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Temperature Capstone and Humidity Monitoring using Iot with Machine Learning Algorithm

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Abstract : Controlling temperature of a controlled environment is an important aspect of any workspace whether it is a commercial space or a domestic space. If temperature or humidity is either increased or decreased of any area, it becomes very difficult to be there and thus if possible, should be kept in comfortable conditions at all times. One way to do it is to monitor and control the temperature of the closed surroundings using the concepts of Machine Learning and IoT. This research's purpose is the same to find an easy and an inexpensive way to find an alternative to it which is based on microcontroller, a Wi-Fi Module, Buzzer, few Temperature sensors and a Solderless board. The system is designed in such a way that the temperature can be monitored whether it is in the given range of temperature as prescribed by the user. We are also enabling to predict the temperature which will predict the temperature according to the temperature graph being made as by the input taken by the Temperature Sensors using Polynomial Regression Algorithm. Also, if the temperature of the enclosed area is not in the threshold range as suggested by the user, the System will automatically send a notification to user(s) via SMS, E-Mail or even through a Telegram Channel .

Keywords : Monitor and Control temperature; IoT; Microcontroller; Wi-Fi Module.

I. INTRODUCTION

Environment temperature should be a comfortable one, where the people can work comfortably and can go up to their efficiency and can work comfortably whether it is machinery or manpower.

One of important factors that are needed be monitored is the temperature and humidity of the room, because if any one of the two goes mismatching it creates an unpleasing and uncomfortable environment. One way that can be used to control and monitor the temperature and humidity of the targeted environment is to use the system based on Internet of Thing (IoT). It is a concept where an object that has the ability to transfer data over the network without requiring human to human interaction or human to computer interaction. By using IoT based systems on temperature monitoring, data of temperature, humidity and electricity voltage can be automatically monitored using sensors and microcontrollers connected to local and internet networks. Temperature and humidity control can be controlled by applying artificial intelligence so that the temperature and humidity of the closed surrounding can stable at a standard range. One of the most suitable method can be used for control system based on microcontroller can be combining IoT with Machine Learning Algorithm. Earlier research has discussed about control of room temperature and humidity using fuzzy logic based on microcontroller but the drawback of that logic is that it is very much complex and confusing for the majority of the people and not much people are aware of it. So, we designed a simple yet effective algorithm that is easy to explain and understand using JavaScript and Python. The system is also designed to be able to monitor data temperature, humidity and can predict the future temperature taking the past values as inputs and using Polynomial Regression Algorithm.

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II. RELATED WORK

Ema and Eko(2018)[11] have previously described in their model controlling of temperature and humidity in an small area using the matlab code and some fuzzy logic with the help of Arduino and IoT. Also with this current technology we can't be able to predict the future temperature values that is going to increase or decrease.

Mazumdar, Nemer and Brooks(2018)[7] have used the permanent magnet for the temperature control which can produce some current and magnetic fields, which can lead to the change in temperature near by system hence can take variable temperature and can produce inaccurate results in temperature monitoring.

III. METHODOLOGY

In this section, we discuss our proposed design of temperature and humidity control system using IoT and Machine Learning Algorithm based on microcontroller. In this proposed system, we proposed temperature and humidity control system using IoT with ML as the decision making to maintain surrounding temperature and humidity by controlling the setting of air conditioner based on the measurement of sensor data. In this system, we collected sensor data such as temperature, humidity, from the sensor that implemented using microcontroller. The system read temperature, humidity and it automatically upload the data to cloud server via UART protocol, so all users can access sensor data via mobile or web-based monitoring applications (PCs, Laptop, Smartphone).

The Input is automatically fed in the respective formulae and algorithms to find whether the current temperature and humidity is in the threshold range or not. If the current input satisfies the required threshold condition then it will work perfectly fine and will keep on monitoring. If the current values are not in the threshold range then the System will inform the user(s) either by SMS, E-Mail and even through Telegram Channel.

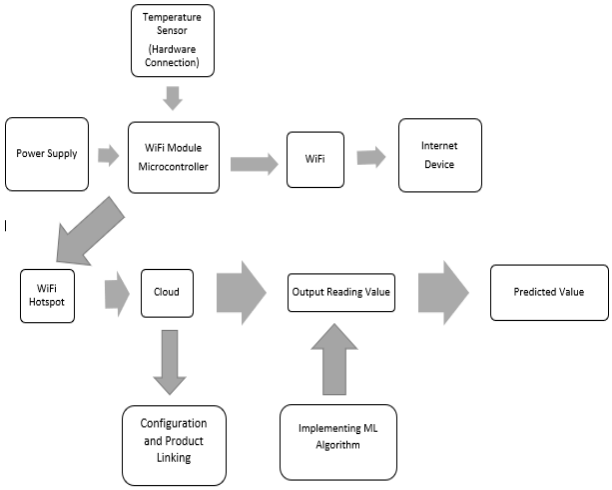


Figure 1: Architecture Diagram based on the proposed system.

Also, we are using Z-Score analysis which also help in detecting the anomaly of the temperature sensor which means a variable's value going beyond a certain range of values (upper and lower bound).These bound can be calculated using input values, frame size and multiplication factor, where frame size is minimum number of input values needed for Z-Score analysis and these predictions as well as the old values, all will be plotted on a graph, which the user can easily understand what could be the next game of plan.
So, we gonna use a formula to find any kind of anomaly that can happen in the proposed system.

$$Mn = \frac{\sum_{i=1}^{r} Vi}{r}$$

$$Zn = C * \sqrt{\frac{\sum_{i=1}^{r} (Vi - Mn)^2}{r}}$$

$$Tn = Vi \pm Zn$$

So in the above listed formula,
r = Frame Size
C = Multiplication factor
Given above is the formula to calculate the bounds. Here the input is represented as 'Vi', 'r' denotes the frame size and 'C' is the multiplication factor. Firstly we calculate the mean (Mn) of the input values (for every new input, the mean is calculated again). The variation of each input value (from the mean) is given as (Vi - Mn)^2. The Z-score (Zn) is calculated as shown above (square root of the mean of the variation of each input value multiplied by the multiplication factor). The bounds are represented as 'Tn' and the upper bound is calculated as (Vi + Zn) and the lower bound is calculated as (Vi - Zn).

The frame size and multiplication factor are determined using trial-and-error method.

IV. RESULT AND DISCUSSION

In this research, we test the temperature module and get this simulation result as in the table1 and the alert notification being sent to the system along with the prediction table or the graph. So we fixed the minimum and the maximum temperature within a range (270-300) as listed in the table1. Now the temperature sensor reads the surroundings temperature value and if the value is in between the fixed range then it gives the current and predicted temperature value along with the humidity value, also didn't trigger the alarm and did not send the notification to the connected device.

But if the temperature value is lower or upper than the fixed temperature value then it triggers the alarm and tells the current and predicted temperature value, also sends the notification to the connected device ,telling that the temperature is not in the fixed range as shown the table1.

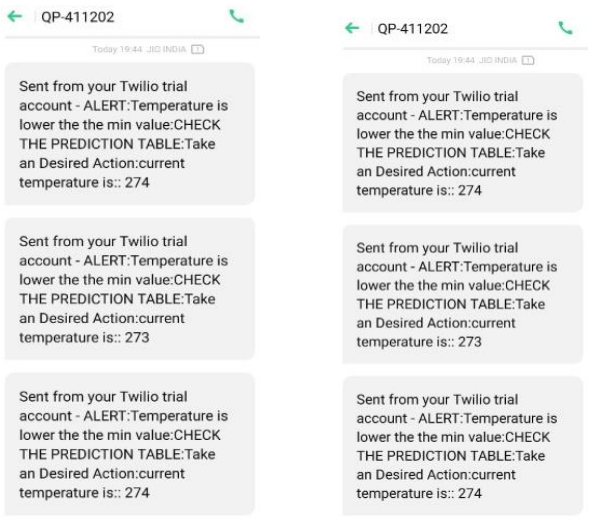
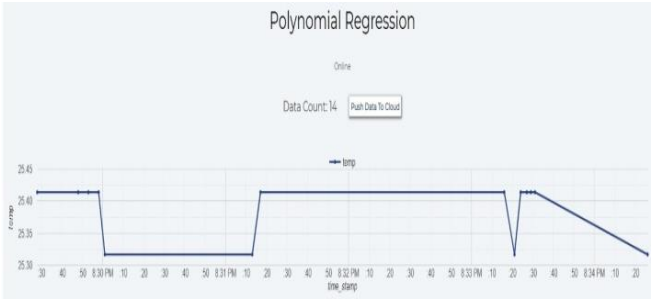


Figure 2 : Result showing notification status sent to the connected devices.

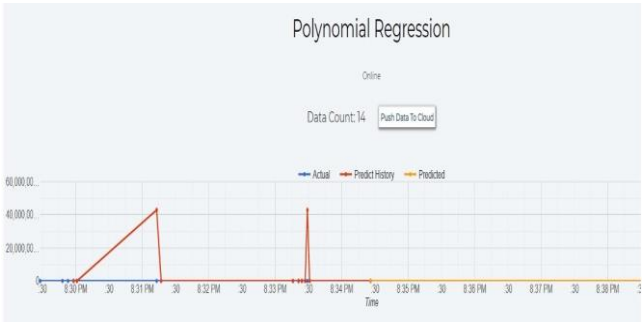
Now based on our notification status the result that has been sent to the connected device is shown in the figure2. Basically it tells the current temperature value of the proposed system and tells the user to change it accordingly. Some of the notification snaps that send to the device is taken and shown in the figure2.

There are also some prediction graph which are drawn using the proposed system. For drawing the graph, we did the prediction using the JavaScript code which was run on the MCP(Microcontroller cloud Platform). The predicted graph which are listed in the graph 1 & 2 is drawn against time and temperature(time VS temp).



Graph 1 : Graph showing the current temperature values.

In the graph 2, Blue line shows the actual value of temperature, Red line shows the Previous predicted temperature and the Yellow line shows the Predicted value of temperature based on each time interval. The graph 1 only shows the Temperature value which is going up and down along the time interval as shown in graph 1.



Graph 2 : Graph showing the prediction values of the proposed system.

Table 1: Testing of the proposed system across various temperature and humidity input values.

Threshold Value (mV)		Input		Output		
Min	Max	Temp (mV)	Humidity (%)	Predicted Value	Alert Status	Notification Status
270	300	262	60	263	Trigger	Sent
270	300	262	60	263	Trigger	Sent
270	300	261	70	263	Trigger	Sent
270	300	235	72	230	Trigger	Sent
270	300	237	70	233	Trigger	Sent
270	300	252	74	249	Trigger	Sent
270	300	270	78	275	Not trigger	Not Sent
270	300	310	77	312	Trigger	Sent
270	300	318	75	301	Trigger	Sent
270	300	270	62	270	Not Trigger	Not Sent

In the Table 1 we have varied a number of temperature and humidity values and according to that values we have created graphs 1 & 2 which depict the temperature change according to the time interval and also predicted the future temperature.

V. CONCLUSION

Based on the testing and samples from the prototype it can be concluded that the Algorithm we used with IoT on microcontroller for controlling the temperature and humidity of any closed environment was successfully designed and implemented. The system is also capable of displaying temperature, humidity and predicted temperature in real time through web-based application or through a Telegram Channel. For Alerts the system can send it through SMS, E-Mail or through a Telegram Channel. The testing results have been drawn in the form of table, graphs and SMS output. Based on the training and testing we got an accuracy of about 95 %.

FUTURE WORK

In this proposed system, designing an algorithm for temperature and humidity control has been successfully performed but the optimum working temperature could be increased by using heavy grade sensors and equipment. Also, the algorithm can be improved a bit more to give more precise and accurate result. The complexity and the accuracy of the code that has been used in the proposed system can reduced.

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