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Assisting Farmers in Optimizing their Crop Yield

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Abstract

Effective Cultivation and yield of a crop depend on the type of soil, crop selection, water availability, and weather condition. Farmers face many challenges to identify the crop that best suits their land. In this paper, we propose AgriBot, a farmer's assistant that captures various dependent factors of the agricultural land and predicts the best-suited crop that maximizes the yield. AgriBot moves along the field to capture all the parameters that impact cultivation. The exact location of the bot is known using Geotagging. It uses various sensors to capture temperature, humidity, pH, moisture level in the soil and uses image processing to identify the type of soil (black soil, red soil, etc). On the captured data, predictive analytics is applied using Artificial intelligence to suggest the crops that could be grown and their ideal conditions. AgriBot's web app uses the Government's API to display various agricultural schemes, daily prices of agricultural commodities in different markets, etc.

Keywords: *Crop yield, Bot, image classification, predictive analysis, suggestions*

1. Introduction

Climatic challenges, crop selections, groundwater level, weather conditions, land fertility, manpower, urbanization, skilled labor, individual challenges, etc are some of the problems faced by farmers. Indian soils have been used for growing crops over thousands of years without caring much for replenishment which has led to soil degradation and thus exhausting essential soil nutrients resulting in the low crop yield. Causes of soil degradation are both natural and human-induced. In [1] Soil degradation in India is estimated to be occurring on 147 million hectares (Mha) of land, including 94 Mha from water erosion, 16 Mha from acidification, 14 Mha from flooding, 9 Mha from wind erosion, 6 Mha from salinity, and 7 Mha from a combination of factors. This is extremely serious because India supports 18% of the world's human population and 15% of the world's livestock population, but has only 2.4% of the world's land area. To know the exact details of soil nutrients and crops that are suitable for their field it may take days to find out since the soil sample has to be taken to the nearest soil testing laboratory and various tests have to be conducted to know the exact details through results generated. All these factors account for low productivity and low yield of the crops. Lack of technological awareness in the field of agriculture in India has been the reason for farmer's suicide. In [2] The National Crime Records Bureau of India reported that a total of 296,438 Indian farmers had committed suicide since 1995. Irrespective of the season, some farmers are facing many problems and incurring losses due to various reasons like difficulty in crop selection, flood, drought, climate change, demand and supply gap, etc which directly or indirectly impact their income. Our proposed solution the AgriBot helps farmers overcome some of these problems by assisting them in various ways as discussed below.

The objective is to introduce a bot (AgriBot) that is implemented with Raspberry pi3. It uses i) image processing to identify the type of soil ii) capture the soil properties by using the various sensors and then iii) predictive analysis is performed on the output generated from the points I and ii to suggest the crops that maximize the yield. The bot collects soil data from different locations to improve the accuracy of the results and finally displays the generated results via a web app.

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2. Literature Survey

In [1] it is observed that soil degradation in India is estimated to be occurring on 147 million hectares (Mha) of land which accounts for the low yield of crops.

In [2] according to the National Crime Records Bureau of India reported that a total of 296,438 Indian farmers had committed suicide since 1995 due to various reasons like debt, low income, flood, drought, etc.

In [3] Quantification of Soil Image processing is done but the accuracy is very low. Images were classified with an unsupervised nearest neighbor classification method with several different processing steps. Five classes were separated and quantified for each sample. Classified features were checked with 500 reference points under the petrographic microscope.

In [4] Images always contain noise. Noise is defined as any undesirable signal, disturbance, or changes in the signal that mask the desired information. Noise is present in an image due to several reasons like improper illumination source, improper sampling frequency, distortions caused by the imaging systems, etc.

A model that estimates the values of nutrients i.e. NPK values of the soil based on pH value. Later based on NPK value, the list of suitable crops and fertilizers is predicted in [5].

The Government of India has established Soil Testing labs in various districts[6] to help the farmers by providing a facility to test the fertility of their soil but it may not be accessible for some farmers in their districts and it may up to 3 days to get the results.

In [7] Under the digital India initiative, the Government of India is providing access to many government databases as well as API's to retrieve real-time information.

3. Methodology

To help the farmers in agriculture, our design choice is to build an AgriBot. It comprises of 3 stages -

The first stage is the data collection stage where various dependent factors that directly or indirectly affect the crop yield are captured by the bot from the agricultural field.

The second stage classifies the image taken by the bot in the agricultural field.

The third stage performs predictive analysis on the output generated from the first two stages and displays the suggestions on the web app.

The detailed description of each stage is given below:

1. Data Collection by AgriBot:

AgriBot is a semi-autonomous bot controlled by Raspberry pi 3 which moves around the field to collect various samples at different locations in the field. The bot is embedded with a pi camera and various sensors. The pi camera is used to capture the images of the soil and the sensors are used to collect the information regarding humidity, moisture, pH level in the field. The information that is collected directly from the field by the bot is very crucial to analyze the crops that give maximum yield on this field. The bot can do a continuous analysis of soil, crop health and push notifications to the web app.

2. Image classification

The soil image captured by the bot is fed into a pre-trained CNN model which is built with Keras and TensorFlow to classify the type of soil. The model is trained over 1000 augmented samples of each type of soil image collected from google images and tuned to give an accuracy of over 90%. The accuracy could be improved over time as the data increases by training over the user-provided data. It is a lightweight model that can be fit into the bot to predict the type of soil.

3. Web app

The type of soil predicted by the image classifier in stage 2 and the data collected from sensors in stage 1 are used as input for the predictive analysis. After the predictive analysis is carried out, using AgriBot's web app the following suggestions are made to the farmer on i) the crops that are suitable to their field ii) optimum conditions to grow them iii) necessary information to educate farmers like soil report, groundwater level report iv) displays daily prices of various commodities in the market of various districts and v) the weather forecast. The detailed implementation of AgriBot is discussed in the next section.

4. Implementation

The bot is designed to be semi-autonomous where it collects data from the field on its own and sends it to the server without any human intervention. The bot is capable of doing real-time monitoring of the soil and crop health. The bot is designed in a modular fashion which makes addition or removal of features very easy.

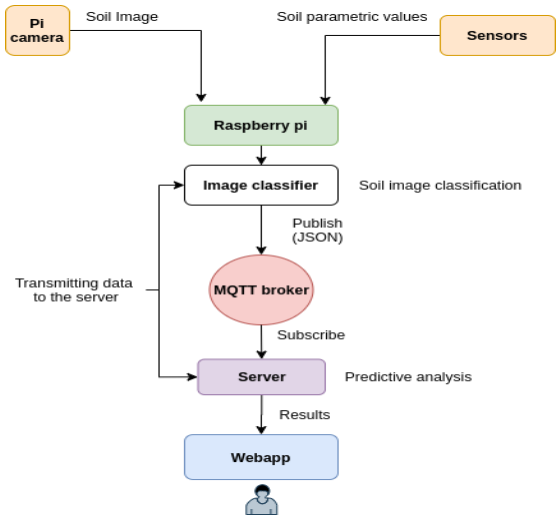

Figure 1: Block Diagram

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The block diagram of AgriBot is depicted in ***Figure 1***. Pi camera and different sensors connected to the Raspberry pi capture the image of the soil and various dependent factors of the field like pH, humidity, temperature, moisture level, etc. The soil image is classified using the embedded pre-trained image classifier as shown in ***Figure 2.*** The classifier can recognize different types of soil. The soil type along with senor captured data is enclosed in a format like JSON and is sent to the server via the MQTT broker using the MQTT protocol (Client-server model).

The server runs on the flask framework and uses open Government data and soil database for predictive analysis. Using these databases and weather API predictive analysis is done on the data sent by the bot and accurate results (suggestions) with a soil report are generated for the farmers. This whole IoT network is lightweight and always connected. So real-time monitoring and all the necessary information are just a tap away on the web app.

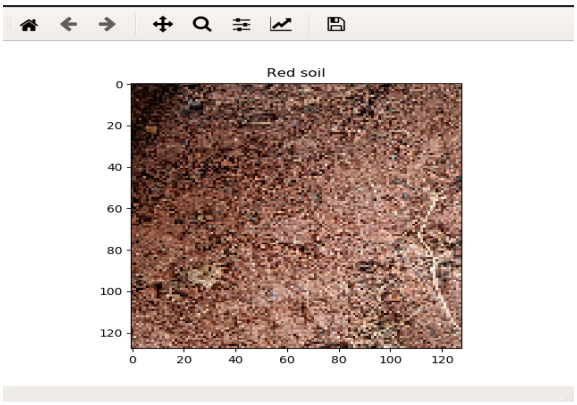


Figure 2: Image Classification

The web app displays the results of the predictive analysis sent by the server in a user-friendly interface as shown in ***Figure 3.*** This web app is a lightweight application compatible on PC and phone as well and displays all the necessary information like the weather forecast, daily prices of various commodities in various markets located in various districts and shows the minimum price guaranteed by the Government for their products using the open Government API given in [7], agriculture-related latest news and various schemes and benefits being provided to them by the Government. After configuring, Users also get notifications for watering, SOS alerts, etc when notified by the bot.

5. Results

Soil images can also be directly uploaded in the web app as shown in ***Figure 3***. Red soil images were uploaded in web app and the server classified the type of soil using the pre-trained model with an accuracy of over 90%. Considering weather conditions at that location, predictive analysis was applied and suggestions were made regarding different crops that could grow well in that soil along with the optimum temperature, rainfall. The suggestions are depicted in ***Figure 4***.

Other necessary information like daily prices of different agricultural commodities in different markets, the latest agriculture news, and various schemes provided by the Government to farmers, weather forecast etc is also displayed in the web app.

In comparison with the Government soil testing lab's test report generation, it may take upto 3 days to get the accurate soil report whereas our proposed AgriBot generates it immediately and gives a basic idea about their soil like soil type, nutrients it is rich in , nutrients it may lack etc.

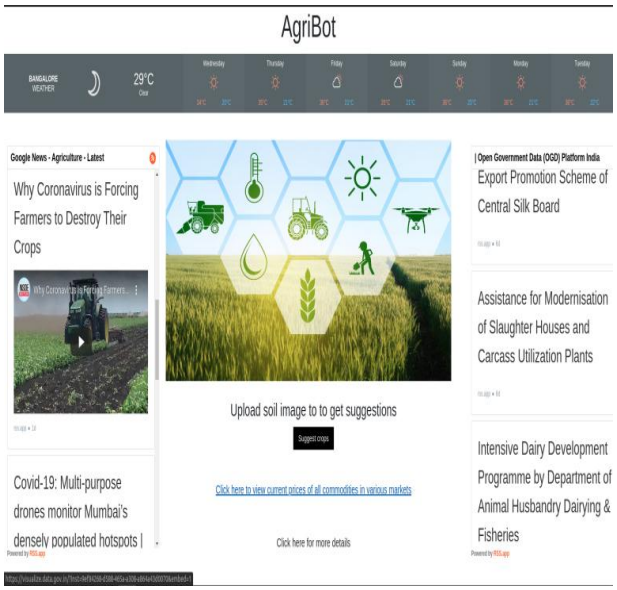
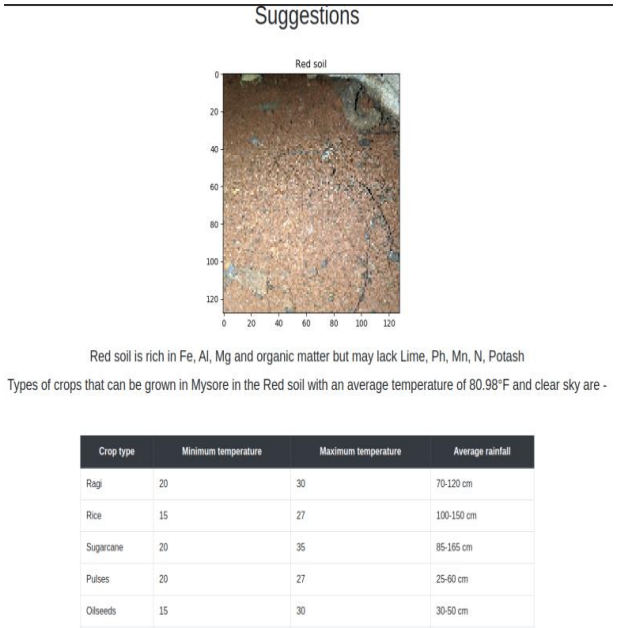


Figure 3: Web App Home page



Crop type	Minimum temperature	Maximum temperature	Average rainfall
Ragi	20	30	70-120 cm
Rice	15	27	100-150 cm
Sugarcane	20	35	85-165 cm
Pulses	20	27	25-60 cm
Oilseeds	15	30	30-50 cm

Figure 4: Suggestions provided by Web app

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6. Conclusion

This idea points to the outline that advancement & manufacture of a bot that can generate soil reports quickly, monitor the health of a crop from the field data collected by the bot. It suggests the farmers with the crops that maximizes the yield. Since all the required parameters in farming like soil health, groundwater level, humidity, temperature are monitored by the bot, the farmers can easily grow crops with less risk and even educate them with the best rate for their commodity. This project reduces the prerequisite of substantial labor & cost of gear, making it reasonable to ranchers. Computerization in farming is acknowledged, the selection rates will turn out to be high & the expenses of innovation will descend. Our project is an attempt to revolutionize Agriculture and reduce the number of farmer deaths in India.

As a future scope, we like to extend our work by i) adding images that caters to various types and subclasses of soil which increases the accuracy of the classification model and also helps to distinguish more properties of the soil ii) building a fully autonomous bot, which is currently semi-autonomous iii) adding a functionality that identifies and pluck the weeds and iv) connecting farmers directly to retailers to sell their products at the best rate using Blockchain Technology and hence reducing the gap between demand and supply.

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