Implementation of Soil Moisture Monitoring System and Value Prediction Using Machine Learning

G. Vijay Kumar

Department of CSE, Amrita Sai Institute of Science & Technology, Paritala, Andhra Pradesh, India

Abstract: Exponential growth within world's population requires an increasing food supply. There is a significant need towards sustainability to satisfy future nutritional requirement. In order to enhance production, it is critical to identify soil moisture levels. However, most farmers cannot afford high-cost soil moisture measuring system. Our research in this paper tends to focus with efficiency of soil moisture monitoring system. We introduce a method in this article about the generation accurate moisture level by providing information on the water source required for successful farming. A system of soil moisture monitoring based on the sensors that have been linked to Arduino Nano is the primary objective of the document. The humidity sensor DHT11 is the sensor used in the process. Connected the device and stationed on the floor with Arduino Nano. The sensor is analyzed to ascertain what level of moisture value in different Substance. The implementation of a sensor of soil moisture reduces the water content to a certain locations. It also has proved intuitive in all the values obtained in wet and normal conditions.

Keywords: Humidity Sensor, DHT11, Accurate moisture value, Types of soil, Arduino Nano

1 Introduction

A qualitative strategy incorporating the existing system for moisture levels, salinity and PH quality monitoring is the Soil Monitoring System for Precision Agriculture. This system has several parts: one is a notification system used to alert or send farmers (users) information on whether the moisture, Ionic strength ratios and saline of the soil are low or high relative to normal values, and are used to monitor process data in its totality. A Wi-Fi shield would've been expected for monitoring system (that works when we execute the program). In order that perhaps the users can use functions in the application comfortably, fundamental provision underlying robustness the Wi-Fi shield is incorporated on the notification. This should store the data because this is a statistics device. A service is available for everybody reason. The paper attempts to develop a prototype product using IOT [1] technology, which reflects on soil moisture and humidity control and maintenance.

In this paper, we are focused primarily on overcoming management issues for farming technologies acquisition in the water-related domain and improving a moisture measuring system based on captors. We too try to understand the outcomes of representation position of liquid measurements. Major determinants for the farming technologies are the temperature control [2] and water management that are in connection with wholesome growth of agricultural Manufacturing as well as research concentrates on water and moisture management [3]. Moisture is tightly correlated to the various characteristics and forces of the soil. The ability to maintain water and strong farming in sand and clay is different. The different devices which demonstrate the moisture [4] concentration are related to the force needed to extract water from the soil, instead of merely showing the liquid with the percentage (percent). Correspondingly, calculations of water content have indeed been strongly correlated with pF values with tensiometer [5].

2 Problem Statement

Throughout India, farming is the breathing need of most Indians and is a large livelihood source. The economy of such a country is also impacted via agriculture. Water consumption improves hour after hour, which could also lead to water scarcity. Now a day is not just challenging for crops beyond their households. This paper is mostly designed to inform farmers of an intense moisture value, who've been talking about reducing the worldwide usage of water. When moisture is limited, The farmer is ready towards prepare use Liquid consequently. Dumping machine learning (ML) into the development should be exact and efficiently forecast the next attribute (MOISTURE VALUE).

3 Analysis of Existing Work

3.1 Calculating Sensor Data

The sensor's moisture distribution can indeed be measured in the 20, 30, and 50 cm of ground level and dampness can indeed be corrected automatically between 0 and 100 cm in the Planet's surface. layer. Based on the calibration results, 0.99 was Soil's dampness content sample, and a relative error of 0–1.17%, the field test undertaken in very many soils, with an R2 of 0.96, and a root average square error of 0.04, would result in accurate moisture content. The sensor reliability calibration was 0.1-1.17%. In a sensor accuracy test R2, the determined effectiveness the device recommended & the portable soil moisture [6] monitoring system Diviner2000 was higher A comparative error compared with fewer than 5% becomes 0.85.The R2 for other soil layers remained consistently higher than 0.8 between numerical results and inversed soil moisture. This sensor is suitable for reasonable agricultural swirls with consistent results and easy implementation in alignment with a calibration test and field test with low cost, good operability and high integration

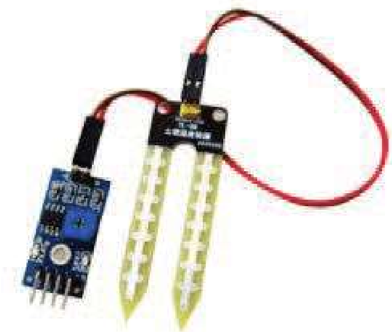

Fig 1. Soil moisture sensor

3.2 Disadvantages of existing work:

- Cannot predict accurate moisture value
- Low efficiency
- The site specific conditions should first be measured until the appropriate humidity Sensor is identified.
- The collection of information and maintaining of measuring processes are desired.
- Requirement of labor

3.3 Proposed work:

Here we use machine learning, to predict the accurate moisture value

3.3.1 Machine learning: The Internet of Things generates big information volumes from thousands of subscribers. Drive business machine learning and brings it insight. Machine learning incorporates behavior from of the past to recognize patterns and build models to predict future actions and events. Machine learning is a data computation methodology that automates computational architecture of analytical solutions. It is an artificial intelligence branch that suggests that Systems will learn from information, recognize trends and evaluate with very little human involvement. Predictive analytics uses machine learning predictive modeling. The purpose of predictive analytics is very specific: to use Additional information to decide a destiny. Analytics or some kind of are simply applied mathematics — often referred to as data gathering.

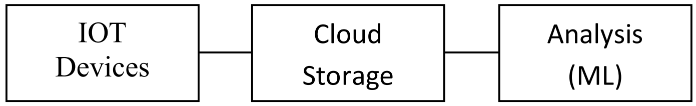

Fig 2. Connection between IoT and Machine Learning

Machine learning Algorithm's used in this paper are :

- Linear regression
- Random forest regression

4 Soil Moisture Monitoring System

4.1 Model building and training:

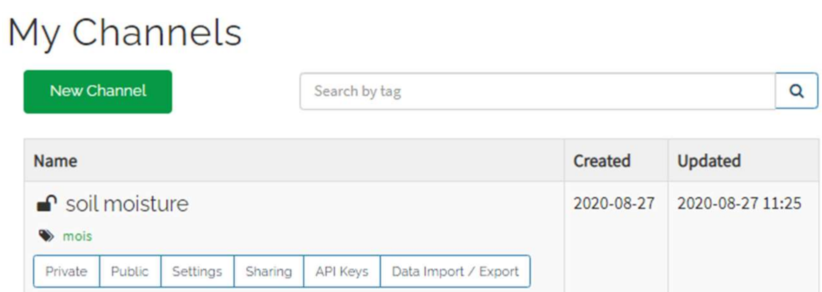

Fig 3. Creating a channel in Thingspeak (cloud storage)

Fig 3: We have to construct a channel in the Thingspeak [7] that's a public cloud storage platform, where we should communicate detected information from sensors to cloud storage via API keys. So, indeed that requires a channel to provide all the information on the particular sensor

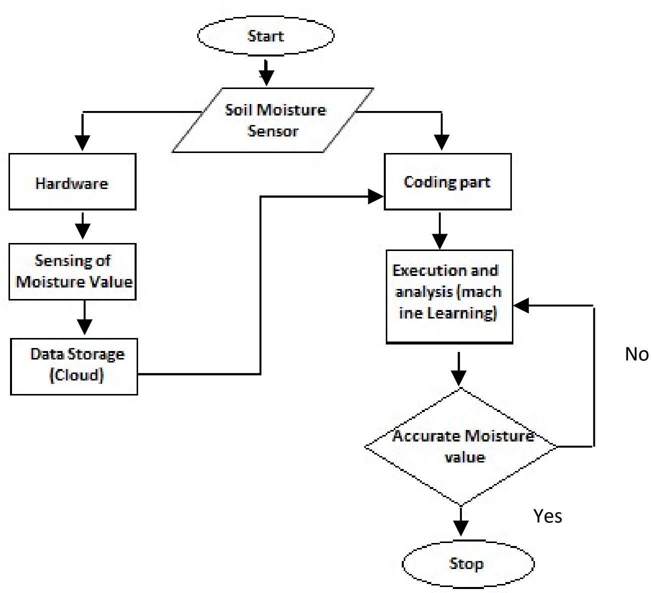

Fig 4: Flow chart for the Process

data. It prompts us to enter our information concerning the sensor and fields in which the sensor is going to provide the efficient values where the channel can even import/export our data in the form of CSV files which are being employed as a dataset [8]. Using the obtained dataset we can perform machine learning algorithm's to predict the most efficient moisture value.

4.2 Flow chart for the implementation:

Fig 4: The flow of figure 3 shows the flow of work that relates on the ground. Moisture sensing system, here first the moisture sensor collects data through different types of soils as well as the information is gathered cloud storage [9]. The data is sent from sensors to cloud storage using API keys. The detected information is also provided under this portion that codes the prediction of efficient moisture value using some algorithms related to the machine learning

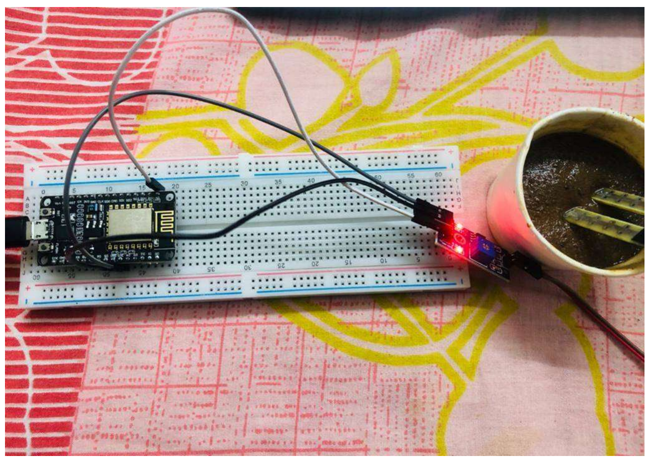

Fig 5. Hardware implementation for soil moisture sensor

Fig 5: Hardware implementation and connections, where the sensor is placed in the soil to sense the moisture value among the given environment and the sensor may be even placed in different soils to get the most Precise proportion of dampness. A sensor is then Linked by Arduino Nano [10] through connecting wires with a base help of breadboard. The whole setup passes via the supply voltage the pc using a USB cable, by using software named (Arduino IDE) within a pre-installed libraries in it. Output is displayed in serial monitor, there are many pre-installed libraries present in it.

Fig 6: This picture shows the code that required for calculate potential benefits of dampness libraries that opts the moisture sensor. The amount of water is evaluated Remove its grain yield from the initial weight, and the moisture content is then measured as the amount of water divided by the dry weight or total weight, predicated on the reporting method.

Formula to calculate moisture value

% moisture by volume = % moisture by weight Ã— bulk density of the soil.

The math following is a brief provided to change the percent Soil Ph by weight to the percentage per soil moisture via volume: Moisture percentage by volume = moisture percentage by weight â soil volume fraction. This value indicates water in inches per foot depth when determined for a depth of 12 inches. Tax (°F or °C), grams per cubic meter of concrete (g/m3) or hundred worth of

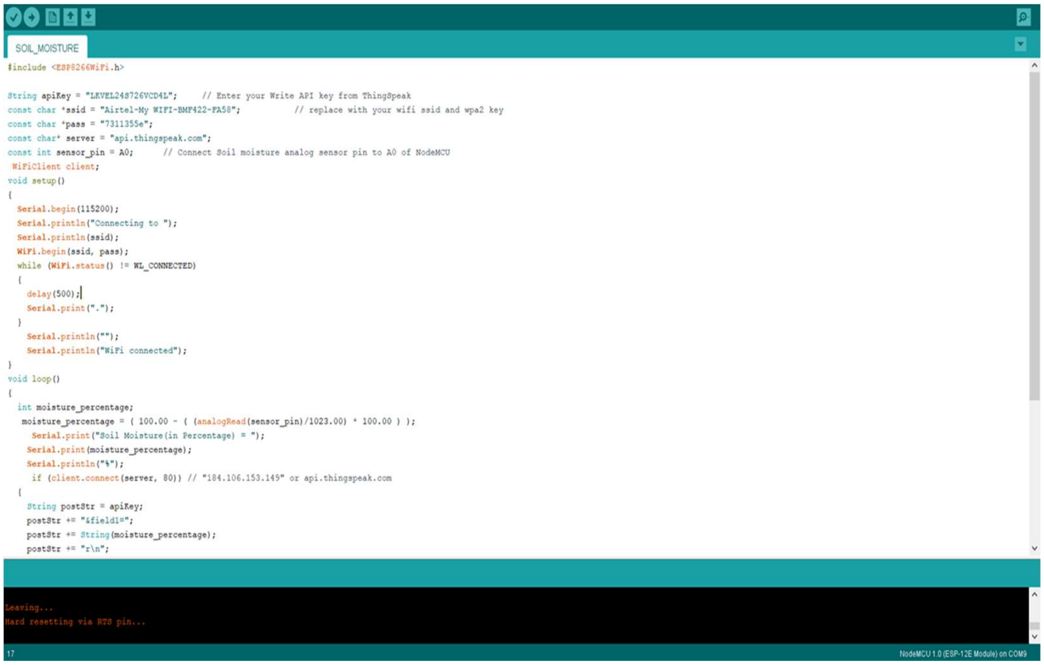

Fig 6. Code for calculating the soil moisture value

fluid cubic feet (lb/f3) are the appropriate word units. A total of four unique humidity states are generally observed. The commodities are oven-dry, air-dry, saturated, dry and humid surface (SSD) (or wet).

5 Experimental Results

When the functionality is provided in the Arduino IDE the output Amongst the performed code will be displayed in the serial A Biosystems Analyzer, all the data is send to the thing speak via API keys and fig 7 show the output by the fig 8 Programming show the graph that obtained by the data sent sending through cloud to a particular channel developed on behalf of the sensor. The channel contains all types of information that relates a device; data like, when the channel is created, when the last entry of the sensor data to cloud was taken place, total number of entries made to channel based on the sensor data. We can even made the channel settings to public as well as private instant communication additionally might be provided to certain authorized users by activating their mail id's. Here all the transmitted information to the cloud storage is been exported in shape of CSV file which can been further used in the domain of value prediction.

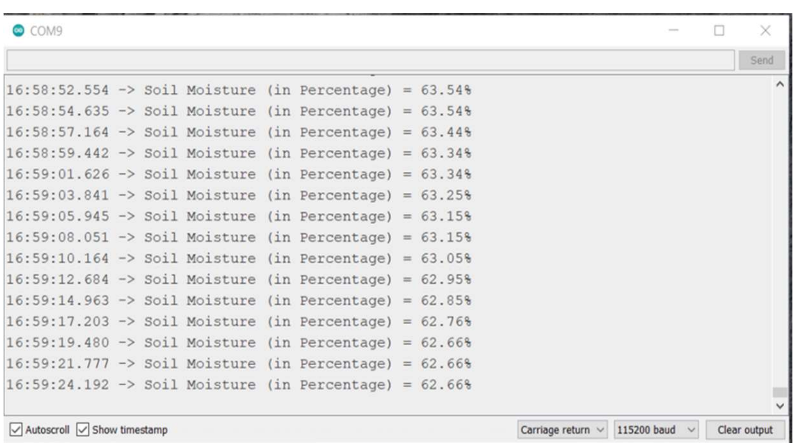

Fig 7. Serial monitor output in Arduino IDE

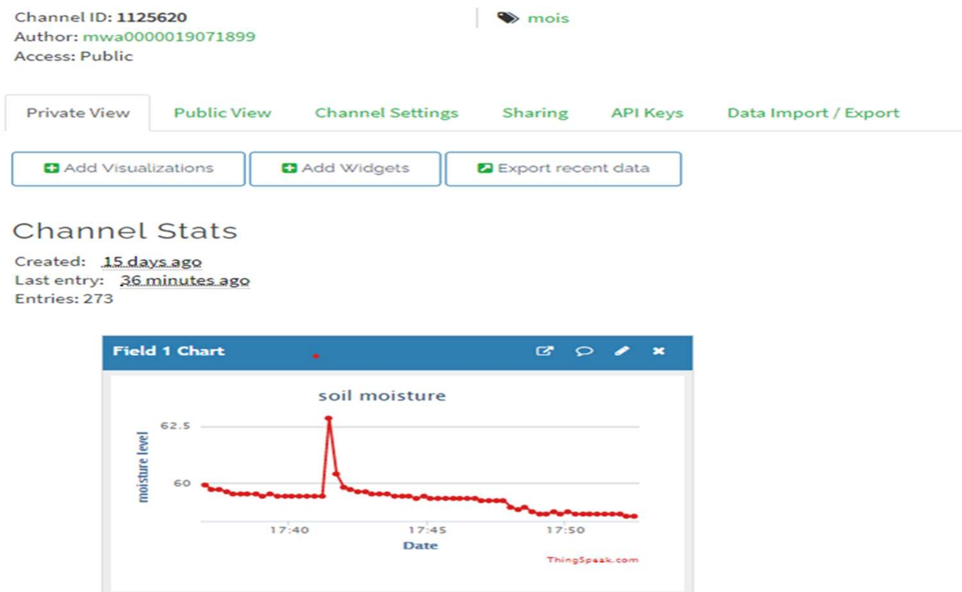

Fig 8. Thing Speak output

5.1 Value prediction using machine learning (ML):

Using specified algorithms we predict the next accurate value suing ML from the obtained dataset from thing speak

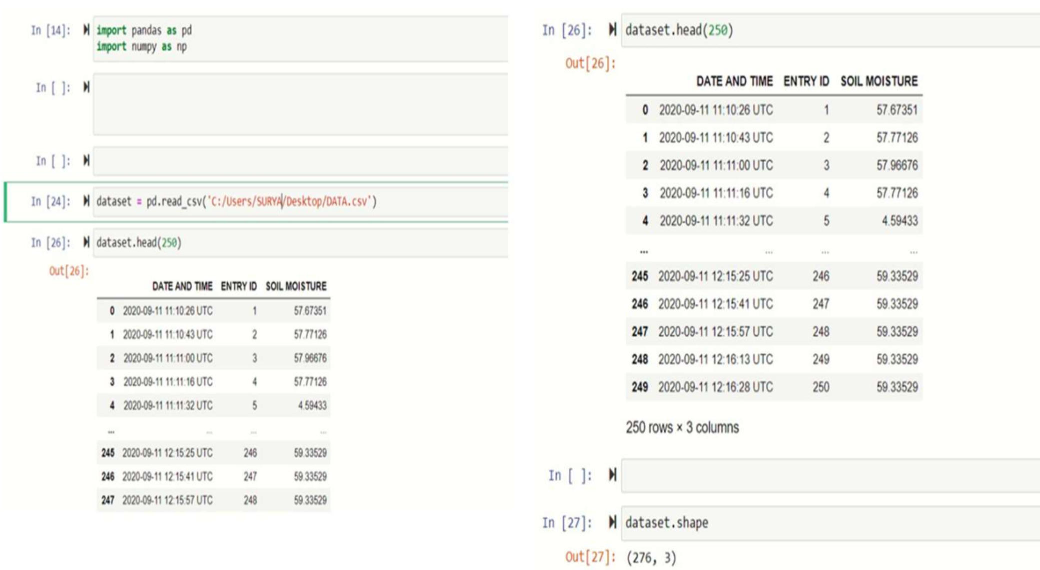

Fig 9. Performing operations on the dataset using jupyter notebook

```
In [28]: dataset.describe()
```

Out[28]:

	ENTRY ID	SOIL MOISTURE
count	276.000000	276.000000
mean	138.500000	46.599587
std	79.818544	24.236251
min	1.000000	-0.097750
25%	69.750000	49.169110
50%	138.500000	58.651030
75%	207.250000	59.628540
max	276.000000	99.608990

```
In [113]: from sklearn import metrics

          print('Mean Absolute Error:', metrics.mean_absolute_error(y_test, y_pred))
          print('Mean Squared Error:', metrics.mean_squared_error(y_test, y_pred))
          print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(y_test, y_pred)))

          Mean Absolute Error: 0.030298807852965716
          Mean Squared Error: 0.0019506006016641385
          Root Mean Squared Error: 0.044165604282791586
```

Fig 10. Output's from jyputer notebook

Using Linear Regression Algorithm:

```
In [124]: print("Training Accuracy = ", regressor.score(X_train, y_train))
          print("Test Accuracy = ", regressor.score(X_test, y_test))

          Training Accuracy =  0.22373924747047869
          Test Accuracy =  0.24648312674488848

In [ ]:
```

Out[123]:

	Actual	Predicted
0	0.6999	0.506906
1	0.4751	0.526563
2	0.7400	0.632289
3	0.6276	0.548861
4	0.5210	0.531265
5	0.7312	0.603859
6	0.5777	0.647093
7	0.4633	0.531514
8	0.4604	0.504015
9	0.4741	0.512689
10	0.4907	0.516610
11	0.7058	0.518670
12	0.7361	0.640131
13	0.5601	0.583322
14	0.4673	0.506026
15	0.7204	0.600918
16	0.5445	0.531315
17	0.4790	0.525483
18	0.5601	0.654886

Fig 11. Output using linear regression algorithm

Using Random Forest Regression:

```
In [115]: from sklearn.metrics import confusion_matrix, accuracy_score

          print("Training Accuracy = ", regressor.score(X_train, y_train))
          print("Test Accuracy = ", regressor.score(X_test, y_test))

          Training Accuracy =  0.9100934186981224
          Test Accuracy =  0.8248140213939292
```

Out[114]:

	Actual	Predicted
0	0.6999	0.628219
1	0.4751	0.471696
2	0.7400	0.729252
3	0.6276	0.497957
4	0.5210	0.500323
5	0.7312	0.734002
6	0.5777	0.563798
7	0.4633	0.462501
8	0.4604	0.479365
9	0.4741	0.484552
10	0.4907	0.527971
11	0.7058	0.638426
12	0.7361	0.724426
13	0.5601	0.540404
14	0.4673	0.489902
15	0.7204	0.730173
16	0.5445	0.501800
17	0.4790	0.548791
18	0.5601	0.571821

Fig 12. Output Deploy algorithm of random forest regression

6 Conclusion

The ambience is the principal resource in this root zone. It is also regarded as the life among all living organisms on earth. Soil can comfortably accommodate living and non-living if sufficient. Optimum soil incorporates both in performance and quantity its components in an "outstanding for living and semi material. The most critical part altering the vegetation cover was living things, especially crops on the earth. The content of Ground dampness effects one tremendously country's agricultural productivity. Such as improved growth & production of plants, optimum Dampness or water required. Some of the advantages of forecasting Dampness are its soil saving water, predicting temperature, Reduction & productivity of environmental degradation. Improper cultivation of plants includes disadvantages such as land degradation, water pollution, having to sort of plants and limits plant output. It is also important to properly predict and analyze soil moisture.

References:

1. G. Vijay Kumar, A. Bharadwaja, R. Nikjil Sai, "Temperature and heart beat monitoring system using IOT", International Conference on Trends in Electronics and Informatics, pp. 692-695, Jan 2018.
2. Y. Zhou, Q. Zhou, Q. Kong, and W. CAI, "Wireless temperature amp; humidity monitor and control system," 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet), April 2012, pp. 2246–2250.
3. Sai Prasanna G.V., Vijay Kumar G., "Controlling and monitoring the plant growth conditions using embedded systems", International Journal of Innovative Technology and Exploring Engineering, Vol 8(6), pp. 1552 to 1555, 2019.
4. N. B. A. Karim and I. B. Ismail, "Soil moisture detection using electrical capacitance tomography (ect) sensor," Perak Darul Ridzuan, Malaysia, 2011.
5. M.B. Kirkham, in Principles of Soil and Plant Water Relations (Second Edition), Tensiometers, ScienceDirect, 2014.
6. Keith Bellingham, Soil Moisture Applications and Practices using the Hydra Probe II Soil Moisture Sensor [Online]. Available: http://www.stevenswater.com

7. M. Ramesh, Dr. S.A.K. Jilani, Mr.S.Arun, “An Automated ThingSpeak Weather Monitoring System using Raspberry PI”, International Journal of Engineering Trends and Technology (IJETT) –Volume33- March2016.
8. “Thingspeak” access:- https://thingspeak.com/login?skipSSOCheck=true
9. Cloud Storage Models: https://yourtechdiet.com/blogs/cloud-storage-models/
10. “Arduino” Software Free installation-: http://www.arduino.cc/download/