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Temperature Monitoring and Multi-Alert System for Indoor Farming

[1]*Varun N. Dhanpal*

[1]*Jain (Deemed-to-be) University, Bangalore, Karnataka, India*

ABSTRACT

With the recent rise of indoor farming and medical inventions, temperature plays a very important role as a metric. Hence weather monitoring and forecasting are important parts of day to day life. Temperature as a metric plays a vital role in applications ranging from agriculture to military operations. Usually, conventional weather monitoring stations require a lot of maintenance and up-keep, while also requiring skilled labor to operate and analyze the systems. Therefore keeping temperature as the main metric, this paper is an attempt to design and implement an inexpensive way to monitor temperature. The main aim of the system is to alert the user in multiple ways of any fluctuations in the temperature

Keywords - Temperature Monitoring, Internet of Things (IoT).

1. INTRODUCTION

With the advancements in multiple fields such as indoor farming, pharmaceuticals, etc. monitoring of temperature is more of a need than a necessity. Recent indoor farming trends do show that monitoring of overall temperature and climatic conditions does yield a better crop harvest, ensuring higher quality and quantity of product. For example the difference between the temperature of the plant and room temperature lets us know if the stomata of the leaves are open. If the stomata aren't open then the plants can't absorb CO_2 .In a scenario like this, the monitoring of temperature will allow us to ensure optimum survivability of plants.

Advanced technology has become the integral part of our life [1]. To satisfy the need of the society, almost in each work, we use the technology[2][3]. In current era computer science is major subject [4]. It has many real life applications such as cloud computing[5], artificial intelligence[6], remote monitoring[7], Wireless sensor network[8, 9, 10], internet of things[11, 12, 13], Neural network[14, 15], FSPP[16, 17, 18], NSPP [19, 20, 21, 22, 23], TP[24, 25, 26], internet Security[27], uncertainty [28, 29, 30, 31, 32] and so on. Technology is the mode by which user can store, fetch, communicate and utilize the information[33]. So, all the organizations, industries and also every individual are using computer systems to preserve and share the information[34] . The internet security plays a major role in all computer related applications. The internet security appears in many real-life applications, e.g., home security, banking system, education sector, defense system, Railway, and so on. In this manuscript we discuss about the protection of authentication which is a part of internet security.

The features of the proposed system are:

a) LM35 Temperature Sensor[35]
- Low cost sensor.
- Can measure temperature ranging from -55^o Celsius to 150^o Celsius.
- ±0.5°C Accuracy
- Consumes less power, and since it's small it can be used in remote applications.

b) Bolt IoT WiFi Module
- ESP8266 board with custom firmware.
- Custom Bolt Cloud
- Handles all the information from the temperature sensor.
- Responsible for predictive analysis and communication with third party API's.

c) Bolt Cloud
- Acquiring information from the temperature sensor.
- Visualization of predictive analysis [36] graphs.

d) Mailgun API
- API accessed through python script for anomaly detection.
- Used to notify users via email regarding fluctuations.

e) Twilio API
- API accessed through python script for anomaly detection.
- Used to notify users via SMS regarding fluctuations.

All the above mentioned services together form the system that allows the consumer to monitor the temperature from anywhere at any time.

1.1 Motivation

The main motivation behind this paper is indoor farmers in developing nations. Developing nations where the mean income of the populace is low are always in an uphill battle to catch up with the rest of the world and its technologies.

Indoor farming [37] requires temperature monitoring to ensure an optimum yield. Temperature can be monitored easily when at the physical location, the main issue arises when the person isn't physically present at the farm. In such a scenario alerts play a very important role in notifying the farmer about the fluctuation. So that they can take the necessary steps to resolve the issue.

2. LITERATURE REVIEW

[38]In this paper the author talks about how, monitoring weather is one of the most important parts of day to day life. The proposed architecture in the paper is akin to that of a hybrid system. Where various sensors deployed in various regions collect data and create a centralized resource that can be accessed by various people. This proposed system is carried out by sensors that are deployed in smart phones, cars, roads etcetera where hardware already exists or can be acquired for a very low cost. A wide range of sensors over a large hybrid network allows the system to track weather and fore warn the people of any impending disasters.

[39]In this paper the author talks about the use of WSN (Wireless Sensor Networks) in PFAL(Plant Factory with Artificial Light). Here it's mentioned that the usage of multiple wireless sensors such as light sensors, humidity sensors, and temperature sensors were employed to increase in the yield of the crop. It also mentions about the current necessity of indoor farming due to the rampant urbanization. Urbanization and Housing for growing population requires a large amount of land space. Hence indoor farming would decrease the need of land space while increasing the amount of yield.

[37]In an article published in HortiDaily by Dr. M.Krijin he explains about how vertical farming indoors has many advantages compared to the usual traditional methods of growing crops. But to have an consistent yield in indoor vertical farming is very tough without the help of sensors. Some of the most important factors to be monitored are temperature, humidity, CO_2 levels, plant temperature, soil health and phenotyping. In the terms of temperature as a factor he goes on to explain about how the difference between the plant temperature and the air temperature lets the scientist determine whether the stomata of the plant are open or not. This is important because if the stoma of the plant isn't open then it cannot absorb $CO_2$and convert it into biomass. If the CO_2 absorption is greater then, the yield of the crop will also be greater. In the end the author also talks about how with the help of new advancements such as AI, we can create an eco-space where all the factors are automatically controlled to ensure the most precise growth conditions and optimal growth.

3. PROPOSED ARCHITECTURE

The architecture contains the following components

a. Software Components

- Twilio API
- Mailgun API
- Bolt IoT application for PC and Mobile devices.

b. Hardware Components

- Bolt IoT Wifi Module
- LM35 Temperature Sensor

An overview of the proposed architecture is shown below.

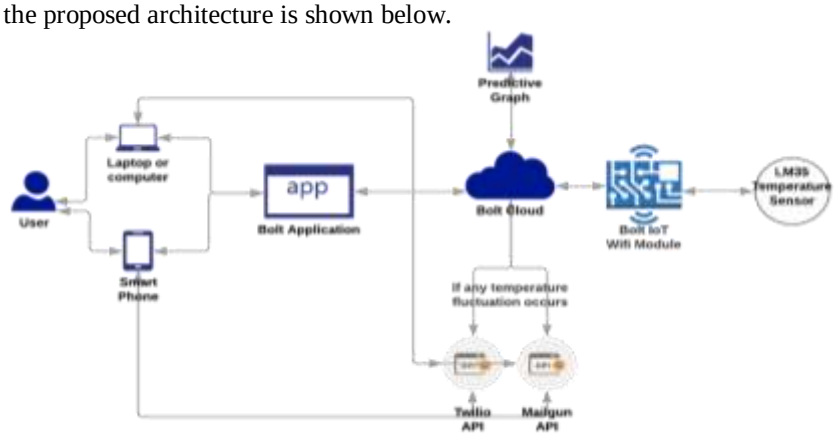

Fig 1.1 Proposed System Architecture

3.1 Dataflow Diagram

The four main scripts running in the platform are -

- Anomaly Detection Script - The main role of this script is to identify the fluctuation using z-score analysis[40]. It is also responsible for calling the other scripts for communication.
- Twilio Configuration Script - This script is to configure the communication between Bolt IoT device and the Twilio API.
- Mailgun API - This is to configure the communication between the Bolt IoT device and the Mailgun API.
- Prediction Graph Javascript[36] - A script to create a visual predictive graph.

In the diagram (Fig 1.2) we can see how all the scripts are running with their respective API's to ensure that there is communication with the user, in case of any temperature fluctuations. The diagram also represents the data flow between all the different applications required for the system to function.

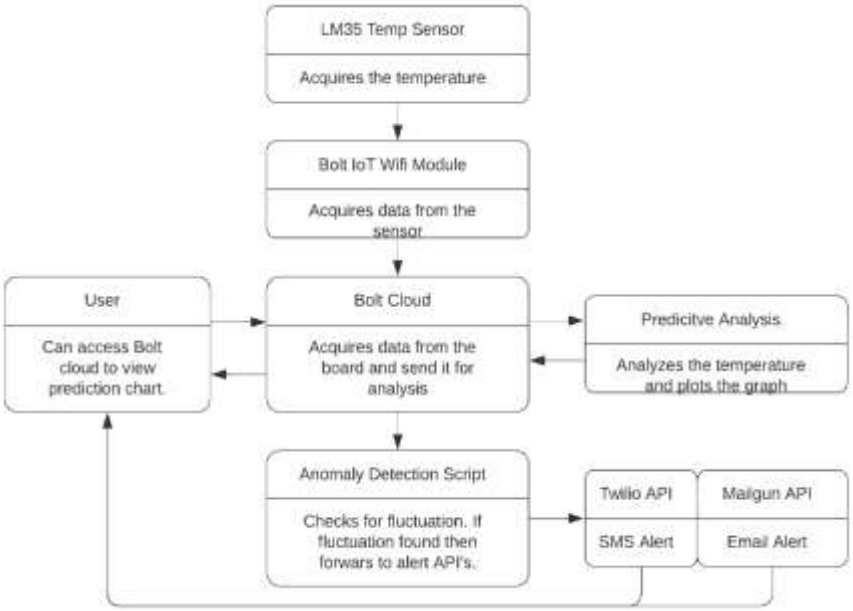

Fig1.2 Data Flow Diagram

4. RESULT

There are two results that can be acquired from this project. Whether the system is alerting the user and whether the system is predicting future temperature for monitoring purposes.

4.1 Prediction Result

The predictive chart[36] is shown on the Bolt IoT cloud platform. The visual interpretation of the temperature readings can be seen below.

Fig 1.3 Temperature Fluctuation Prediction Chart

Key for Prediction Chart -

Blue Line - Recorded Temperature
Red Line - Previous Predicted Temperature
Orange Line - Next Predicted Temperature

4.2 Alert Result

If any anomaly occurs in the temperature then the alert API's will activate and send the alert to the user about the fluctuating temperature.

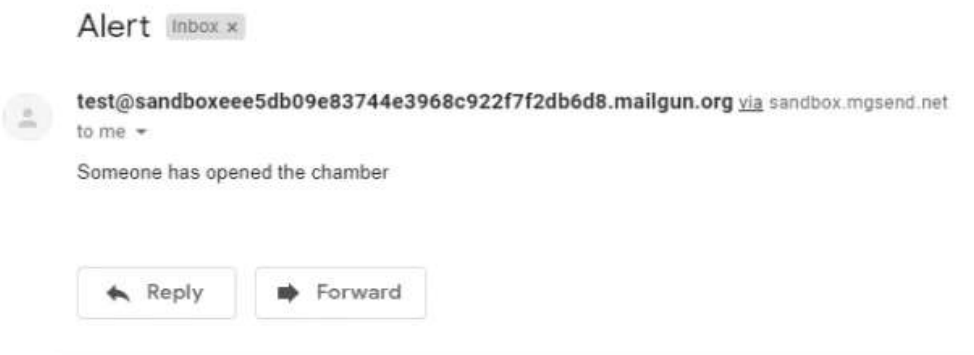

Fig 1.4 Email Alert

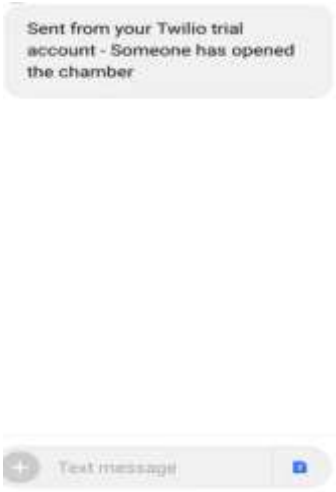

Fig 1.5 SMS Alert

5. CONCLUSION

The main goal of the paper was to bring forward a cost effective and efficient way to monitor temperatures from anywhere. With the help of low-cost services, sensors and modules we are able to create a system that is usable and dependable.

With the help of the predictive graph and alert system one can easily monitor their indoor farm from anywhere at any time. Thus fulfilling the main objective of the paper.

6. FUTURE SCOPE

- The system can be equipped with more sensors to monitor more aspects of the indoor farm.
- With more funding and company tie-ups this can be converted into a large scale business covering multiple users.
- It can be implemented with other technologies that allow for changing the temperature remotely or even automatically.

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