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A Real Time Weather Analysis and Prediction

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Abstract - *A weather analyzer can be described as one or more instruments or devices, which gives us the information about weather conditions from our surrounding environment. For example they sense surrounding condition like temperature, pressure, humidity, light intensity, rain value etc. By following the information we can compute the dew point, atmospheric pressure and many more. The sensors accumulate information by the assists of local processing unit, which converts the analog information in to digital information. The brain of the prototype is the ESP8266, which gives Wi-Fi platform. ESP8266 connects the all hardware devices with cloud. Daily life affects the changing of atmosphere. If we know weather predicted value, it assists us in different arena. For understanding the atmospheric process and predict weather conditions of future here introducing moving average technique. Moving average filter method is used for comparing the actual and predicted value. It is an important technique that calculates the overall trend in a data set. Moving average is very useful for forecasting short-term trends. For better result we must compare one algorithms with another, so second weather prediction algorithm is decision three based regression which also an advance and accurate algorithm for different forecasting area.*

Key Words: **IoT, Sensors, Arduino-Nano, ESP8266, Thingspeak, Moving Average Filter, Decision tree based Regression**

1. INTRODUCTION

New era has started, world befitting a global village. Whole living and nonliving things can connected with each other by the assist of technology. Advanced and updated life can possible causes of technology. Human can know the tiny things about it and utilized them excellently. It is all about the Technology which provides the flexibility to connect all human fellowship. The wonderful updates and new assembly in arena of technologies provide us a better and improving life style. We all can efficient to share own information or knowledge to all over the world. Internet is the most common and wide technology which is responsible for interconnecting humans. It is not only connecting people but also connecting all electronic gadgets, devices. Based on the connection, there was a new technology introduced in 1999 named as Internet of Things (IoT) developed by Kelvin Ashton from MIT. Human to human, device to device and human to device all communication can possible and the intermediate term is internet which can gather all the credit for it. By the combination all human device or machine and internet, this advanced technology is introduced. It gives a real time magnificent and fluent connection by help of this we can analyzed and authorized from any places of the world. It is the collaboration between experimental and theoretical concept also leads the collaboration of educational system with industrial systems. Advanced and updated life can possible causes of technology.

The apprehension of connecting all the sensors or actuators to the internet is IoT. It gives a platform to the offline equipment for sharing data in internet. As early mentioned, IoT not only capable to connect humans but also capable connect device to device connection. Device to Human connection can be possible. The cardinal perception behind this technique is to connect numerous electronics devices around a network to redeem the information or reading from sensors which can be circulated in any arena, upload them to cloud service in where one can analyze and process the information from which we can exploit the data from any area. The motto behind this experimental work to have a mini weather analyzer and store the information in cloud. This system basically accumulates the environmental parameters by the help of some actuators.

Weather analysis is a special presentation of a weather system which assists us to gain information about weather and also gives an idea to know about near future of a particular area. It is related with weather evolutions, weather elements or parameters, changes in weather condition and many more. Analysis in this area gives an idealized description about how atmospheric parameters are related with each other and what are the relation among them. Apart from this Forecasting or prediction is a technique that uses historical data as inputs to make informed and estimates that are predictive in determining the direction of future trends. Businesses utilize forecasting to determine how to allocate their budgets or plan for anticipated expenses for an upcoming period of time. When forecasting part is added with the weather it shows different meaning. Weather forecasting is the application of current technology and science to predict the state of the atmosphere for a future time of a given location. There is some basic parameter are presents, which helps for the forecasting. The basic parameters are temperature, humidity, atmospheric pressure, wind speed. This system is a combination human and devices which is much better than computer models. This present days a human with good experience can still do a better predicting work as compare with computerised model. Weather prediction is based on

two method, one is long term method another one is short term method. Generally a short term method works on the weekly or daily basis but in case of long term method it works on the basis of months or years.

For weather analysis we carefully choose the atmospheric parameter. In this work three parameters are chosen for weather prediction. In every forecasting there are some most common parameters are present. Here based on temperature, humidity and pressure we trying to predict the future condition. We have to know some basic relation among the parameters and note down the changes in reading of parameters according to season or according to day night. The basic relation between temperature and humidity is when the temperature increases humidity also increases. Actually humidity is defined as the amount of moisture in air. When the temperature is increase the humidity also increases for a certain point. Temperature and pressure follow Gay-Lussac's law. According to this increasing in temperature leads with increasing in pressure. The less temperature causes air pressure to drop. From a study it is realized that in sunny day the temperature high with normal humidity and air pressure. But in rainy day the humidity level is very high as compare with other season. The air pressure is low in rainy day. In winter season the air is dry and the moisture contain capacity of air is very less. In these days the air pressure is high as compare to other day.

2. MTHODOLOGY

A competitive study about it is helps to gain basic idea about weather forecasting. We also know what factors are affecting this. Generally in weather forecasting, primarily it performs collection of reading about atmospheric parameters like atmospheric temperature, humidity, barometric pressure and wind speed. After this we calculate the future condition by following some algorithms.

2.1 Moving Average Filter-

It belongs to time series analysis. A moving filter technique is calculate the overall trends in a data set. This techniques is a very useful techniques for short term forecasting. But for a long time weather forecasting it is more popular. In this technique, firstly we take some number of samples, add them calculate the average value. This step continue till the end. At the last of this calculation we see a new average values are formed.

Mathematically

$$y[i] = \frac{1}{M}\sum_{j=0}^{M-1} x[i+j]$$

Where x [ ] is the input value (select the point from start), y [ ] is the output value (result of average calculating value). M is the number of samples, which are taken for calculation the average value. When the number of taken samples is less the resultant values are closer to the actual value.

In the above procedure we find the predicted value, for difference between predicted output and original value we follow Root Mean Squared Error (RMS) method.

Equation of MSE-

$$RMS = \frac{1}{n}\sum_{i=1}^{n}(Y_i - Y'_i)^2$$

Where Y_i=original value and Y'_i = predicted value

By following above mathematical formula we find out the error, which is the difference between predicted and real value. In moving average concept the mean squared error is depends upon the number taken points or window values.

2.2 Decision Tree Based Regression-

Decision trees classify the examples by sorting them down the tree from the root to some leaf node, with the leaf node providing the classification to the example. Each node in the tree acts as a case for some attribute, and each edge descending from that node corresponds to one of the possible answers to the test case. This process is recursive in nature and is repeated for every sub tree rooted at the new nodes. This technique belongs to the supervised learning algorithms. It able to solve both regression and classification based problem. The main object behind this is to create a training model that can use to predict the class or value of the target or problem. Generally the decision thee is based on classification or regression type. In this work we used the regression based decision tree for forecasting. The core algorithm for building decision threes is called ID3. It can be used to construct a decision three for regression by replacing information gain with standard deviation reducing.

Important terminology of decision trees.

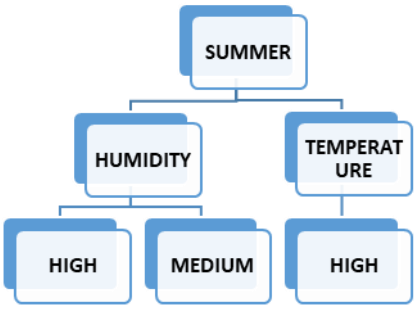


Figure-1: Bock diagram of decision three

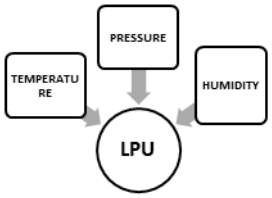
The above is a basic diagram of decision three. Always the above node is the base or root node which divide according to user application. The base node is divided in to decision node again this node divided in to terminal node. The advantages of decision three is it is transparent by nature.

3. SYSTEM ARCHITECTURE

This session is explained the total system architecture which gives a basic idea about entire step related to work. It is included in the development system with the less expensive sensors. The sensors accumulate the real time data. We can see them by connecting desktop with the Arduino-Nano board. Then data store in cloud with the assist of Wi-Fi module. The store data helps to analysis and predict the weather conditions. The prediction process proceed by assist of moving average algorithm and decision tree based regression algorithm. After predict the future weather value we compare the actual weather value with algorithmic value and see which prediction value is near the real value.

Total system is divided in to three part; primary part is collection of data from environment. DHT-11 measures the temperature and humidity. BMP180 is collect the atmospheric pressure. Once it is started all primary data are going to the Arduino-Nano, where the primary raw data are converts in to a meaning full data. The local processor converts the data in to digitally and prepare them to store in cloud. ESP8266 module gives the internet connection to the offline system. Here primary part is end. The data are sent through this module to the cloud, this module works like a gateway.

Last part is to predict the weather condition by using previous value. The store data are save in a file, in which atmospheric reading is saved. We can saw this data by the help of Thingspeak. It gives a free user space for creating the data channel and automatically it plots the data in a proper graphical presentation. For communication with Thingspeak we have to program ESP8266. Prediction is contain specific algorithm by follow which we can find the future values. The rest prediction algorithm is proceed by help of MATLAB. Here we first write some code based on moving average and decision three and converts the store file in to .m file. After inserting the data in algorithms some graphical presentation are shown according to the data. This data not exactly equal to future condition of weather. But almost near with the future weather condition. After analyzing the resultant value we can see which algorithm is nearer equal to future weather condition.



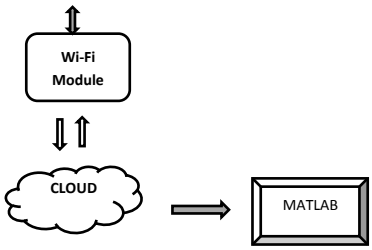


Figure-2: Block diagram of system architecture

4. OUTPUT

Here one day temperature data is used for analyzed which method gives better result.

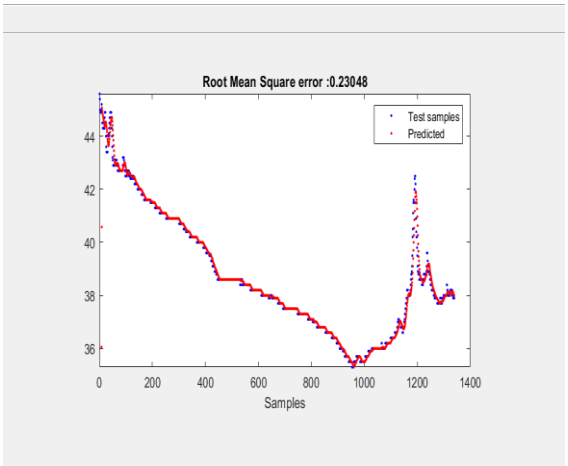


Figure-3: Output of Moving Average with 0.23048 RMS

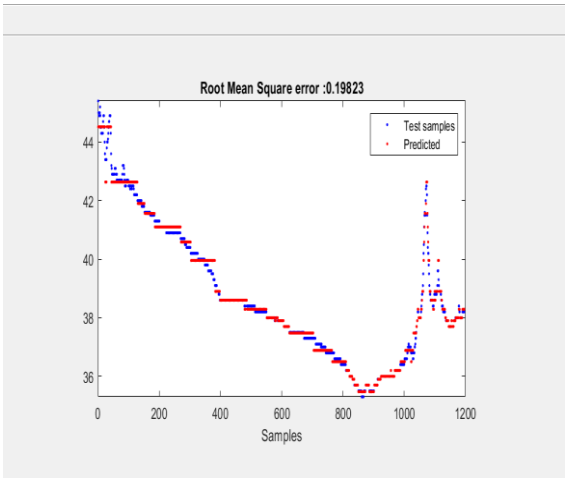


Figure-4: Output of Decision Tree based Regression with 0.19823 RMS

The above output is shows the root mean square of two method in which we can see the RMS value is less in decision tree based algorithms. And the less in error very import in prediction system.

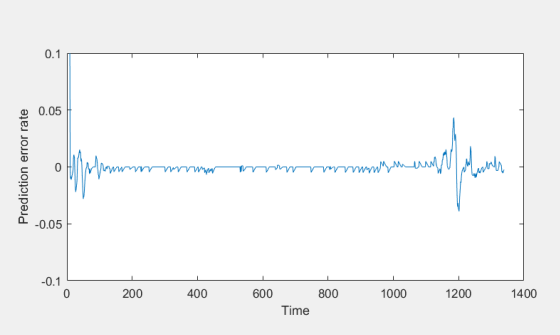


Figure-5: Prediction error of moving average filter

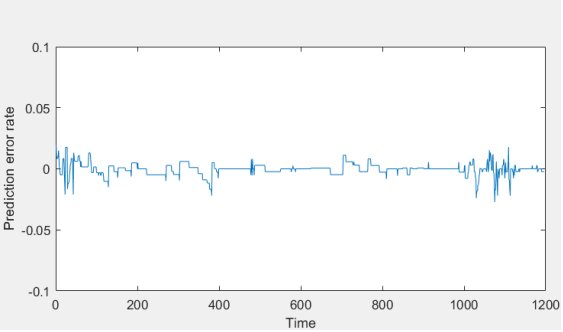


Figure-6: Prediction error rate of decision tree based regression

The above two error prediction graph show the error rate of two methods. When difference between predicted samples and real samples is less then prediction error rate lies in orbit line. And from above it clearly see some starting predicted value present far from orbit line in moving average prediction graph but in case of regression tree the rate started smoothly from orbit line.

Real time Sensors Output

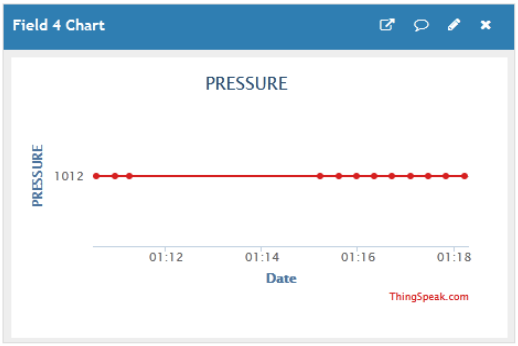


Figure-7: Output of pressure

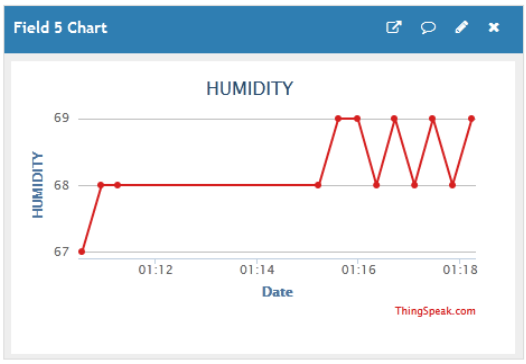


Figure-8: Output of humidity

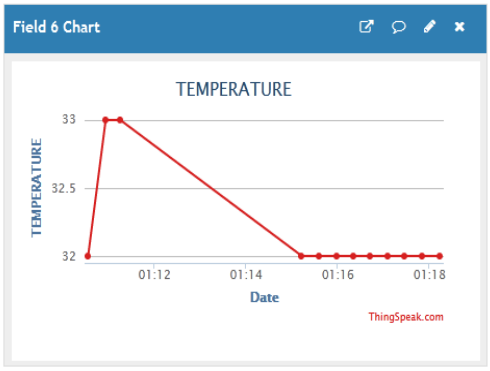


Figure-9: Output of temperature

5. CONCLUSION AND FUTUREWORK

This work is a research and implementation work of weather analyzing system, with help of different atmospheric parameters. The analysis part is totally based on IoT technique. This system provides low cost and user friendly which can implement different field like in agriculture, freezer food storing room, smart home This system also includes the prediction work by using moving average and regression tree algorithm. It observes that between them regression tree algorithm gives more accurate predicted value with less error. This system is tried in open area and it is successfully updates the atmospheric data from sensors.

It assists in different arena like by adding some gas sensor this helps for measuring the pollution level present in air. We can add GPS system, it gives information about environment with area location. This system also modified with addition of GSM module, whenever a message or email is sent from a specific phone number or email id to the server.

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