AI BASED CROP RECOMMENDATION AND IRRIGATION SYSTEM WITH SOLAR TRACKER

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OBJECTIVE OF THE PROJECT

- This project will use machine learning techniques in order to recommend the type of crop to grow and to provide irrigation to the crops.

- This system consists of solar powered water pump along with an automatic water flow control using a humidity sensor value.

- A solar tracker provides the power supply for this system, which is also designed using artificial intelligence technique.

CONTENTS

INTRODUCTION

PROJECT BACKGROUND

- Due to the lack of rainwater, high labour cost and the lack of water on the land, the watering system needs machine control. The solution to this serious and critical problem could be automated watering using solar-based tracking.

- The solar trackers do not have light-dependent sensors, so they will track the sun from east to west using AI techniques.

- By choosing renewable energy for this kind of system, electricity can be saved. They can be easily fixed in agricultural areas so that maximum power is achieved by solar trackers.

- Farmers generally need to approach soil testing laboratories to learn about the suitable crop for their field. This is done by knowing the soil characteristics, nutrients contents, PH level, moisture level, etc.

- There may be a delay in the results since the laboratory will have too many samples to test. Once the results have been obtained, farmers can determine the suitable crop to grow in that soil.

- To avoid such time delay and complications, we are also in building a crop recommendation system in this project which will be more useful because it senses the pH, nutrients, temperature and humidity levels of soil using the necessary sensors and compares with dataset values to produce accurate results for farmers.

- Usually the crop recommendation system consumes less power for accurate results, so it is very easy to run any other system connected to it.

DETAILED DESCRIPTION ABOUT THE PROJECT

- Machine Learning-based crop recommendation system that considers all relevant data to predict crop suitability. In this system, farmers are provided with crop recommendations, which is the primary role of an Agro Consultant.

- This crop recommendation system uses a **Random Forest Classifier** to classify soil parameters and predict the most suitable crop for them.

- A variety of machine learning algorithms were used to train the crop recommendation model, including SVM, KNN, Native Bays, Logistic regression, Decision Tree classifier, and finally Random Forest classifier. Compared to other algorithms, the Random Forest classifier produces more accurate results.

- For crop recommendations, the following values will be considered: soil pH, humidity, NPK levels, rainfall, and temperature.

- In this system, the field can also be irrigated. The irrigation process will be determined by the water content present in the soil using a humidity sensor in the system. For irrigation, a water pump is installed with a motor driver circuit in the field.

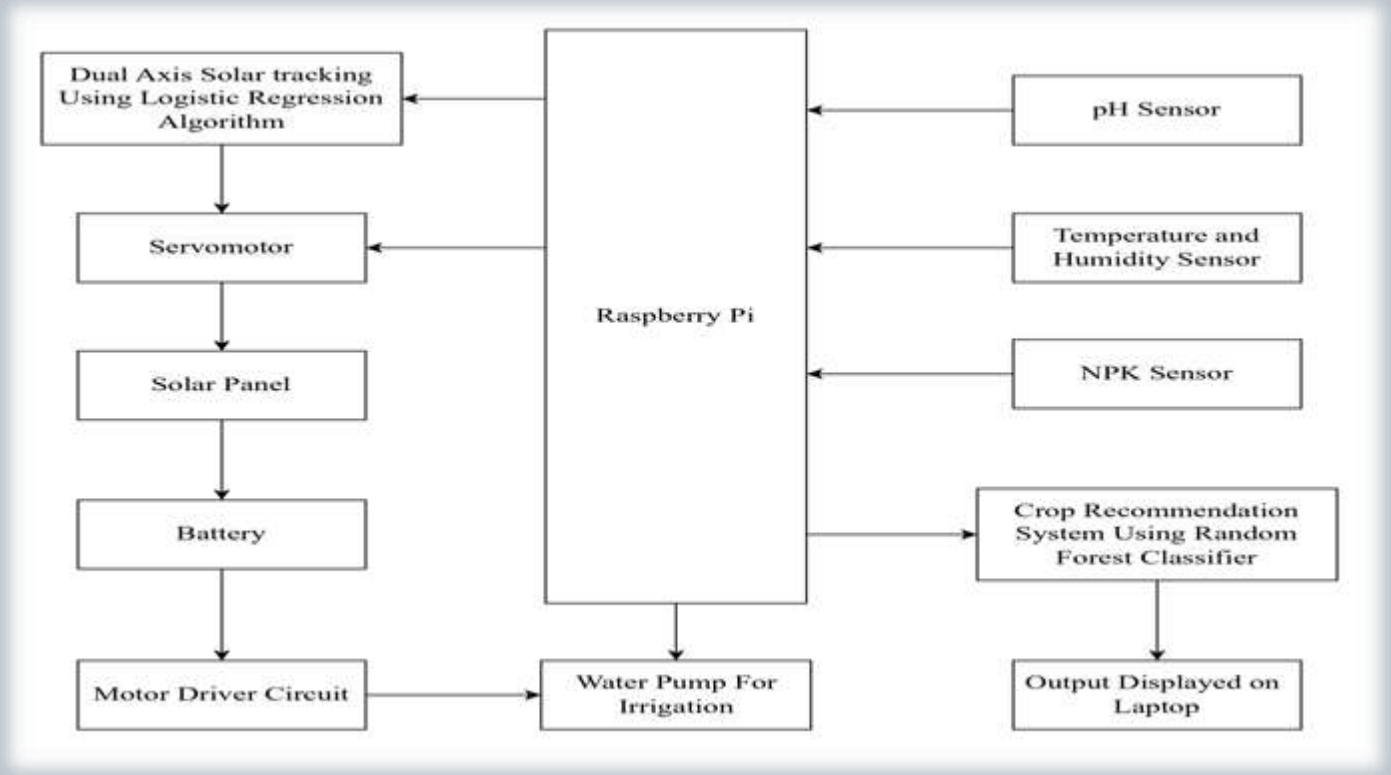
- Based on the humidity value near the soil, the water pump could be turned on/off. This water pump works using Solar tracker for supplying power to irrigation process, that will work based on ML technique.

- A **Logistic Regression Classifier** algorithm was used in the solar tracker. This technique is used to improve efficiency. Solar trackers constantly adjust the PV panels towards the sun to maximize energy capture.

- Solar PV systems are employed in the farms to produce the required electricity that is stored in batteries and used when required. This not only reduces power consumption from the electricity supply but also saves money for farmers in the long run.

PROPOSED SYSTEM

BLOCK DIAGRAM



- In this block diagram the entire system is designed to be controlled by a single microprocessor which is a Raspberry Pi 3 model B. Let's begin with crop recommendations. The PH sensor, NPK sensor, temperature and humidity sensor, and rainfall values are collected to recommend the most suitable crops based on the data.

- The collected data will be compared with the data values in the dataset we got from the **Kaggle website** to create the necessary output. These data will be classified based on the **Random Forest algorithm**.

- This is one of the most famous and widely used techniques for supervised learning. Compared to all other algorithms, the model has produced maximum output through this algorithm during our model training period.

- The suitable crop names and sensor values are displayed on the monitor by **Putty software**. We use this humidity sensor not only for crop recommending system, but also in irrigation process in the field.

- We are using solar power for the irrigation. This will be carried out by turning on and off the water pump according to the soil water vapour level. This will be done with the help of a motor driver circuit.

- In order to increase crop productivity and maintain crop health, the sensor could sense the water level and pump water at the right time. Here the panel works by the mechanism of a tracking system which can track sunlight and convert it into electrical energy.

- This tracker will work without light dependent sensors since the entire tracking system is designed to be controlled through a **Logistic Regression Algorithm** in machine learning. It is easy to use, very efficient to train and can classify unknown data records very quickly.

- A servo motor rotates the solar panel according to the angle of sun irradiation and the time period. The angle of the panel will be changed corresponding to the sun's position which has been programmed in the algorithm with respect to the time period.

HARDWARE COMPONENTS USED

Raspberry Pi :

The Raspberry Pi is a type of single-board computer (SBC), meaning that its entire hardware process can be controlled by an single electronic board. While Raspberry Pi is a microprocessor (used to perform ALU operations – Arithmetic Logic Unit) based mini computer (SBC).

Motor driver Circuit:

L293D IC is a typical Motor Driver IC which allows the DC motor to drive a pump in order to deliver water to the agriculture field.

Servomotor :

Here MG996R has been used. This servo motor rotates the solar panel. The servo will move the solar panel towards the light incident angle according to suns position with respect to time.

Temperature and humidity sensor:

A DHT11 sensor is used in this project which are stable after many experiments. It provides an efficient and accurate method for real-time soil temperature and humidity acquisition. Soil moisture sensors measure or estimate soil water levels.

pH and NPK sensor:

The NPK and pH sensors are used to find the N, P, K and pH value of the unknown soil which is used for crops. The tested result is compare with the results of the soil which is tested in soil testing lab.

Solar panel:

In this solar tracker, Solar panels are those devices used to absorb the sun's rays and convert them into electricity or heat.

Water pump:

Irrigation pumps are used to pump water from a lower to a higher level from which the water then flows through channels to the fields requiring irrigation (lift operation) or to raise it to the required pressure head so that it can be sprayed on the fields via piping systems (sprinkling).

Battery:

A Battery is used to store the excess energy generated by solar panels. This energy can then be used to power for irrigation system.

SUBSYSTEM BLOCK

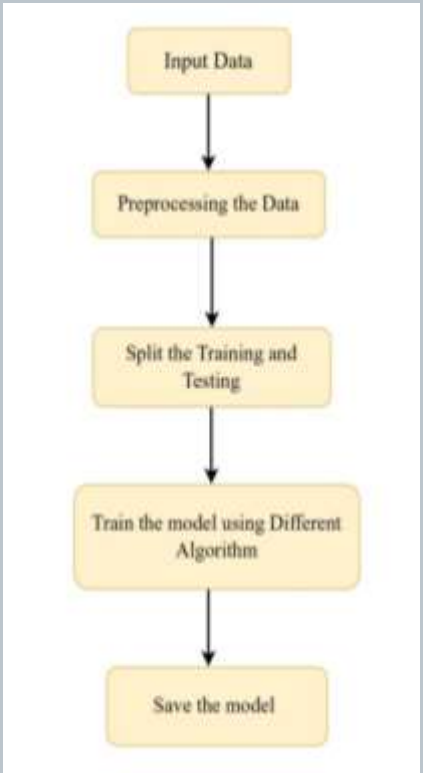
- Machine Learning algorithms learn hidden patterns from the data, predict the output, and improve the performance from experiences on their own.

- Training/testing is a method to measure model accuracy. It is called Training/Testing because we can split the data set into two sets: a training set and a testing set. In this project we use 70% for training, and 30% for testing.

- We can train the model using the training set and test it using the testing set. Training a machine learning (ML) model is a process in which a machine learning algorithm is fed training data from which it can learn.

FOR CROP RECOMMENDATION SYSTEM

✓ TRAINING THE MODEL:



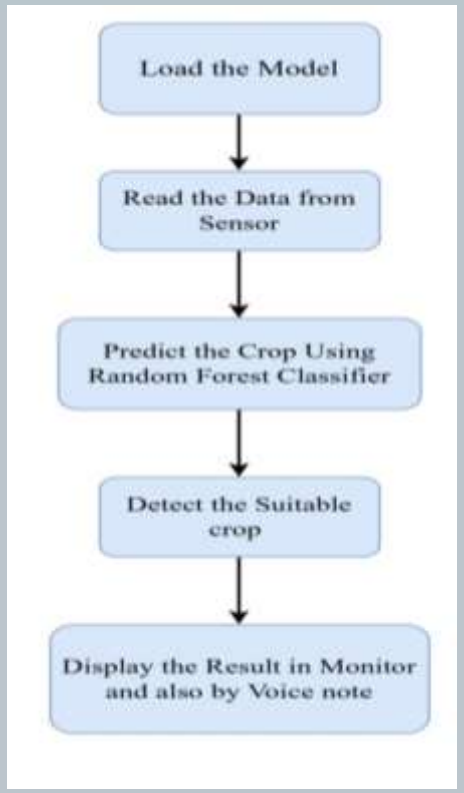
1. Initially the input data will be fed to the model by dataset by Kaggle. After the data has been uploaded, it is pre-processed using null values and the data format.

2. The training model for crop recommendation will be done using various machine learning algorithms like SVM, KNN, Native Bays, Logistic regression, Decision Tree classifier, and finally with Random forest classifier.

3. Compared to other algorithms, the Random Forest classifier produces more accurate results. Once the model produces maximum accuracy, the algorithm tests the model by saving it.

4. The Random Forest algorithm builds many decision trees and blends them together to make predictions.

✓ TESTING THE MODEL:



1) Once the model is saved with the appropriate algorithm, it will be ready for testing. First we need to load the model and read the data from sensors used in this project.

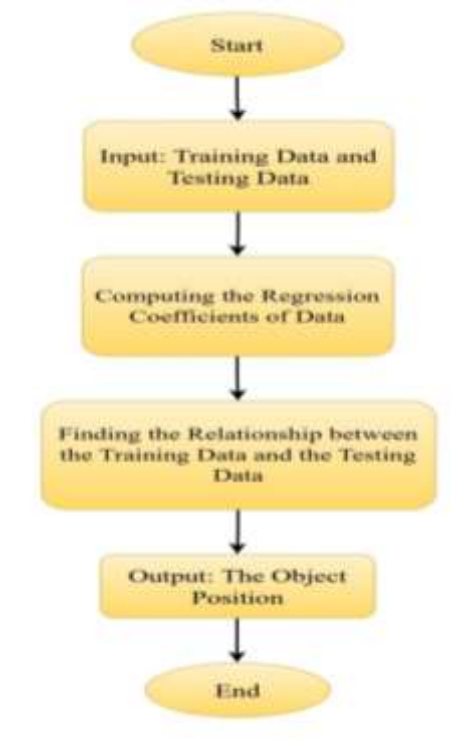
2) These sensors include pH, temperature, humidity, NPK and also rainfall values. We will compare the data sensed with the dataset values.

3) When the comparison has been completed, the appropriate crops will be produce voice note of crop name.

4) It also displays the results along with the sensor values along with the conditions of water on or off.

FOR SOLAR TRACKING SYSTEM

✓ TRAINING AND TESTING MODEL:



1) In dual axis solar tracking system the Logistic regression algorithm is applied to rotate the panel according to the mentioned angle.

2) For this model, training and testing will be done based on this logistic regression algorithm. So it will be easy to position the solar tracker with a servo motor at the desired angle.

3) The testing and training data will be given to input them and it computes the data with regression coefficients using Sigmoid function.

4) After finding a relationship between training and testing data, the object position can be determined.

5) By using this tracking system, power would be provided to the water pump for irrigation process. Once the humidity value reaches below the predetermined value, power is supplied to motor driver circuit for driving the water pump for irrigation.

HARDWARE CIRCUIT

HARDWARE EXPLANATION

I. In the above hardware circuit connections are given as per the block diagram. Sensor values are collected and sent to microprocessors.

II. Once the model is trained, it can be tested through putty software. Initially we need to detect our coded file ones accessed and ready to collect the sensed data from processor.

III. After getting the data it will be compared with dataset values uploaded and trained through machine learning algorithm. We have tested the hardware kit for three variety of soil samples.

IV. As soon as the crop is compared, the suitable crop will display on the monitor. In addition to irrigating the crop, this humidity sensor turns on the water pump by the help of motor driver circuit. A backup battery is also connected for the power supply for water pump.

V. Whenever the water vapour value goes below the determined value, this irrigation system will receive power supply from motor driver by solar tracking. Using logistic regression algorithm, this panel would rotate using servomotors.

HARDWARE RESULTS

TRAINING RESULTS:

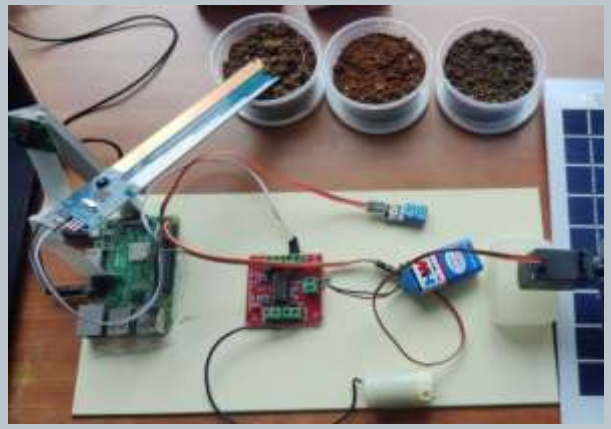
We have used six different machine learning algorithms in the Crop recommendation system in which the Random Forest classifier produces maximum accuracy. Because the Random Forest algorithm builds many decision trees and blends them together to make predictions.

```
Random Forest Accuracy on training set:  1.0
Random Forest Accuracy on test set:  0.9954545454545455
Logistic Regression  :  0.95
Decision Tree  :  0.9878787878787879
K Nearest Neighbors  :  0.9787878787878788
Naive Bayes  :  0.9939393939393939
svm  :  0.3151515151515151
RandomForest  :  0.9954545454545455
```

Algorithm	Accuracy (%)
Logistic Regression (LR)	95%
Decision Tree Classifier	98.78%
K Nearest Neighbors (KNN)	97.87%
Native Bays	99.3%
Support Vector Machine (SVM)	31.51%
Random Forest Classifier (RF)	99.54%

TESTING RESULTS:
SAMPLE A RESULTS

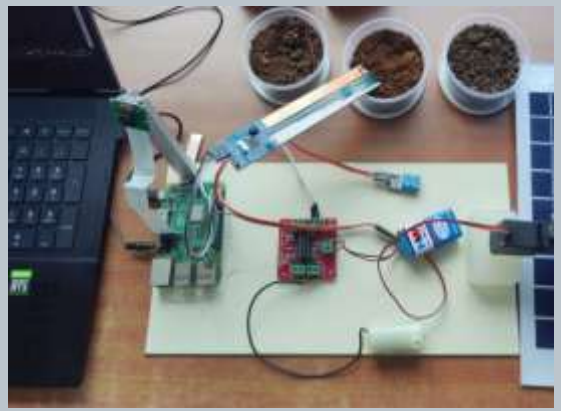
Using this hardware setup we tested the system using three different soil samples.



```
b'PH:37.72, W: 0, L: 220, T:  98,\r\n'
7 220  98
[['88' '73' '175' '33.0' '65.0' '37.72' '30']]
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451
  "X does not have valid feature names, but"
['muskmelon']
Temp=33.0C Humidity=65.0%
water pump On
```

Sample A soil will be tested using sensors dipped in the soil. The most suitable crop name will be displayed on the laptop screen. And the suitable crop in this soil is Muskmelon.

SAMPLE B RESULTS



```
wait for getting sensor data.
Temp=33.0C Humidity=71.0%
water pump On
water pump off
b'PH:31.60, W: 0, L: 216, T: 122,\r\n'
7 216 122
[['91' '79' '94' '33.0' '71.0' '31.60' '170']]
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451:
  "X does not have valid feature names, but"
['banana']
```

Likewise, the testing was carried out at Sample B, and the suitable crop grown in this soil is banana. Additionally, if the humidity value falls below the determined value, the water pump will automatically irrigate the soil. Crop productivity can be improved as a result.

SAMPLE C RESULTS

```
wait for getting sensor data.
Temp=33.0C Humidity=72.0%
water pump On
water pump off
b'PH:31.45, W: 0, L: 216, T: 118,\r\n'
7 216 118
[['76' '40' '22' '33.0' '72.0' '31.45' '230']]
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451:
  "X does not have valid feature names, but"
['coffee']
```

In the same way, the soil sample C is tested, and the best crop for this soil is coffee. As we already mentioned, the irrigation pump is used. With the help of a solar tracker, this water pump will receive power. Using a logistic regression algorithm, this solar tracker can track maximum energy and reduce farmers' electricity bills.

CONCLUSION

- ✓ This project proposes and implements an intelligent crop recommendation system, which can be easily accessed by farmers across India.

- ✓ It would help farmers decide which crop to grow based on Nitrogen, Phosphorous, Potassium, PH Value, Humidity, Temperature, and Rainfall. Water flow is automatically regulated by using a water pump and temperature and humidity sensors.

- ✓ Water pump powered by solar tracking. Solar panels are rotated by a servo motor. Batteries are utilized to store electricity and supply it to a motor driver, which controls a water pump.

- ✓ Powering the farm with solar will provide a better habitat for plants and wildlife. It will also provide solutions to ongoing drought issues, decrease electric bills, reduce the farm's environmental impact, and increase the value of the farm.

- ✓ By using a smart irrigation system water can be saved and labour costs can be reduced. This entire system can be controlled by a single microprocessor called the Raspberry Pi.
- ✓ Based on the analysis of these six types of machine learning algorithms for crop recommendation, Random Forest Classifier achieved the best accuracy.
- ✓ The updated machine learning framework is faster and more accurate than the original implementation according to results.

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THANK YOU