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Personalized Weather Station With Machine Learning Based Rainfall Predictor

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Abstract: *Weather changes have been happening all around the world. And it has become quite a task to predict weather over a particular area. Weather stations are places equipped with instruments necessary for measuring atmospheric conditions. These stations study weather patterns and climatic conditions to provide weather forecasts. The proposed system is a weather station used to monitor the climatological data over a particular petit are a like households and farms that predicts the current weather condition. This system includes different sensors to sense various parameters like temperature, pressure, humidity, wind speed and wind direction. For a long-term basis, the collected data is subjected to machine learning algorithms to predict rainfall. This helps people to take preventive measures and to estimate risks to life and property.*

Keywords: Weather station, climatological data, rainfall, prediction, machine learning

I. INTRODUCTION

Nature surrounds us and to understand it is a fascination. Analysis of nature is mainly done through observation. And one such environmental source is weather. To determine weather, weather stations are used. These are facilities that are either located on land or sea. Weather stations are the primary source for weather data. These stations use multiple methods to forecast rainfall which is a tedious work, and it needs to be accurate as much as possible to be taken into consideration. Automatic weather station is an automated version of the traditional weather station to enable measurements from remote areas. The specific configuration may vary due to the purpose of the system. In the past, automatic weather stations were often placed where electricity and communication lines were available.

Nowadays, solar panel, wind turbine, and mobile phone technology have made it possible to have wireless stations. Weather stations can be made to save the obtained data in a data logging system that can be retrieved and used later. This is where, machine learning comes into play. The datasets collected are converted and stored in a database. Huge amounts of data are needed for such prediction. And the accuracy level achieved is still not cent percent. Predictions can only be accurate if the value to be predicted is near the present time. As the predictions tend to move further into the future, the accuracy level becomes less accurate and only the approximate value can be predicted. Comparison of various modern techniques and algorithms help in enhancing the accuracy of forecasting rainfall. Scientists and researchers throughout the world are trying to improve the accuracy of rainfall forecasting. Several statistical and numerical models have been proposed for predicting rainfall. With the ongoing advances in computing approaches, artificial neural networks have become an inductive approach for forecasting. Data for Machine learning algorithms need to be cleansed and organized in a proper tabular configuration to generate optimal inferences. Pre-processing of data is performed to extract meaningful information from the existing raw database. After the implementation of algorithms based on their output accuracy, the system is deployed.

II. PROPOSED SYSTEM

This project deals with creating a mini weather station that can sense different parameters and display them. The values that are sensed are stored in a database. This database is extracted and pre-processed for applying machine

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learning algorithm. The system is trained with it and the model is used for predicting future rainfall. The main idea is to bring down the number of parameters used for predicting rainfall and to increase the accuracy of prediction by covering a specific area. Weather changes happen all around the world. In the past few years, there have been drastic changes in their pattern. And predicting weather has become one huge task. Multiple ways of prediction are being followed in different regions based on the terrain. This weather station is designed for covering small area. It consists of different sensors for measuring temperature, pressure, humidity, wind speed and wind direction. And again, for measuring temperature, four different sensors are used. Of these four values, the average is taken as the optimum temperature value. These parametric values obtained are used to predict future rainfall. Thus, this system helps the users to have a better sensed weather data.

Temperature, humidity and pressure are sensed through thermistor, LM34, LM35, DS1820, NXP sensor and DHT11. Anemometer is used to sense wind direction and wind speed. The power supply is given by a 5Volt battery connected directly to the switch box or solar panel can be used [10]. The temperature is calculated using four different types of sensors, from each sensors different type of reading is observed. The reading of each temperature sensor is added and given as average it is taken as temperature value. since the temperature is the main parameter to predict the rainfall different sensors are used. The data sensed are obtained by Arduino and transferred to PC by RS232 cable. Also, the sensed values are displayed on a 16x2 LED [14]. The received data is stored as a csv file and it is also uploaded in cloud for future references. The csv data file which is taken as input for deploying multilinear regression. Once the code is run, the output is displayed on a HTML webpage coded with python flask framework [15].

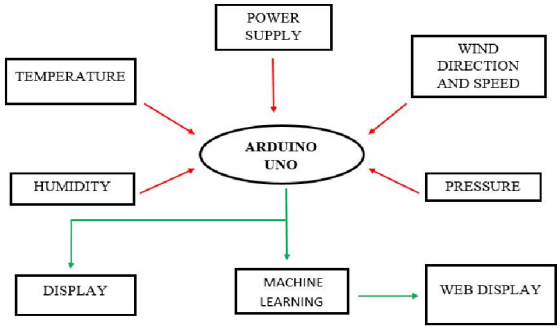

Figure 1: Block diagram[9]

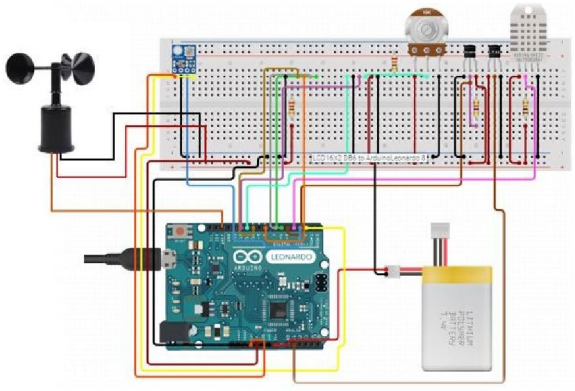

Figure 2: Circuit design[10]

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_p x_{ip} + \varepsilon$$

Figure 3: Multilinear regression formula[11]

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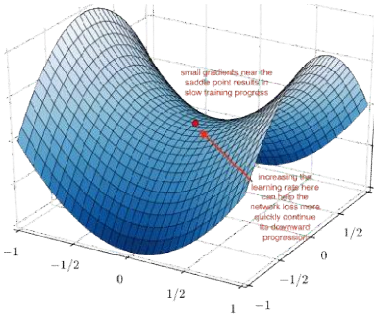

Figure 4: Adam optimizer [12]

T1	T2	T3	T4	PRESSURE	HUMIDITY	WIND SPEED	WIND DIRECTION
28	29	28	28	29	76	7	SE
28	28	29	29	30	75	7	SE
29	28	28	28	30	76	7	SE
29	28	29	28	30	76	7	SE
29	28	29	28	29	76	7	SE
28	29	29	29	29	76	7	SE
29	29	29	29	29	76	7	SE
28	28	29	29	29	76	8	SE
28	29	29	29	28	75	8	SE
29	28	28	29	29	75	7	SE
29	28	28	29	29	76	7	SE
29	29	28	28	29	76	7	SE

Figure 5: Sensed values stored in dataset[13]

Figure 6: Hardware

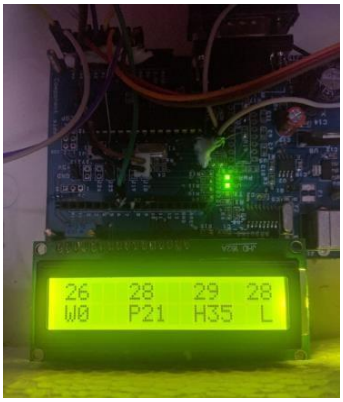

Figure 7: Values displayed on the LED display [14]

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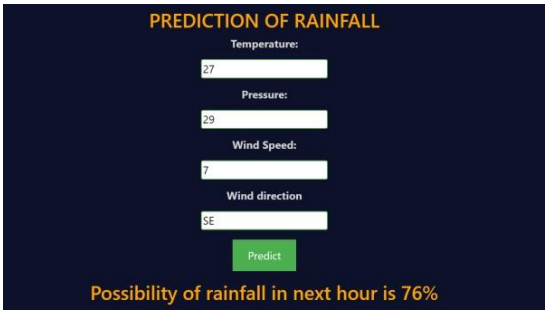

Figure 8: Predicted output displayed on a local server [15]

III. WORKING

The basic setup is like that of a weather station with different sensors placed at a distance for the acquirement of climatological data. In this project, Arduino UNO is used to collect the data and send it to an external device like a computer. The parameters considered are temperature, pressure, humidity, wind speed and wind direction. First part is the estimation of temperature. For this, four different temperature sensors namely LM34, thermistor, LM35 and a one-way thermocouple are placed, and their readings are noted. Of the above used temperature sensors, only the one-way thermocouple is of digital type while the other three sensors are of analog type. The average of these four values is taken to be the approximated temperature value. Humidity is measured using a specialized sensor named DHT11. The DHT11 used here has values that decreases if the humidity in the air increases. NXP pressure sensor is used to sense the pressure values [9]. Moreover, the pressure value remains mostly unchanged since there will only be a small significant change in the pressure value. The last part involves an anemometer that was specifically designed for this project to sense wind speed and wind direction. The anemometer gives the wind speed in the range of km/h and the direction is based on the side the wind wane turns. All these sensors are connected to the Arduino UNO which collects the data and transfers it to the personal computer via a RS232 cable [8].

The whole weather station comes with a solar panel and batteries that can store energy and use it up when the kit needs to be powered on. It can also be powered by connecting it to an external power supply. The data from the Arduino is obtained in the computer and stored as a database file in excel format or as a csv file [13]. The values being obtained in real time are displayed on the computer 32 screen. The command prompt is opened and new Jupiter notebook is created where the code for machine learning is to be coded. The jupyter notebook comes under the anaconda navigator, which is a tool for coding python. The dataset is imported in the notebook. Libraries like Numpy[1] and pandas are also imported. The dataset is checked for null values. If found, these values are either dropped or assigned special values. Next, the dataset is checked for textual data. Mainly, algorithms are preferred to be done on numerical data. So, textual data are converted to numerical data using label encoder. The various sensor values in the dataset are considered as inputs and the humidity column is taken to be the output. Once divided, the dataset is split into train and test data, where 70% is taken for training and the remaining 30% is taken for testing [6]. For this function, a special library called Sklearn is imported into the workspace. Since, there are multiple inputs based on which the output is to be predicted, multilinear regression algorithm is employed. The model is trained, tested and an accuracy of 91% is obtained[8]. Keras library is imported for deploying Artificial Neural Network. The regressor function is used with relu activation function and a mse loss metric. Mean squared error metric is used as a procedure for measuring unobserved quantity. Relu has been investigated thoroughly and universally results in improvement in results. Relu function is used as it can be used for real deep multi- layered networks.

A neural network is easy to optimize if its behaviours is linear or close to linear. Relu function is a nonlinear activation function function[4] but mostly looks and acts like a linear function. Adam optimizer[12] is used along with the specification of batch size and number of epochs for it to run. It achieves good results fast. Once the code is run, the creditability is checked with values from the testing data set and the accuracy is obtained. Then the model is saved as a h5 file that can be run with python code in the command prompt. H5 file is a file format for storing

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structured data and it is not a model itself. Keras saves models in this way since it can easily store weights [7] and model configuration in a single file. The prediction is done based on the intake parameters. The possibility of rain is high if the temperature value lies below 14 degrees Celsius, humidity value above 35 and wind speed greater than 7km/h. And based on this scale as the values shift, the possibility of rain varies. An HTML page is created for showcasing the sensed input values and the overall prediction of the weather system. Additional CSS code is added for better styling of the output displaying page. This code is integrated with python flask framework that can host this page on a local server.

IV. Results And Conclusions

Thus we have successfully developed a weather monitoring system to sense climatological data and predict future rainfall. This is a weather monitoring system to be used by people from households and agricultural field. The proposed system monitors weather both while being static and in motion. Here, the working of parameters such as temperature, humidity, pressure, wind speed and wind direction are combined to predict rainfall.

It can be improved by connecting the weather station to a household or a working environment and automating it, so that based on the weather, brightness of lights can be changed automatically. This system can be further integrated with other such mini weather stations in order to cover a wide area Since it is cost efficient weather station it can be used in portable station and it can be used in no network area and no power area.

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