International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 4 ǁ April 2023 ǁ PP. 509-514

Design and Implementation of Deep Learning Model For Soil Moisture Analysis.

[1]Jyoti Pal
[2]Harshal Bodhe
[3]Tejas Kapse
[4]Manisha Neware
[1-4]Projecties
Department of Information Technology
Kavikulguru Institute of Technology and Science,
Nagpur, India
[5]Mrs. Saroj Shambharkar
[5]Assistant Professor and Head
Department of Information Technology
Kavikulguru Institute of Technology and Science
Nagpur, India

Abstract— *Soil Moisture, Humidity, Temperature, etc. are responsible for yields and growth of crops. For the growth of the plant in the agriculture field soil moisture is a vital parameter. Maintaining the necessary soil moisture levels in the field through continuous monitoring results in higher agricultural productivity. The Internet of Things (IoT) is a modern technology that has widespread applications in diverse fields such as military, industries, homes, education, healthcare, and agriculture. The proposed system utilizes IoT technology for the continuous monitoring of soil moisture levels in agricultural fields.*

Keywords— *Soil Moisture, humidity, monitoring, Internet of Things, irrigation, microcontroller, moisture sensors.*

Date of Submission: 08-04-2023 Date of acceptance: 22-04-2023

I. INTRODUCTION

The agricultural sector contributes around 17-18% to India's GDP, and to enhance its productivity, the latest technologies of artificial intelligence, machine learning, IoT, and IT are being adopted. Soil is a fundamental component of agricultural activities, as crops absorb various nutrients, water (moisture), and minerals from it. The depth of the soil profile that is essential for plant growth is between 100-200 cm, with some crop roots having a length of 120cm. Soil contains numerous minerals, organic matter, air, water, moisture, nutrients, pollutants, Ph., thermal conductivity, temperature, electrical conductivity, color, texture, structure, and bulk density. Soil moisture plays a crucial role in influencing soil properties and moisture distributions, such as soil texture, structure, bulk density, color, thermal conductivity, and electrical conductivity. Soil moisture can be classified into two types, soil water content and soil water potential. Soil weight remains unchanged when soil is heated between 100-110 degrees Celsius, and the water content is evaporated from the soil.

Soil moisture is a vital factor for supporting plant growth and improving farm productivity in agriculture. Low moisture levels in the plant area can result in yield loss and plant death, while high moisture levels can cause root diseases. Continuous monitoring of soil moisture for long-duration crops is a challenging task, and proper water irrigation is needed to maintain the required level of soil moisture. A soil moisture sensing system is used to help irrigators identify and maintain the required moisture level.

In the existing system, the moisture level was identified through manual work by dipping sensors in the agricultural field. If the farmer needs to identify the entire field's moisture level, it is a tedious task to dip the sensor in various places to acquire the data. To overcome this drawback, the proposed system uses GPS mechanisms to get temporal and spatial data regarding a particular location where soil moisture is measured. The proposed system's main advantages are continuous monitoring and recording of soil moisture, enabling farmers to manage the irrigation system's schedule based on the results. The measured value of soil moisture can be accessed anywhere through the IoT system.

II. LITERATURE SURVEY

A. An IoT Based Soil Moisture Monitoring on Losant Platform

The research paper titled "An IoT Based Soil Moisture Monitoring on Losant Platform" by Ravi Kishore Kodali and Archana Sahu in 2016, aimed to develop an IoT system for continuous monitoring of soil moisture using the Losant platform. They used an esp8266 microcontroller and a moisture sensor to design a wireless sensor network in combination with a water flow sensor using a zigbee protocol for communication among them. The system's status can be viewed on a web portal, and water flow notifications can be sent to users via GSM. The complete hardware and software setup were used to monitor the soil moisture level of the field. The researchers tested the system in a small scale by inserting a moisture sensor and visualizing the readings. A customized dashboard called "desk plant" was created in Losant platform to view the moisture level over time. A workflow was imported to set up alerts via SMS or email to the intended person whenever the moisture level of the plants was less. The system would also subscribe to commands from Losant to turn on the LED if the percentage of moisture in the soil fell below the threshold value. The system offered real-time data visualization of sensor data that could be accessed from anywhere in the world, regardless of the field's location..

B. Soil moisture monitoring using IoT enabled arduino sensors with neural networks for improving soil management for farmers

The research paper "Soil moisture monitoring using IoT enabled arduino sensors with neural networks for improving soil management for farmers" proposes a simple and affordable method to continuously monitor soil moisture levels using IoT-enabled Arduino sensors and neural networks. The system consists of a soil moisture sensor connected to an Arduino board, which is then interfaced with an Android application using a Wi-Fi shield. The sensor continuously monitors the soil moisture and sends the output values to a database. Correction factors and a neural network algorithm are then used to process the data and provide soil monitoring assessments. The output values are displayed on the Android application, which allows farmers to make informed decisions about irrigation and soil management. This system is cost-effective and low maintenance, making it suitable for small-scale agriculturists and rural areas.

C. IoT Enabled Plant Soil Moisture Monitoring Using Wireless Sensor Networks

The research paper “IoT Enabled Plant Soil Moisture Monitoring Using Wireless Sensor Networks” by A. M. Ezhilazhahi and P. T. V. Bhuvaneswari (2017) describes a system that uses a Wireless Sensor Network (WSN) integrated with the Internet of Things (IoT) to remotely monitor the soil moisture of plants. The Exponential Weighted Moving Average (EWMA) event detection algorithm is used to enhance the network lifetime. The system uses a soil moisture sensor that is immersed into the soil to display the percentage of water present in the soil on an LCD screen. The data obtained from the sensor is given as input to the EWMA algorithm, which specifies the threshold values for the WSN. The data received from the sensors is then transmitted through a Zigbee transceiver to the Raspberry Pi, from which the data is uploaded to the cloud. The nodes in the WSN are battery operated and to enhance their lifetime, the EWMA event detection algorithm is used to generate events only when threshold conditions are met. The nodes are in a sleep state for the rest of the time to save energy. The system can be extended to include more than one sensor module for further monitoring of the soil moisture levels.

D. Design and Development of Iot Based Soil Moisture Sensing System

The research paper “Soil Moisture Retrieval Using Convolutional Neural Networks the paper proposes the use of a convolutional neural network (CNN) as a feature extractor and regression model for predicting daily global soil moisture from brightness temperature. The method involves preprocessing the images, training the CNN model, and predicting new brightness temperature using the trained model. The CNN model is trained using AMSR-E brightness temperatures to predict the ECMWF model. The deep learning-based method is shown to be more suitable for global soil moisture retrieval compared to classical inversion methods and is well-supported by GPU acceleration for handling massive data inversion. The CNN-based approach is capable of learning complex texture features from big remote sensing data and outperforms support vector regression (SVR) for soil moisture retrieval.

E. Design and Development of Iot Based Soil Moisture Sensing System

Dr. R. Rajkumar, Dr. T. Arumuganathan, Dr. S.Saira Banu (2020) in this system, IoT technology is used for continuous monitoring of soil moisture levels in the agricultural field. The user can easily get real-time data through their Mobile phones. Based on the data collection, the irrigation schedule can be planned. The proposed system is compact, easy to handle, portable, Robustness, access anywhere to get data and economically benefited. The design and construction of the proposed system are done by using components like Microcontroller, Moisture sensors, LCD (Liquid Crystal Display), GPS (Global Positioning System), and mobile app. The data presentation of the system describes the performance and execution of the soil moisture measuring methods. The results were carried out using several samples ranged from the low-level moisture to high-level moisture of a soil sample. The proposed system was able to produce the accurate soil moisture data along with the location of the samples using Global Positioning System (GPS) and their result was displayed in the smart mobile with the help of IoT technologies. By using the GPS, the farmer can easily get the soil moisture level of each part in the wide agricultural field. So that, farmer can maintains the required level of irrigation for crops in the entire agriculture field

Tools and techniques:

- Programming Languages: HTML, CSS, Python, MySQL
- Software: Windows 7+
- Hardware: processor 64 GB, RAM 4 GB, Hard Disk 80 GB

Jupyter Notebook

Jupyter Notebook is a powerful and versatile open-source web-based environment that enables users to create and share interactive documents containing live code, mathematical equations, graphics, maps, plots, visualizations, and narrative text. It seamlessly integrates with a wide range of programming languages, including Python, PHP, R, C#, and more, making it a flexible tool for various data analysis, research, and development projects. The name Jupyter is derived from the combination of Julia, Python, and R - three programming languages that it was originally designed to support. However, it has since expanded to support over 40 programming languages, making it a truly multilingual interactive computing environment. With Jupyter Notebook, users can easily bring together data, code, and prose to create interactive computational stories that can be shared with others. Whether you are analyzing text, creating art or music, or developing engineering concepts, Jupyter Notebook provides an intuitive and interactive interface for combining code and explanations with the interactivity of the application. Overall, Jupyter Notebook is a valuable tool for anyone seeking a flexible and powerful platform for data analysis, research, or development.

Use-Case diagram

In this Use-case diagram, it contains number of functions works on hydroponic tank, external water tank, micro-controller/ arduino, Nutrient box. Hydroponic tank to control the hold water, regulate pH, create light setting, water level indicator, Flush nutrients to plants. External water tank to controls the hold water and water level indicator .arduino works on functioning of sensors and monitor Growth and also nutrient boxes of main function is Flush nutrients to growth.

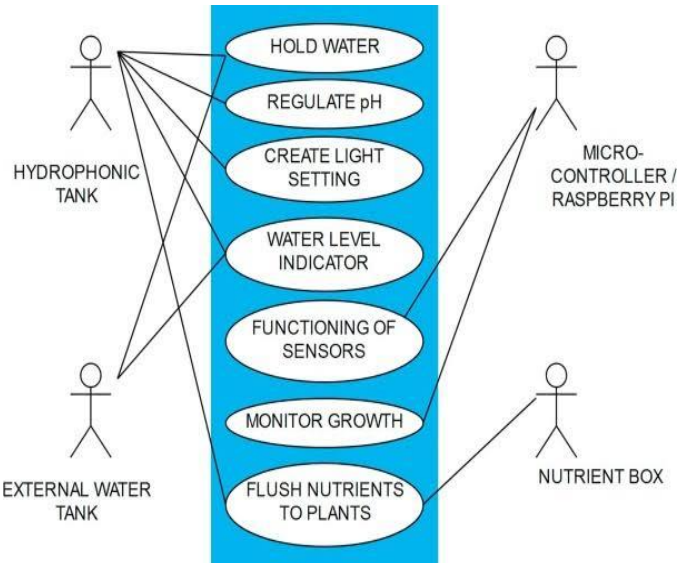

Fig: Use-case Diagram

Class Diagram

In this class diagram, we take a labeled Experimental dataset containing soil, plant, weather attributes. These Dataset train and test dataset and its goes through machine learner and predictive model. these machine learner and predictive model gives irrigation decisions like timing , volume ,pump speed , stressed filed zones detection using desired control parameter sometime it gives retrain to reduce prediction error.

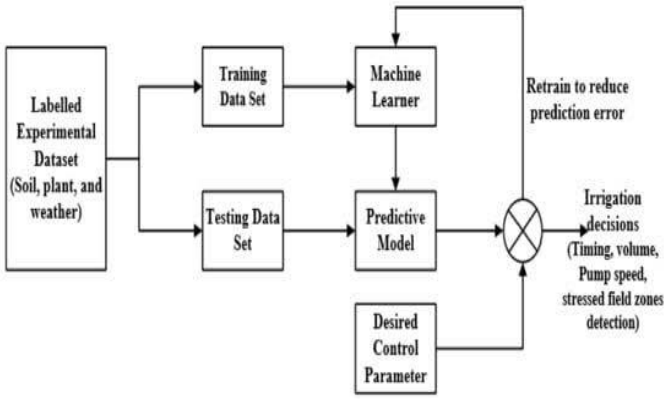

Fig: Class Diagram

Architecture

Soil moisture sensor measure the volumetric content of water in soil, Soil moisture sensor has two probes. Electric current is sent from one probe to the other if there as high electric conductivity resistance is low and hence the water content in the soil is high and if there is how electric conductivity, resistance is high hence water content and is low.

Water content in the soil is inversely proportional to Resistance

$$\text{Water content} \quad \alpha \quad \frac{1}{Resistance}$$

Soil moisture sensor is placed near the plant in the soil and collects the moisture readings from the soil and transfers the readings to the Node MCU unit.

In Node MCU analog output of Soil moisture sensor is processed and that analog value is converted to digital value. These digital valves are given to the arduino. Arduino is a small microprocessor unit which can be programmed as per the user requirement.

In our case Arduino is programmed using Deep Learning model, which Uses ANN algorithm.

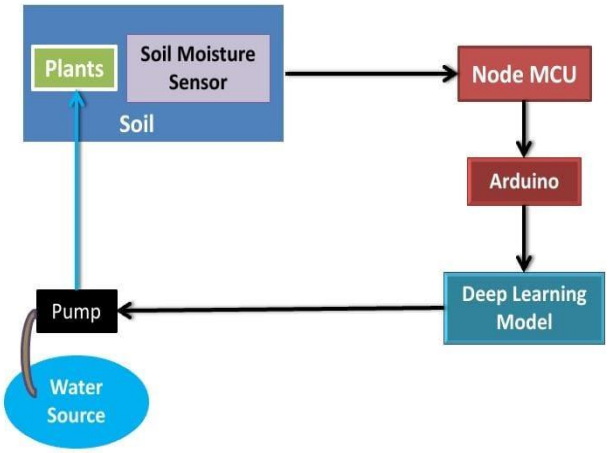

Fig: System Architecture

Proposed Approach

The proposed work aims to develop a soil moisture prediction model using simulated data to optimize irrigation scheduling and improve crop yields. The model will be based on deep learning techniques and will be trained and tested using simulated data generated from a soil moisture simulation model.

The simulation model will accurately represent the behavior of soil moisture in agricultural fields, taking into account factors such as soil type, weather conditions, and irrigation practices. The simulated data will be used to train and optimize a deep learning model that accurately predicts soil moisture levels.

Several deep learning techniques will be explored, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and other deep learning algorithms. These models will be trained using the simulated data and evaluated for accuracy and performance.

Once the best-performing deep learning model is identified, it will be integrated into a software tool that can be used by farmers and other agricultural stakeholders to predict soil moisture levels and optimize irrigation scheduling. The tool will take into account factors such as weather conditions, crop type, and irrigation practices to provide accurate predictions of soil moisture levels.

The proposed work has the potential to provide significant benefits for agriculture and water resource management. By accurately predicting soil moisture levels, farmers can optimize irrigation scheduling and reduce water usage while maintaining crop yields. This can lead to more sustainable agriculture practices and better management of water resources. The use of simulated data also allows for testing and optimization of the model without the need for costly and time-consuming field trials. Overall, the proposed work has significant potential to improve agricultural practices and contribute to more sustainable use of natural resources.

V.CONCLUSION

A specialized approach is being used to design the soil monitoring system for measurement and control of the soil moisture. The data which we get from the measurement has shown that the system performance is quite dependable and correct. Soil moisture sensors are used in detecting the changes which are required and to calibrate irrigation practices. These minor changes in irrigation practices help in increasing yield and saves water. The lead to proper irrigation management using soil moisture sensors is disciplined monitoring of the sensors to get the soil moisture level when the data obtained is in the determined range for the specific soil type. With the neural networks we can use the same to predict seasonal variations and rains in an area which can also help the farmers to plan their future harvest which can be future work on this project

References

[1]. Almaw Ayele Aniley, Naveen Kumar S.K and Akshaya Kumar A, "Soil Moisture Sensors in Agriculture and the Possible application of nanomaterial's in Soil Moisture Sensors Fabrication", International Journal of Advanced Engineering Research and Technology (IJAERT), Vol.6(1), 2018, pp. 134-142

[2]. Pavan Kumar Sharma, Dheeraj Kumar , Hari Shanker Srivastava and Parul Patel, "Assessment of Different Methods for Soil Moisture Estimation",A Review, Journal of Remote Sensing & GIS Vol.9(1), 2018, pp. 57-73

[3]. SK Soam, M Balakrishnan and et al, "Artificial Intelligence and Internet of Things: Implications for Human Resources in Indian" NARES, 2018, pp. 1-4

[4]. Boobalan. J, Jacintha. V and et al, "An IOT based Agriculture Monitoring System", IEEE Advancing Technology for Humanity, 2018,pp. 0595- 0598.

[5]. Mustafa Alper Akkaş and Radosveta Sokullu, "An IoT-based greenhouse monitoring system with Micaz motes", Procedia Computer Science, Vol. 113, 2017, pp. 603–608
[6]. Rabelo S. L and et al, "Construction of soil moisture and irrigation IoT monitoring system using Project Based Learning", International Journal for Innovation Education and Research, Vol.6 (8), 2018, pp. 99-111.
[7]. Ram Krishna Jha and et al, "Field Monitoring Using IoT in Agriculture", 2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), 2017, pp. 1417- 1420
[8]. Prathibha S R, Anupama Hongal and Jyothi M P, "IOT Based Monitoring System in Smart Agriculture",International Conference on Recent Advances in Electronics and Communication Technology (IEEE), 2017, pp. 81 -84.
[9]. Lavanya G, Rani C and Ganeshkumar P, "An Automated Low Cost IoT based Fertilizer Intimation System for Smart Agriculture", Sustainable Computing: Informatics and Systems, 2018, pp.1-12.s
[10]. Amarendra Goapa ,Deepak Sharma, A.K. Shuklab and C. Rama Krishnaa, "An IoT based smart irrigation management system using Machine learning and open source technologies", Computers and Electronics in Agriculture, Vol. 155, 2018, pp. 41-49
[11]. Fenil Dankhara, Kartik Patel and Nishant Doshi, "Analysis of robust weed detection techniques based on the Internet of Things (IoT)", Procedia Computer Science, Vol. 160, 2019.
[12]. Jirapond Muangprathuba, Nathaphon Boonnam and et al, "IoT and agriculture data analysis for smart farm, Computers and Electronics in Agriculture", Vo. 156, 2019.
[13]. A. R. Al-Ali and et al," IoT Solar energy powered smart farm irrigation system", Journal of Electronic Science and Technology, 2019.
[14]. Jash Doshi, Tirthkumar Patel and Santosh kumar Bharti, Smart Farming using Patel and Santosh kumar Bharti, "Smart Farming using IoT, a solution for optimally monitoring farming conditions", Procedia Computer Science, Vo. 160 ,2019.
[15]. Takkasila Akbar Saleem and K Sreenivasa Rao, "Automatic Crop Monitoring using Embedded System", International Research Journal of Engineering and Technology (IRJET), Vol. 4(7), 2017, pp.651-657