AI Based Optimal Water Usage Predication Using Machine Learning for Farmers

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***Abstract*—The issue of water management is essential for the current generation of cultivators, especially for those who inhabit regions with minimal water availability or unpredictable climatic conditions. Conventional irrigation strategies depend on scheduled water application or on farmers' instincts, which might cause water waste or reduced crop yield potential. The proposed research introduces a machine learning algorithm for computing the optimum irrigation demands according to the type of crops.**

We are heading to the Moon. Not merely for the purpose of reaching the Moon but for the challenge it presents, and we shall go there because it is difficult and will make us reach there and do everything related to that endeavor. Humans will unite and collaborate and employ their innovative thinking and capabilities to develop solutions to achieve that objective and complete it. It is precisely because of such reasons that last year I decided to change from a passive to active participation in the country's space exploration program, which is among the crucial decisions I would make as the President of the USA.

I. INTRODUCTION

Food security and economy development in any nation cannot be achieved without farming, but one problem is the sustainability of our irrigation because of more people, changing climatic conditions, and rainfall patterns. In conventional farming practice, irrigation needs the manual assessment of the water quantity to be used or a time schedule before planting the crop. This implies that either there will be less or too much watering of the farms, hence resulting in inefficient use of fields.

The evolution of Artificial Intelligence (AI) and machine learning (ML) has brought new hope in agriculture practices. The utilization of ML in agriculture has enabled the assessment of environmental data in relation to agriculture through trend analysis and prediction. These developments have brought a revolution in agriculture through precision farming, where decision-making is based on real-time information.

Agricultural applications of machine learning include predicting water consumption for irrigation of crops (i.e., determining the amount of water required to satisfy the needs of the crop). Machine learning models have been used to successfully predict the requirements of crops in terms of water by using such information as the temperature, humidity, rainfall, and moisture content in the soil. Through the predictive power of machine learning algorithms, the farmer would be able to make better use of water in irrigating crops, developing more efficient irrigation techniques.

The proposed project seeks to build an irrigation prediction model that uses machine learning algorithms and the environmental variables previously mentioned to predict the water needs of crops with respect to environmental variables. Such a model would be capable of providing farmers with useful suggestions via an intuitive user interface.

II. LITERATURE REVIEW

There is literature examining the application of AI and ML technologies to agricultural systems for improving irrigation systems.

Jain et al. (2020) have developed an IoT-based Smart Irrigation System that uses real-time data collected through sensors and employs ML to make informed decision-making concerning the appropriate time frame for irrigation. While this irrigation system is efficient in terms of how water is used, it does not utilize existing infrastructure because it employs sensors to collect real-time environmental data.

The study carried out by Reddy and Kumar (2020) involved using historical data to create a machine learning model capable of predicting the amount of water needed for the cultivation of various types of crops. According to the results of the study, using machine learning technology allows the model to analyze existing agricultural data and estimate the required amount of water.

Predictive analytics will help develop models based on environmental factors and utilize machine learning algorithms to decide when the irrigation is required to water the crops using their irrigation system. It was found out from the results of the study that the water management system used by the researchers led to better management of water resources but was complicated due to the integration of hardware into the system.

Liakos et al. (2018) offered an overview of the use of machine learning in agriculture and discussed the importance of using predictive models to improve agriculture through efficient crop management and resource utilization.

Although numerous developments in technologies and software solutions have been achieved, there are systems which are still considered too costly or too complicated to be used by small-scale farmers. Thus, the need arises for easily affordable and straightforward systems to help farmers forecast irrigation based on water resources and available data.

III. METHODOLOGY

The software program has a well-thought-out set of procedures which may be broken down into a few basic components (steps).

1. Gathering Data

Data relating to agriculture and environment will be gathered from the various sources as well as the data bases available. The data will come from both of these sources and will consist of, among others, the following:

- Temperature
- Humidity
- Rainfall
- Soil Moisture
- Crop Type

2. Data Cleansing

The information gathered from both these sources will then be cleansed/formatted before analysis can take place. This is done by the following steps:

- Deletion of all blank spaces
- Normalization of data
- Selection of variables

3. Determination of Variable(s)

These variables will depend on how well they correspond to the irrigation needs.

4. Developing Models

Making use of the processed data for developing machine learning models (algorithms).

Method(s) which would be used to develop model(s):

- Linear Regression
- Decision Trees
- Random Forests

5. Model Evaluation

Models developed in Step 4 would be tested against the following standards:

- Mean Squared Error (MSE)
- Root Mean Squared Error (RMSE)
- Prediction Accuracy

6. Water Prediction

Water Needs Prediction The trained model predicts water needs on the basis of certain environmental variables.

Fig. 1: Workflow Diagram

IV. SYSTEM ARCHITECTURE

Architecture of the system consists of several components:

1. Input Layer: It collects various environmental inputs including temperature, humidity, rain, and soil moisture content.

2. Data Processing Layer: These data are preprocessed where they are cleaned and transformed to be ready for further analysis or for use with machine learning approaches.

3. Machine Learning Approach: To analyze the effects of environmental factors on crop water demand, Random Forest and Decision Tree algorithms were applied.

4. Forecasting Engine: Having learned from the previous data, the system makes predictions of the required irrigation level.

5. User Interface: The system provides farmers with a convenient tool to monitor their irrigation recommendations.

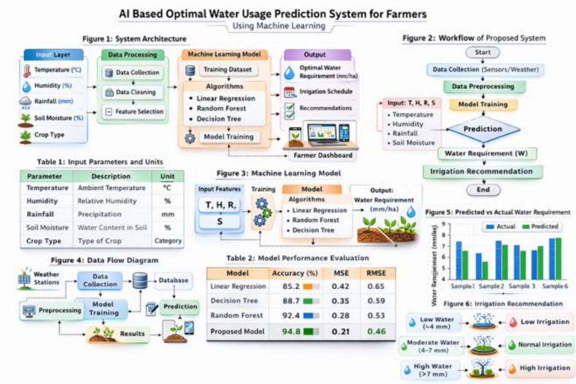


Fig. 2: System Architecture

Figure 2 illustrates the structure of the system whereby environmental data feeds into the predictive machine learning model to come up with suggestions on irrigation.

V. MATHEMATICAL MODEL

The regression model is expressed in form of a linear regression equation shown below:

$$W = \beta_0 + \beta_1 T + \beta_2 H + \beta_3 R + \beta_4 SM + \varepsilon$$

Where:

W – Denotes the expected water need.

T – Temperature.

H – Humidity.

R – Rainfall.

SM – Soil Moisture Content.

β – Slope of the variables.

ε – Predictive error

The model's accuracy will be determined based on MSE formula that can be expressed as follows:

$$MSE = (1/n) * \Sigma(y\_i - \hat{y}\_i)^2$$

VI. PUBLICATIONPRINCIPLES

The performance of the model designed for irrigation prediction was carried out by using the agricultural database that contained important environmental parameters concerning irrigation. The number of samples included in the dataset was 500. The factors of air temperature, air humidity, rainfall, and soil moisture were taken into account in terms of influencing the need for irrigation.

The database was divided into two types: 80% of the dataset for the training process and 20% of the data set for testing purposes. The reason for dividing the dataset was to analyze the effectiveness and prediction capability of the models developed.

Performance Evaluation of Models

Machine learning models have been implemented to assess the performance of the irrigation prediction model in terms of its accuracy using Accuracy (%) and Mean Squared Error (MSE).

Model	Type of Model	Accuracy (%)	MSE
Linear Regression	Regression	85	0.42
Decision Tree	Classification/ Regression	88	0.36
Random Forest	Ensemble Learning	92	0.28

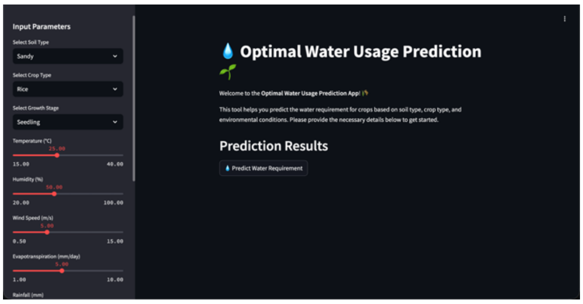


Fig. 3: Project Overview

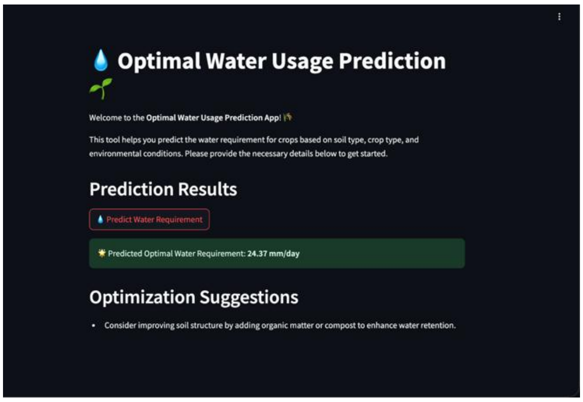
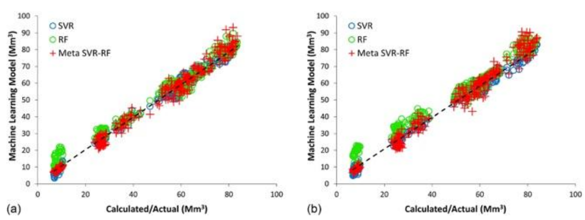
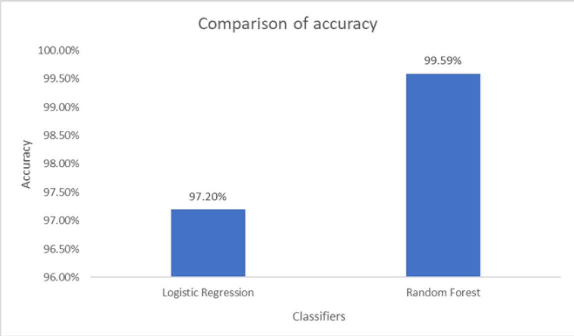
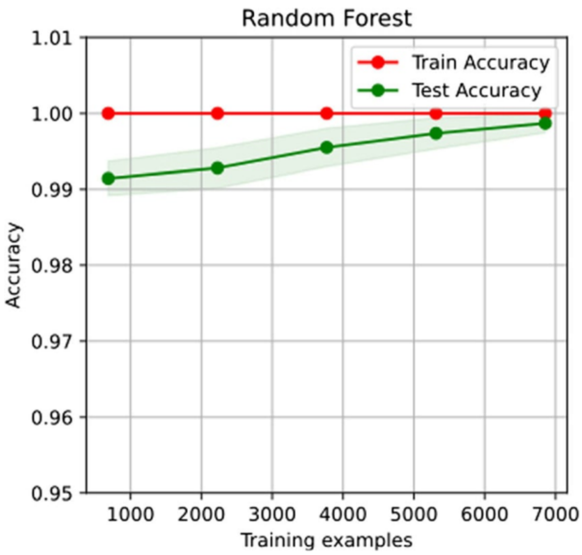


Fig. 4: Water Prediction Results







VII. CONCLUSION

The study developed an irrigation prediction system using a machine learning technique and aimed at making the process more efficient in terms of water usage. In discussing the workings of the system, we explained that the system takes into consideration certain environmental conditions, including temperature, humidity, rainfall, and soil moisture, in order to determine the amount of irrigation needed per crop.

Based on the experiments conducted, it was found out that a machine learning model is very effective in irrigation planning and resource utilization.

The model will save water usage from being a guessing game for farmers, thereby making the irrigation process more efficient. There is a possibility that future improvements in the model might integrate IoT sensors and weather data to improve the prediction accuracy and even allow us to develop an automated irrigation system.

Matplotlib library, which was indispensable during the creation and verification of machine learning algorithms applied in the project.

The final thanks go to the countless open-source databases and online resources that have made such a valuable exploration and investigation of the field of smart farming and irrigation possible.

Last but not least, I would like to thank my friends and family members who encouraged me to do this research project.

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