



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 3, March 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijrset@gmail.com

www.ijrset.com

Precision Irrigation Based on IoT and ML

Mr. S. Saida Rao, K. Jagadeesh Varma, A. Chandra Manikanta, K. Nageswara Rao

Department of Computer Science and Engineering (IoT), Vasireddy Venkatadri Institute of Technology, Namburu,
Andhra Pradesh, India

C.S Student, Department of Computer Science and Engineering (IoT), Vasireddy Venkatadri Institute of Technology,
Namburu, Andhra Pradesh, India

ABSTRACT: A Precision Irrigation system driven by IoT and machine learning is created for sustainable farming. Our primary goal is to optimize water usage, increase crop yield, and follow ecologically friendly procedures. The system will use tiny sensors dispersed around the farmland to keep track of important variables, including soil moisture, temperature, humidity, pH and meteorological conditions. These sensors will gather data in real-time, giving important insights into the water requirements of crops at various growth stages. Our Precise Irrigation system will dynamically alter irrigation schedules and amounts by analyzing this data with clever algorithms, ensuring that water is given precisely where and when it is most required. This focused strategy will result in better crop yields and higher farmer revenue. The main objective is to reduce water usage by employing ML models for crop prediction. These predictive models will utilize historical sensor data, environmental parameters, and crop characteristics to forecast crop growth and yield. Through rigorous testing and evaluation in real agricultural settings, we aim to create an affordable and scalable Precise Irrigation system that contributes to sustainable agricultural practices, ensuring food security while safeguarding water resources for future generations.

KEYWORDS: Precision Irrigation, Agriculture 5.0, Support Vector Machine, Internet of Things, Machine Learning, ThingSpeak

I. INTRODUCTION

In the twenty-first century, agriculture—which is essential to both global food security and economic stability—faces a number of difficulties that are made worse by factors including soil degradation, water scarcity, and climate change. Conventional agricultural practices frequently find it difficult to adjust to these changing circumstances, which leads to inefficient use of resources and lower crop yields. A rising number of people are interested in using cutting-edge technologies to transform agricultural methods and guarantee sustainable food supply for future generations in response to these difficulties.

The convergence of machine learning (ML) with the internet of things (IoT) presents hitherto unseen possibilities for tackling important agricultural problems, especially those related to crop selection and irrigation control. Farmers can optimise water usage, increase crop yields, and lessen their impact on the environment by using data-driven decision-making and real-time monitoring of environmental variables made possible by the combination of IoT-enabled sensors and machine learning algorithms.

In this regard, the development and application of an IoT and ML-powered system for automatic irrigation and crop prediction is the main goal of our research. The method attempts to solve two important aspects of contemporary agriculture: forecasting appropriate crops based on real-time environmental data and optimising water usage through autonomous irrigation control.

Our system obtains real-time data on important environmental factors like temperature, humidity, light intensity, rainfall patterns, and soil moisture levels by installing a network of IoT-enabled sensors, such as DHT11, soil moisture, pH, rainfall, and LDR sensors, in agricultural areas. Support Vector Machine (SVM) is one of the machine learning (ML) techniques that are used to process and analyse this data in order to anticipate which crops would be best for a certain soil type.

Our project's two main goals are to predict suitable crops based on environmental variables and optimise water usage by dynamically adjusting irrigation schedules based on real-time soil moisture data. This will help farmers make

informed decisions about crop selection and management techniques. Our approach strives to improve agricultural productivity, sustainability, and resilience in the face of changing environmental circumstances and global issues by giving farmers actionable insights and decision support tools.

The system architecture, methods, findings, and discussion will all be covered in detail in the sections that follow in this paper. We will also examine the implications for the future and potential paths for future study and development. We hope that our initiative will help improve digital agriculture and change conventional farming methods in the direction of a more productive, resilient, and sustainable future.

1.1 Precision Irrigation

Applying water to crops with a high degree of accuracy and efficiency is known as precision irrigation, an advanced agricultural method. Water may be delivered precisely where and when it is needed, depending on soil moisture levels, crop water requirements, and environmental circumstances, thanks to precision irrigation technology. This is in contrast to traditional irrigation methods, which frequently involve uniformly watering entire fields. For the purpose of optimising water consumption and irrigation management, precision irrigation systems combine hardware, software, and data analytics.

1.2 Benefits of precision irrigation

Both water consumption and economic efficiency could rise with precision irrigation. According to Dukes (2004), precision irrigation, which uses drip and sprinklers, has been shown to increase water application efficiency by 80–90%, compared to 40–45% when using surface irrigation methods. Variable rate irrigation case studies revealed water savings in a single year that ranged from 0% to 50%. Precision irrigation has the ability to save costs by either boosting yield with the same inputs or decreasing their cost.

Water Conservation: Precision irrigation helps farmers save water resources and cut irrigation expenses by delivering water exactly where and when it is needed. This reduces water waste and boosts overall water use efficiency.

Better Crop Yields and Quality: Precision irrigation systems can improve crop growth, development, and yield potential by streamlining irrigation management and making sure that crops receive the appropriate amount of water at the appropriate time. This can raise farmers' profitability.

Environmental Sustainability: Precision irrigation systems help to minimise environmental impacts and promote sustainable farming practices by minimising water usage, runoff, and the leaching of fertilisers and pesticides into the environment.

II. RELATED WORK

2.1 Agriculture 5.0:

Following conventional methods (Agriculture 1.0), mechanization (Agriculture 2.0), automation (Agriculture 3.0), and precision agriculture (Agriculture 4.0), agriculture 5.0 is thought to represent the next phase in the evolution of farming. It involves utilizing cutting-edge technology to develop an even more productive, sustainable, and profitable agricultural sector. Examples of these technologies include big data, artificial intelligence (AI), the Internet of Things (IoT), and robotics.

Listed below are a few objectives of Agriculture 5.0:

- Boost crop yields
- Cut back on water use
- Use fewer pesticides and fertilizers
- Enhance soil health.

Farmers may gather and evaluate real-time data on their crops and growth circumstances by utilizing AI and big data. Making more educated decisions about planting, watering, fertilization, and pest management is therefore possible with the use of this data. Robots may be used to do chores like planting, harvesting, and weeding, while IoT sensors can track temperature, moisture content, and nutrient levels in the soil. Though it is still in its infancy, agriculture 5.0 has the power to completely alter how we produce food.

2.2 AI for agriculture:

"Agriculture 5.0" is a conceptual term that refers to the next stage of agricultural evolution, where advanced artificial intelligence (AI) technologies play a central role in revolutionizing farming practices. While the term "Agriculture 5.0" is not yet widely recognized or defined, it represents a vision of the future where AI-driven innovations enable unprecedented levels of automation, efficiency, and sustainability in agriculture.

Logistic regression:

When the dependent variable is categorical and can be expressed as (0 or 1), (True or False), or (On or Off), the model utilized is logistic regression. The logistical role takes the following form:

$$p(x) = 1 / (1 + e^{-(x-\mu)/s})$$

where s is a scale parameter and μ is a location parameter (the middle of the curve) where $p(\mu) = 1/2$.

Neural network:

An arbitrary mapping from one vector space to another can be carried out using the neural network [10]. These neural networks are unable to extract information from the input, but they can exploit previously undiscovered information that is hidden in it. It should be mentioned that learning in mathematical formalism entails changing the weighting coefficients to satisfy certain requirements. Prior to defining a neural network, the linear model is introduced and specified as follows:

$$g(x, w) = \sum_{i=1}^p w_i f_i(x)$$

where the functions $f(x)$ are non-parametric functions for the variable x , and the vector w represents the model's parameter vector. The class of models with non-linear parameters includes neural networks.

Support Vector Machine:

A separation hyperplane is the formal definition of SVM, a discriminative classifier. SVMs can therefore create a hyperplane that classifies the new unlabeled data using labelled training data. Next, a training set $(y_i; x_i); i=1,2,.., n$ is used, in which $y_i \in R^n$ denotes the target element and $x_i \in R^n$ represents the input vector. Numerous SVM varieties have been created to handle various problem kinds and, more crucially, their complexity. The best hyperplane in this study is generated by the linear SVM and has the following form:

$$f(x) = w^T * x + b \quad (1)$$

Then, for each $i = 1, 2, \dots, n, y_i (w^T * x + b) > 1 - \xi_i; \xi_i \geq 0$

III. DISCUSSIONS

3.1 Proposed System

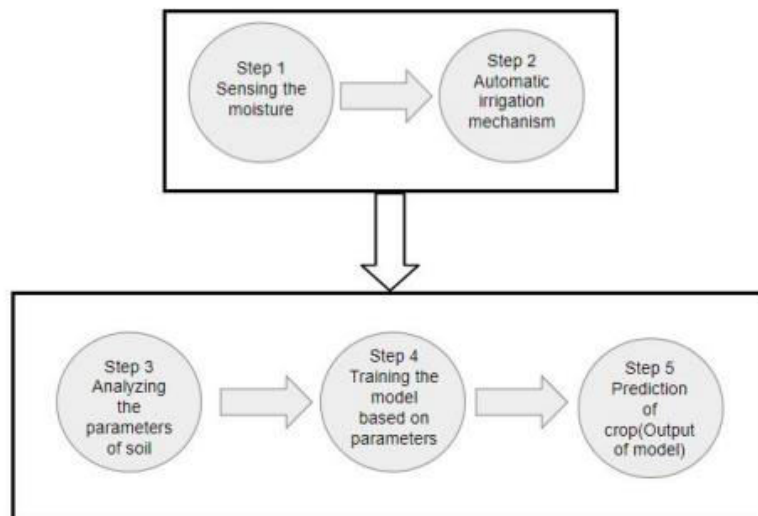


fig1. Proposed System

The proposed system integrates various components and functionalities aimed at optimizing irrigation practices and enhancing crop selection based on real-time environmental data. The system consists of five main steps:

Step 1: Sensing the Data: Setting up a network of sensors in an agricultural field is the first stage in gathering real-time data on important environmental factors like light intensity, temperature, humidity, soil moisture, and pH levels. Comprehensive data about the soil and surrounding circumstances are collected using a variety of sensors, such as the DHT11, soil moisture sensors, pH sensors, LDR sensors, and rainfall sensors.

Step 2: Automatic Irrigation Mechanism: The system uses an automatic irrigation mechanism to control the amount of water that is given to the crops after the environmental data has been gathered. The device dynamically modifies irrigation schedules and water application rates to maintain ideal moisture levels for plant growth while minimising water waste by evaluating soil moisture levels and weather forecasts.

Step 3: Analyzing the Parameters of Soil: In order to evaluate the physical and chemical characteristics of the soil, the system examines the data that has been gathered. The evaluation of many parameters, including temperature, pH levels, and soil moisture, is done to assess the soil's fertility and appropriateness for various crops. The technology also keeps an eye on meteorological variables like rainfall and light intensity to further improve crop recommendations.

Step 4: Training the Model Based on Parameters: The system trains a predictive model by analysing the gathered data using Machine Learning (ML) methods. The machine learning model is trained with historical data on crop performance, weather, and soil parameters. This allows the programme to find patterns and connections between environmental factors and crop suitability.

Step 5: Prediction of Crops (Output Model): Based on the examined parameters, the machine learning model can forecast appropriate crops once it has been trained. The technology creates crop suggestions based on the unique features of the agricultural plot by importing real-time data on environmental elements and soil conditions. These suggestions can be used by farmers to make well-informed choices on crop selection and management techniques.

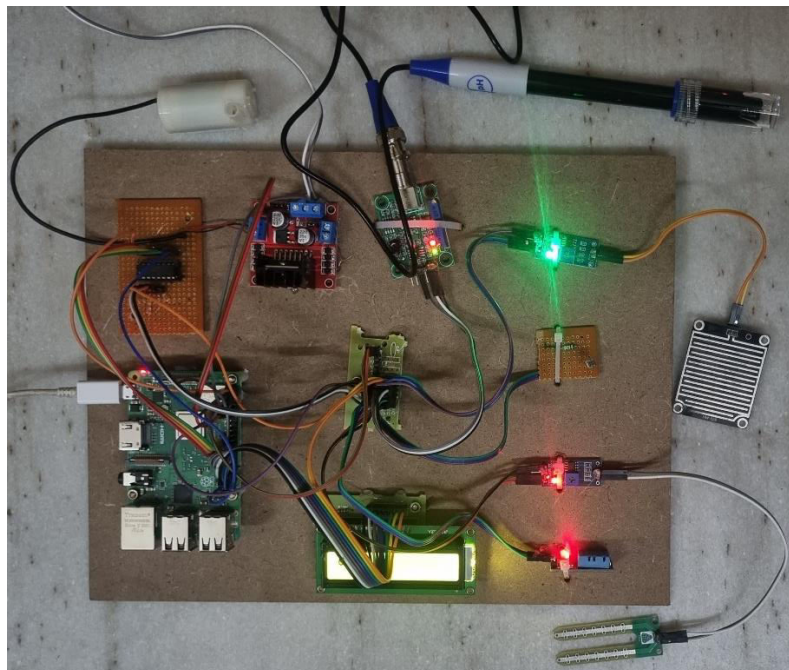


fig2. Realtime development of System

3.2 Data Collection, Storage and Prediction:

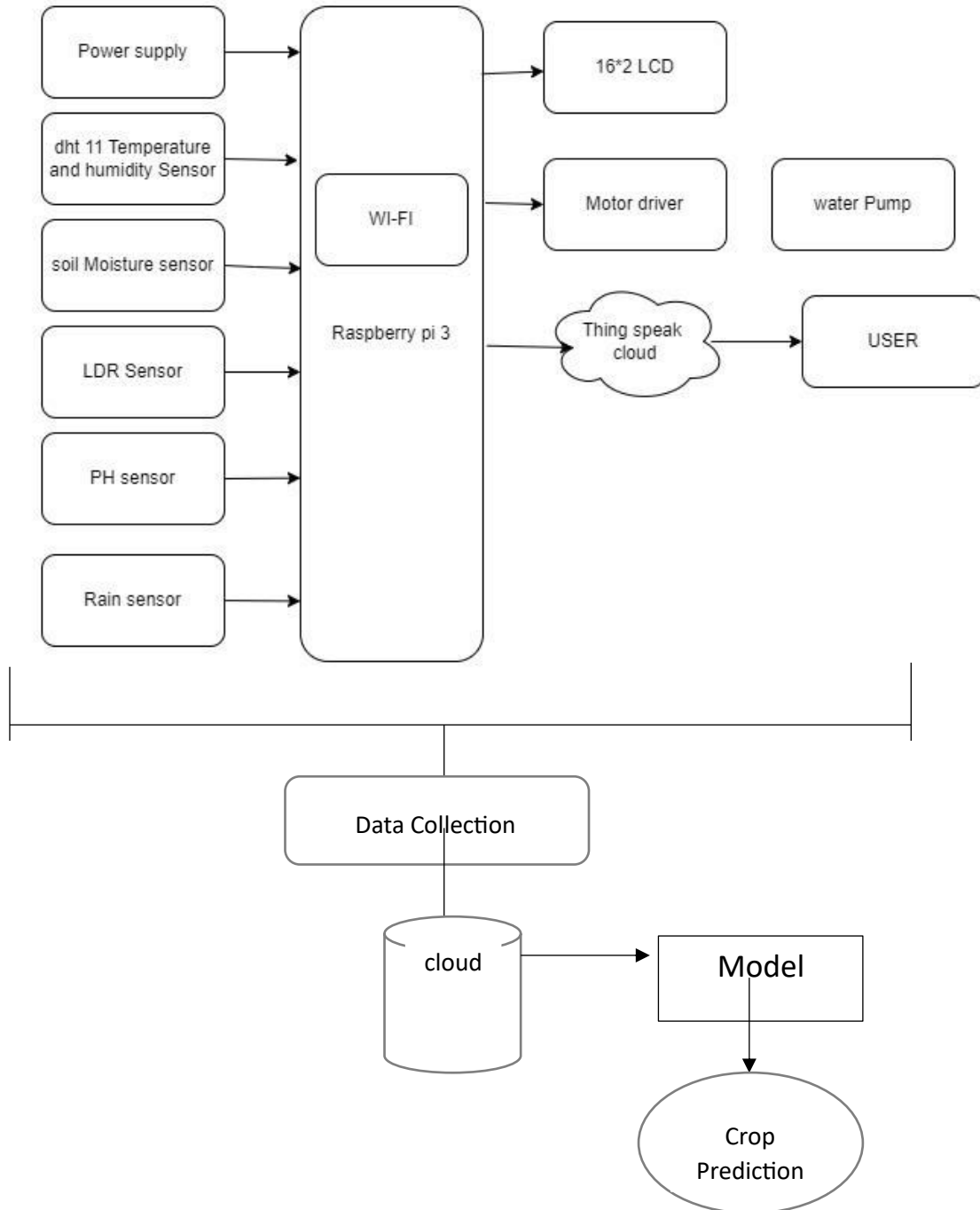


fig3. Irrigation System from Dashboard to Services.

• **DHT11 (Temperature and Humidity Sensor):**

- The DHT11 sensor is used to measure the environment's humidity and temperature.
- It offers up-to-date information on temperature and humidity, two important variables affecting irrigation scheduling and plant growth.
- While humidity data helps track the amount of moisture in the air, temperature data is useful for evaluating the general state of the environment.

- **Soil Moisture Sensor:**
 - The soil moisture sensor is used to determine the soil's moisture content.
 - It offers vital information on soil moisture content, making it possible to precisely manage irrigation and maximize water use.
 - The sensor helps avoid overwatering or underwatering by continuously measuring the amount of moisture in the soil, guaranteeing ideal growing conditions for plants.
- **Rain Sensor:**
 - The rain sensor picks up precipitation, including snowfall and rainfall.
 - It offers information on the frequency and volume of rainfall occurrences, enabling scheduling modifications for irrigation.
 - The system can prevent needless irrigation during times of adequate moisture by integrating rainfall data, saving water resources and cutting down on water waste.
- **LDR (Light Dependent Resistor) Sensor:**
 - The environment's light intensity is measured by the LDR sensor.
 - It offers data on the quantity of sunlight that the crops receive, which is necessary for photosynthesis and plant development.
 - Crop selection based on light requirements is optimized with the use of light intensity data, which aids in determining if the environment is suitable for a given crop.
- **pH Sensor:**
 - The pH sensor is used to determine the soil's acidity or alkalinity.
 - It offers information on the pH of the soil, which affects the availability of nutrients and the health of plants.
 - pH data aids in determining the acidity and fertility of the soil, allowing for necessary modifications to fertilization and soil management techniques.
- **Soil NPK Sensors (Nitrogen, Phosphorus, Potassium):**
 - Soil NPK sensors gauge the concentrations of the three major nutrients in the soil: potassium (K), phosphorus (P), and nitrogen (N).
 - They offer insightful data on soil nutrient levels, which are essential for the growth and development of plants.
 - The sensors help optimize fertilization techniques and guarantee sufficient nutrient delivery for good crop growth by tracking soil nutrient levels.

3.3 Dataset:

This dataset contains essential environmental and soil parameters vital for agricultural management. It includes nitrogen (N), phosphorus (P), potassium (K), pH, humidity, and temperature.



	A	B	C	D	E	F	G	H
1	N	P	K	temperatu	humidity	ph	rainfall	label
2	79	34	37	20.8797	82.0027	6.50299	202.936	rice
3	78	21	20	21.7705	80.3196	7.0381	226.656	rice
4	92	31	34	23.0045	82.3208	7.84021	263.964	rice
5	98	38	45	26.4911	80.1584	6.9804	242.864	rice
6	79	53	43	20.1302	81.6049	7.62847	262.717	rice
7	65	50	36	23.058	83.3701	7.07345	251.055	rice
8	75	23	28	22.7088	82.6394	5.70081	271.325	rice
9	95	35	21	20.2777	82.8941	5.71863	241.974	rice
10	92	30	25	24.5159	83.5352	6.68535	230.446	rice
11	69	35	60	23.224	83.0332	6.33625	221.209	rice
12	75	54	39	26.5272	81.4175	5.38617	264.615	rice
13	98	36	44	23.979	81.4506	7.50283	250.083	rice
14	86	52	48	26.8008	80.8868	5.10868	284.436	rice
15	86	20	31	24.015	82.0569	6.98435	185.277	rice
16	75	22	56	25.6659	80.6639	6.94802	209.587	rice
17	66	35	39	24.2821	80.3003	7.0423	231.086	rice
18	61	46	51	21.5871	82.7884	6.24905	276.655	rice
19	69	45	28	23.7939	80.4182	6.97086	206.261	rice
20	80	26	44	21.8653	80.1923	5.95393	224.555	rice
21	100	46	34	23.5794	83.5876	5.85393	291.299	rice
22	62	49	37	21.325	80.4748	6.44248	185.497	rice
23	63	21	53	25.1575	83.1171	5.07018	231.384	rice

fig4. Dataset Features

Nitrogen (N): Essential for plant growth, influencing yields and nutrient uptake efficiency.

Phosphorus (P): Crucial for energy transfer and root development, impacting crop productivity.

Potassium (K): Vital for physiological processes, such as osmoregulation and disease resistance.

pH (Soil Acidity/Alkalinity): Influences nutrient availability and soil fertility, affecting plant health.

Humidity: Affects transpiration and water uptake, crucial for preventing water stress.

Temperature: Impacts germination, photosynthesis, and microbial activity, guiding planting schedules and crop management.

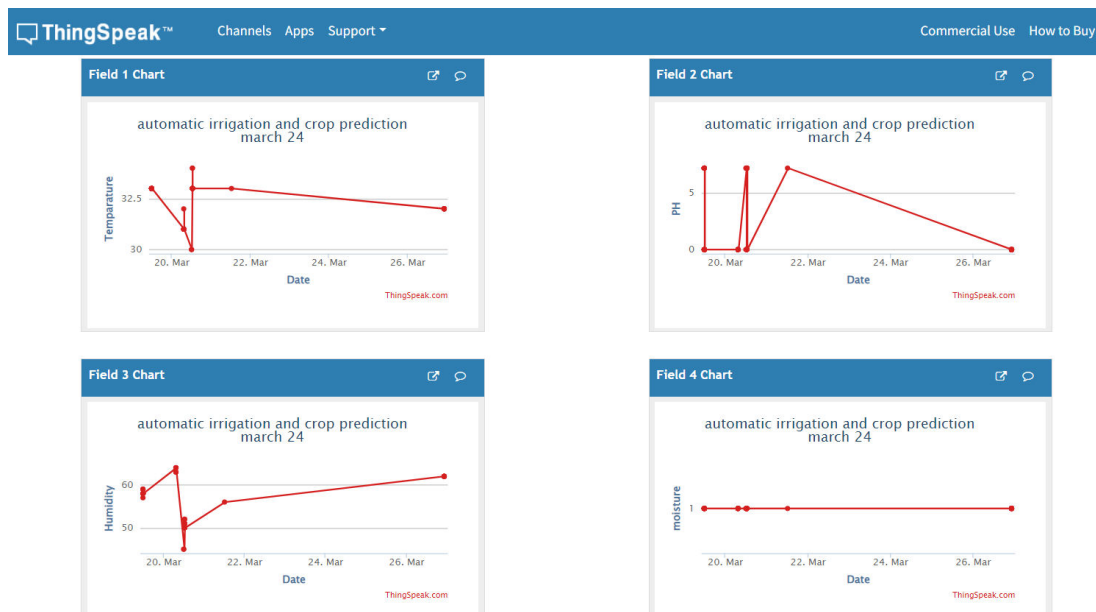


fig5. Scheme of data collected in ThingSpeak

3.4 Technologies

Html & JS

The user interface for the crop prediction model is implemented using HTML and JavaScript, allowing users to input key environmental and soil parameters for analysis. The HTML page features input fields for nitrogen, phosphorus, potassium, pH, humidity, and temperature, enabling users to enter data relevant to their agricultural plot or field. The



JavaScript code facilitates the processing of user inputs and the interaction with the predictive model for crop prediction.

AgriCrop Home Predict Dashboard

Enter the ammount of Nitrogen
Enter the ammount of Nitrogen

Enter the ammount of Phosphorus
Enter the ammount of Phosphorus

Enter the ammount of Potassium
Enter the ammount of Potassium

Enter the value for Temperature
Enter the value for Temperature

Enter the value for Humidity
Enter the value for Humidity

Enter the ph value of the soil
Enter pH value of the soil

Enter the value of Rainfall
Enter the value for Rainfall

Predict

fig6. Input Interface(html)

Machine Learning

For problems involving regression and classification, Support Vector Machine (SVM) is a supervised machine learning technique. To categorize or forecast appropriate crops for a given set of input attributes, SVM uses previous data on environmental and soil conditions. The algorithm finds the best hyperplane in the feature space to divide several classes or categories, maximizing the margin between classes and minimizing classification mistakes.

3.5 Result

After processing the user inputs through the SVM model for crop prediction, the results are displayed on the HTML page to provide users with actionable insights and recommendations. The result presentation includes the predicted crop(s) based on the input environmental and soil parameters, along with suggestions tailored to the nitrogen (N), phosphorus (P), and potassium (K) values entered by the user.

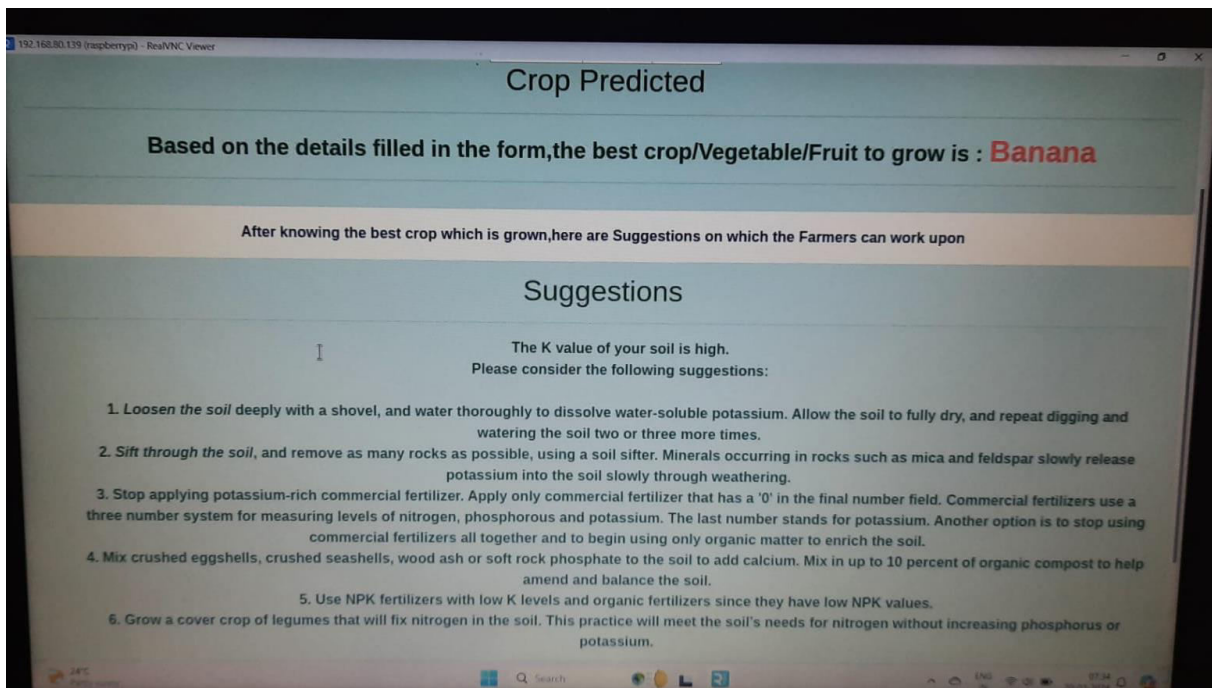


fig7. Crop Prediction Output

IV. CONCLUSION

In conclusion, the development and implementation of the Automatic Irrigation and Crop Prediction system represent a significant step forward in modernizing agriculture practices and addressing key challenges faced by farmers worldwide. By leveraging Internet of Things (IoT) and Machine Learning (ML) technologies, this project has demonstrated the potential to optimize water usage, improve crop selection, and enhance overall agricultural productivity.

The system offers real-time monitoring of critical environmental variables through the integration of sensors like DHT11, soil moisture, pH, rainfall, and LDR. This enables accurate irrigation management and crop-specific suggestions. Support Vector Machine (SVM), a machine learning technique, helps farmers choose crops by providing them with precise crop projections based on past data and present soil conditions.

The Automatic Irrigation and Crop Prediction system effectively ushers in a new era of data-driven decision-making and sustainable farming practices. We can use technology to make the agriculture sector more resilient, effective, and ecologically friendly so that we can guarantee food security and prosperity for coming generations.

REFERENCES

- [1] Afrin, S., Ahsan, R., Mishal, Khan, A. T., Mahia, M., Rahman, R. M., M. R., Ahmed, W. (2018). Analysis of Soil Properties and Climatic Data to Predict Crop Yields. 2018 IEEE/ACIS 17th International Conference on Computer and Information Science (ICIS).
- [2] Ponce-Guevara, K. L., Palacios-Echeverria, J. A., Maya-Olalla, E., Dominguez Limaico, H. M., Suarez-Zambrano, L. E., Rosero-Montalvo, P.D., Alvarado-Perez, J. C. (2017). GreenFarm-DM: A tool for analyzing vegetable crops data from a greenhouse using data mining techniques (First trial). 2017 IEEE Second Ecuador Technical Chapters Meeting (ETCM).
- [3] Dhareesh Vadalia, Minal Vaity, Krutika Tawate, Dynaneshwar Kapse, "Real Time soil fertility analyzer and crop prediction", IRJET, Volume 4, Issue 3, March 17.
- [4] Mrs. N. Hemageetha, Dr. G.M. Nasira, "Analysis of soil condition Based on pH value using Classification Technique", IOSR-JCE, Volume 18, Issue 6, Nov 16.
- [5] Gebbers Robin. Precision agriculture perspectives. <http://dx.doi.org/10.13140/2.1.2465.3601>.



- [6] Albiero Daniel, de Paulo Rodrigo Leme, Junior José Carlos Félix, da Silva Gomes Santos Jenyffer, Melo Rafaela Paula. Agriculture 4.0: A terminological introduction. In: 9th International proceedings on proceedings. 2010, p. 1–2, Author, F.: Contribution title, Publisher, Location.
- [7] Heiman Amir, Miranowski John, Zilberman David, Alix Jennifer. The increasing role of agribusiness in agricultural economics. *J Agribusiness* 20(1):1S30, (Spring 2002).
- [8] Awan Sabir, Ahmed Sheeraz, Ullah Fasee, Nawaz Asif, Khan Atif, Irfan Uddin M, et al. IoT with BlockChain: A futuristic approach in agriculture and food supply chain. *Wireless Commun Mob Comput* 2021:5580179.
- [9] Sinwar Deepak, Dhaka Vijaypal Singh, Sharma Manoj Kumar, Rani Geeta. AI-Based Yield Prediction and Smart Irrigation. http://dx.doi.org/10.1007/978-981-15-0663-5_8.
- [10] Kamienski C, Soininen J-P, Taumberger M, et al. Smart water management platform: Iot-based precision irrigation for agriculture. *Sensors* 2019;19(2):276.
- [11] Nour-El Aine Y, Leghris C. Ensuring smart agriculture system communication confidentiality using a new network steganography method. In: Boumerdassi S, Ghogho M, Renault É, editors. *Smart and sustainable agriculture*. 2021.
- [12] Kant Amitabh, Sawhney Ajay, Aggarwal Vivek, Ranjan Jayesh, Jurgens Jeremy. *Artificial Intelligence for Agriculture Innovation*. COMMUNITY PAPER MARCH 2021.
- [13] Rish I. An empirical study of the naive bayes classifier. 30 Saw Mill River Road, Hawthorne, NY: T.J. Watson Research Center, 1053.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details