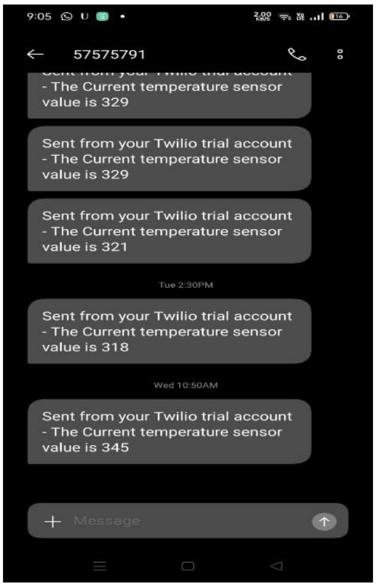


Fig -4: Temperature data SMS received on mobile

3. CONCLUSIONS

Machine learning is a growing technology that plays an important role in the development of the IoT industry. The proposed facilities present an example of a smart office that uses IoT, cloud, and ML technology for office people to improve their performance. It has the nature of multi technology as many technologies are involved in this. Live surveillance of office equipment helps to predict errors early without human intervention and saves a lot of office equipment. This proposed structure identifies and classifies errors prior to their occurrence and, therefore, recommends the most appropriate solution that can be used to correct these errors in the smart office. The Bolt Wifi module is used to automatically alert the existing temperature of smart electrical devices. Temperature sensors are pre-programmed in this system to make the work more comfortable. Whenever the temperature values are not normal, a notification will flash on the end user's smartphone and an email will be sent to the security person concerned. The smart office system extends to every smart building. The ability to predict errors can be extended to include error detection, diagnosis, and prediction. This paper proposed a solution for easily managing and monitoring the electrical machinery in power electrical industries. This proposed system offers many benefits such as safety, improved comfort, and saves energy and costs. Therefore, it helps to build a safe and error free machinery. In the future, new technologies and techniques could be explored to improve the performance and reliability of IoT electronic devices.

Once the complete system construction was completed, the system went into operation. The app started reading temperature and printing it at the terminal and alerts were successfully received both via email and the Android app.

The final result of the forecast cloud chart provides a forecast for the next 20 minutes temperature. Also python code output detects and warns of temperature changes and at unusual temperatures informs by mail, SMS and alarm with LED light as well buzzer. Thanks to this project pharmaceutical companies keep their pills in good condition to avoid vandalism, heavy losses and to be able to fully comply with all government regulations.

ACKNOWLEDGEMENT

It gives me a great pleasure to present the Project Work report done during B. Tech. Last Year. In successfully completing the project, many people came to my aid. I would like to thank all those involved in this work.

First of all, I would like to extend my sincere thanks to my supervisor, Professor SR Madkar, for his enthusiasm, patience, insightful comments, helpful information, practical advice and endless ideas that have always helped me in my research and compilation. His vast knowledge, in-depth experience and expertise in Electronics work have enabled us to complete this project successfully. Without his support and guidance, this work would be impossible. I never thought of having a better manager in my study.

I would also like to thank the following project committee members for their unwavering support, assistance and review. Finally, I would also like to thank my parents and friends who have helped me so much to complete this project in such a short period of time.

Thanks for all your encouragement!

REFERENCES

1. Fernandes, M., Corchado, J.M. & Marreiros, G. Machine learning techniques applied to mechanical fault diagnosis and fault prognosis in the context of real industrial manufacturing use-cases: a systematic literature review. *Appl Intell* (2022). https://doi.org/10.1007/s10489-022-03344-3

2. M. K. Das and K. Rangarajan, "Performance Monitoring and Failure Prediction of Industrial Equipments using Artificial Intelligence and Machine Learning Methods: A Survey," 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC), 2020, pp. 595-602, doi: 10.1109/ICCMC48092.2020.ICCMC-0000111.

3. D. Paul, T. Chakraborty, S. K. Datta and D. Paul, "IoT and Machine Learning Based Prediction of Smart Building Indoor Temperature," *2018 4th International Conference on Computer and Information Sciences (ICCOINS)*, 2018, pp. 1-6, doi: 10.1109/ICCOINS.2018.8510597.

- https://www.boltiot.com/
- https://en.wikipedia.org/wiki/Internet_of_things
- https://www.geeksforgeeks.org/iot-and-cloud-computing/
- https://aws.amazon.com/what-is/iot/
- https://www.udemy.com/course/complete-guide-to-build-iot-things-from-scratch-to-market/
- https://builtin.com/internet-things
- https://www.softwareag.com/en_corporate/resources/what-is/machine-learning.html