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Smart Agriculture System for Optimal Crop, Fertiliser Recommendation and Irrigation System

[1]Pavan Kulkarni, [2]Shrutika Amzire, [3]Arya Ganorkar, , [4]Pawan Bondre

[1234]Department of Computer Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathwade, pune,India.

Abstract : The economy of India is largely based on the agriculture domain. Hence, to strengthen the economy, agricultural production should increase. Farmers use traditional ways of farming techniques. But these ways have certain loopholes that directly affect farmer's production.Due to rapidly changing environmental conditions farmers are unable to predict the weather conditions that are required for the crop to harvest. The practice of identifying the previous patterns and cultivating according to them fails here due to uncertain change in weather conditions. To overcome this ,farmers need to shift from traditional farming to new technology based smart farming. The proposed system seeks to help farmers by empowering them with insights. Factors such as temperature, soil moisture, PH levels and fertility are taken into account.Proposed system utilises Machine learning Algorithms to recommend best crops, its varieties and fertilisers. It also provides automatic irrigation management powered by IoT.

IndexTerms - Smart Farming, Internet of Things , Crop Recommendation System, Automatic Irrigation Management.

INTRODUCTION

An application that can predict the crops based on various parameters and provide features to assist the farmer throughout the agricultural process and complex model for predicting crop yields using cutting-edge machine learning techniques to incorporate multiple variables, such as meteorological conditions, soil characteristics, crop features, and historical yield data, in order to provide accurate and timely crop yield predictions to help agricultural stakeholders make informed decisions and lower crop production risks.

Till date various inventions have happened for making prediction of crop and fertiliser using methods such as SVM, Regression model etc. to get optimal crop for the given region using moisture, ph level, weather forecasting data set.

Agriculture is a major part of the Indian economy but is technologically backward, and the proposed system aims to address this by employing smart irrigation and other technologies to support farmers.Unorganised agricultural sectors like India where current irrigation techniques are inefficient and wasteful, and then states that the paper presents an Automatic Irrigation System based on AI and IoT that can autonomously irrigate fields using soil moisture data and weather prediction algorithms.

The paper uses specifically the Random Forest algorithm, to predict the accurate type and amount of fertilizer to be used for a crop in order to increase crop production and boost profits, while also reducing the atmospheric effect of farming.

An autonomous crop irrigation system based on Artificial Intelligence and IoT that can predict rainfall patterns and soil moisture conditions to selectively irrigate crop fields only when necessary.A smart irrigation system that uses a neural network model to predict soil moisture depending on environmental factors and demonstrates the effectiveness of this system.

The research aims to build a machine learning-based system for anticipating optimal fertiliser usage based on soil parameters in order to enhance crop yields and improve the efficiency of agricultural practices. Systems that use data mining to provide recommendations for the optimal fertiliser ratio that depends on various environmental conditions.

LITERATURE SURVEY .

Several widely used techniques that are extensively utilised such as Polynomial Regression, Gradient Boosting, Random Forest , Linear Regression. Among these , the model that has highest accuracy is Gradient Boosting with 87.9 % accuracy. Random forest has 98 % accuracy when "production" is considered the target variable.[1].

The research deals with various issues by employing various machine learning techniques like LSTM,RNN to predict crop yields based on aspects such as temperature , moisture , weather conditions .The Internet of Things is found to be very effective and helpful for improving crop production in smart farming .Once the user provides input ,the system recommends the most suitable crop as output with accuracy of 96.89 %.[2].

The research aims to provide the best optimal result to farmers . To do this , it incorporates various factors. Out of all algorithms , Naive Bayes and Bayesian Networks yield the highest accuracy. K-Nearest Neighbors (KNN) helps to recommend fertilisers [3].

The paper focuses on prediction of wheat crop yields by looking at all historical patterns .Comparison of different machine learning algorithms are done like Multiple Linear Regression, Artificial Neural Networks.These procedures include steps starting from collection of data, cleaning it, selection of key features, classification of the data, and prediction of yields. These steps help farmers improve productivity by making better decisions .The models with the most accuracy are used for prediction [4].

Research presents a Smart Farming framework which is designed to increase production by providing real time monitoring . Algorithm that is used in this system is Kohonen Self-Organizing Map, Back Propagation Network, Modified Support Vector Regression, K-Nearest Neighbors (KNN), ARIMA model, and reinforcement models like Markov Decision Process and Q-learning. Along with this , hardware components like digital temperature and humidity sensors are also used [5].

Random forest is a type of classification method that incorporates a number of decision models , each trained on a separate portion within the dataset. It collects decisions from all trees and delivers results rests on the majority of projections than just relying on a single projection. To convert light energy into electrical energy PV panels are also used [6].

The paper includes comparison of various algorithms. It focuses on considering all necessary features rather than concentrating on a single factor . For processing sequential data , time series machine learning algorithms like Simple RNN and LSTM are used .[7]

Intelligent farming systems utilising IoT and machine learning technologies offer promising solutions for optimising crop yield and resource management in agriculture. These systems integrate environmental sensors to record parameters, to automates irrigation reliant on real-time data . Machine learning algorithms, such as XGBoost classifier, can predict suitable crops based on soil and weather conditions, maximising yield and farmer profits.[8]

Various regression techniques have been employed for predicting agricultural output using historical data on weather and yield . These intelligent systems also provide additional features like weather forecasts, agricultural advice, and market information through mobile applications, making them valuable decision support tools for farmers.[9]

The primary outcome measured in this study is the prediction of the fertiliser on the basis of input variables to predict the suitable variety of fertilizer for farmers based on various factors [10].

RESEARCH METHODOLOGY

The proposed system integrates the crops and its varieties prediction , fertilisers recommendation and smart irrigation system . The system focuses on predicting the optimal crops by using different parameters. Crop's varieties are recommended based on last year's production , time requirement and water requirement . Machine learning algorithms with high accuracy are used for accurate prediction . The system recommends the suitable type and quantity of fertilizer using machine learning algorithms to learn the patterns . Smart irrigation systems maintain the water level and automates the irrigation process . Using soil moisture sensor water level of a particular piece of land is detected.

In our implementation , we are developing a web application which consists of two modules: crop prediction and fertilizer prediction . Users need to register or login with required credentials to use the website . Once registered , users enter the location of the field and select the module. Based on location and dataset collected for that particular region, the system recommends the suitable crops , its varieties and fertilisers. The system also focuses on providing a schedule for crop's growth which includes a smart irrigation system. Additionally , the goal of the system is to deliver real-time updates to the farmers by providing external links of news. The

system informs farmers about government schemes , real-time market prices and cultivation tips . The above architecture diagram shows the implementation.

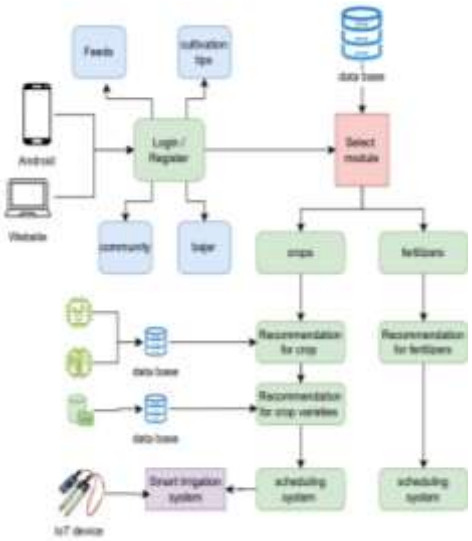

Figure 1. Framework of the proposed system.

3.1. Data Collection : Data is collected from the various resources such as s govt websites, VC From Mandya, APMC website , kaggle website , market place etc . Data collection includes data related to rainfall , humidity , soil fertility , PH value for suitable crops prediction . Data of time requirement , water requirement and last year production is required to predict optimal crop's varieties . NPK (Nitrogen, Phosphorus, Potassium) values are collected for fertiliser recommendation.

3.2. Data Pre-processing : After data is collected from various resources , pre-processing steps are applied. These includes cleaning and dealing with missing values . Redundant values present in data which are not useful are dropped. To acquire better accuracy, incorrect and corrupted data is corrected .

3.3. Methodology :

3.3.1. Crops prediction

The process starts with collection of data related to soil , climate and region .External crop dataset is loaded and pre-processing of data is done as an initial step. Data pre-processing includes cleaning the data and dropping redundant attributes in order to acquire better accuracy . After data pre-processing , feature selection includes selection of relevant aspects like rainfall , weather forecast and PH values . After feature selection is done, the model is trained using Random Forest. Using a random subset of the dataset each tree is trained in Random Forest and predicts the output independently. At the end , Random Forest combines predictions from each tree and averages it to estimate crop yield. Once the model's performance is evaluated , final prediction is made .

3.3.2. Crop's varieties Prediction

SVM technique is utilized for recommendation of suitable crop varieties. The process starts with loading an external data which consists of input parameters . Data preprocessing is done which includes cleaning the data and dealing with missing values . After data pre-processing , feature selection includes selection of relevant features such as time requirement , water requirement and previous year production to predict the crop's varieties with high accuracy . After that, we train the model using the Support Vector Machine classifier with the kernel function as Radial Basis Function .It is trained on a dataset which classifies the data points by a hyperplane that accurately separates the classes . After testing the model , the system predicts and recommends the appropriate crop's varieties .

Equation for Radial Basis Function is as follows :

$$K(d,d') = exp(-\gamma \| d - d' \|^2)$$

- d and d' are data points.
- ||d-d'|| is the square of Euclidean distance between data points.
- γ (gamma) defines the spread of kernels.

3.3.3. Fertiliser prediction

The proposed System aims to recommend suitable fertilisers to be used in order to increase productivity . NPK (Nitrogen , Phosphorus , Potassium) values are monitored to use for recommendation of fertilizer. Fertiliser data is collected from the market place which consists of brand name and NPK ratio . The K Nearest Neighbour algorithm is used for fertilizer prediction and collected fertilizer data is used as an input parameters in the algorithm . After data is loaded , Data preprocessing is done which includes cleaning of data. The model is trained using fertilizer data . Using Cross Validation , choose the optimal k value and calculate the Euclidean distance between new data point and training data . Based on calculated Euclidean distance , select the K point from the training data set which is nearest to the new point. Model then predicts the fertilisers which appear more frequently in K nearest neighbour.

3.3.4. Smart irrigation system

The system's goal is to maintain water level and automate the irrigation process by using sensors . Using sensors, the system detects the water level and automates the irrigation if water level is below requirement . An Arduino Microcontroller is used to gather and process the data . It makes decisions about the irrigation process and controls actuators. Soil Moisture Sensor detects the soil moisture and sends the data to Arduino . Arduino is a central controller which consists of real-time soil moisture and gives accurate precision of determining when and how much irrigation is needed . Main goal of the system is to save time and efforts of farmers by automating the process .

Figure 3. Activity diagram

4.1 Results of Descriptive Statics of Study Variables

The system demonstrated successful implementation using machine learning techniques. Key features include soil fertility , soil moisture and weather forecasting .Random forest was utilised for crop prediction while support vector machine was applied for prediction refinement .It gives highest accuracy which is upto 98.9% while support vector machine gives 97.4% accuracy .To recommend the best fertilisers ,K-Nearest Neighbors algorithm was selected to increase the decision making process of farmers. KNN provides accuracy of 81% . The concept of integration of IOT with machine learning enables accurate crop selection dependent on various environmental and economic factors , nurturing the concept of smart farming.

Figure 4. Crop varieties prediction

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