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A Deep Learning Model for Soil Detection and Crop Recommendation for Small Farmers

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***Abstract*— Agriculture is an important part of a country like India. Technologies such as artificial intelligence and machine learning play an important role in improving agriculture and food production while reducing waste and increasing agricultural productivity make the farm sustainable. Land allocation is a growing science in today's world. Many studies have suggested different strategies to solve these problems , including data mining, statistics, and traditional learning methods. However, there are still many shortcomings in generating accurate classification results. Therefore, this proposed model is a new method for solving land allocation problems using deep learning to build good models. This document describes a model that provides deep learning solution for farmer and crop level small farms. According to the test results,the proposed model succeeded in classifying with 96.25% accuracy.**

Keywords —Soil Analysis, Image classification, Convolutional Neural Network, accuracy.

I. INTRODUCTION

Agriculture is an important sector of the Indian economy. Covering 11.24 percent of the world's arable land area and 4 percent of the world's renewable water resources, India produces sufficient food, feed and fibre to sustain about 18 percent (1.38 billion) of the world's population. Agriculture contributes about 16.5 percent to the country's overall GDP, and employs nearly 42.3 percent of the country's workforce, with an average holding size of just 1.08 hectares. We are entrusted with the task of providing adequate and nutritious food for 9 billion people by the year 2050. Additionally, facing issues of global climate change, systemic supply-chain disruptions, geopolitical tensions, soaring food prices, and inflation, agriculture companies and farmers are increasingly turning to technology to provide efficient and sustainable food security for our planet's population.

Deep learning (DL) is used in many areas,from evaluating consumers's behaviour in stores to predicting consumers' phone usage. Deep learning has also been used in agriculture for many years. Soil identification and Crop approval are some of the most difficult problem in precision agriculture, where many models have been proposed and implemented so far. Deep learning is a cutting-edge modern image processing

and data analysis technique with great results and great potential. Recommending crops is one of the major domains in precision agriculture.Karnataka today is very unique in agriculture compared to other states as agriculture in karnataka is mostly based on a variety of crops. There are many methods for extracting knowlede from large amounts of data files.

There are many ways to solve this problem:deployment,integration,integration,etc. Miller et al. in [3] emphasized the importance of agricultural statistics. They explore ways of data mining and remote sensing to gain information and statistics.Studies have been carried out in agriculture using data mining techniques and algorithms such as K-Nearest Neighbor [3] and Naive Bayes [2] classifier. In this article, we will focus on classification and prediction using centralized links to ensure recommendations are correct.

This paper describes a soil detection and crop recommendation mechanism that uses a Convolutional Neural Network and to solve some of the long-standing problems of the Indian agricultural sector and increase accuracy of classification result. Instead of preprocessing the data to derive features like textures and shapes, a CNN takes just the image's raw pixel data as input and "learns" how to extract these features, and ultimately infer what object they constitute. The system has a soil prediction feature based on color and texture on the ground. The model also includes the creation and use of a website for farmers to acess information on crops suitable for growing certain soil types. The remainder of the paper is divided into 4 sections as follows:

chapter2 presents previous research papers on soil classsification and estimation methods.

Section 3 describes the flow of the proposed system and its implementation.

Section 4 summarizes observations and results.

Section 5 mentions the conclusion and future scope.

II. LITERATURE SURVEY

Scientists have recently provided great progress and provided better results in land classification and crop forecasting using various artificial intelligence techniques.Motivwani et al. in [1],attention is drawn to ease of accessing agricultural data through IoMT tools and the need for affective algorithms for determining soil types.To improve accuracy of feature selection and classification,the authors present a learning algorithm fo soil type classification using vector machines.According to the evaluation made using SVM algorithm,the highest accuracy rate reached is only 83%.

Priyanka C. J et al. in [2] focused on a data mining model as an analytical approach for soil and land classification. The author evaluates the performance K-Nearest Neighbor and Naive Bayes algorithms by comparing it to that of traditional random forest modelling and other top-of-the predictive modelling techniques.However,the process does not work because it only knows the type of soil and does not build on the model.

P.Bhargavi et al. in [4] proposed data mining techniques, when applied to an agricultural soil profile, may improve the verification of valid soil profile classification. The researcher Classified the soils using the Naive Bayesian classification technique.The article aims to determine whether data mining techniques can be used to determine terrain distributions for large datasets of experimental data.

Several researchers have explored machine learning algorithms to control soil classification to identify soil. The authors of this paper in [5] proposed a method to deal with soil classification using the SVM by extracting five different soil types. However, the study remains shortcomings when training a tiny dataset. In traditional learning, the statistical category requires a much larger dataset to affect accuracy.

Raorane and Kulkarni in [6] used data mining techniques to predict crop yield.Mining information from data using patterns in agricultural yeils. The data mining methods they explored include artificial neural network (ANNs), decision trees and support vector machine (SVMs). K-Means is also used to classify plants and soil. Learning models need to measure the accuracy and loss scores by tuning different hyperparameters. Moreover, some conventional learning method remains drawback to obtaining a better accuracy.

Riese, FM and others.in [8] developed a more efficient method for soil detection using the KNN algorithm. The results obtained are sufficient to classify the soil types according to brown color. In the paper provided, the classification of soil uses CNN algorithms. This algorithm the used to study the category of soil texture based on hyperspectral data. The result of this classification model reaches 70%, so it is less effective to determine the effect because the model made is still weak to classify the soil texture.

Bharath et al. in [9] proposed a system to recommend the most suitable crops for a farmer based on nutritional features of land. The system's primary inputs come from lab test results that diagnose the nutritional characteristics of soil. To provide accurate results, data mining and the algorithm are utilized. The system will recommend crops that will benefit the farmer's soil type and yield a profit. The Naive method was used for prediction and the model's accuracy was 75%.

The Author in [10] used random forest algorithm to estimate the crop yeild in Maharashtra.Precipitation, temperature, cloud cover, vapor pressure etc.They collect data from various government websites,including information about weather parameters like The example is more than 75 precent correct.

[11] used a machine learning method to predict crop yield based on weather conditons. The research,presented at the International Conference on Computer Communication and Informatics (ICCCI), used the user-friendly Crop Advisor website,which has recently developed research software tool to predict the effects of weather on crops. In some areas of Madhya Pradesh, the C4.5 method is used to determine the weather conditions that have the greatest impact yield of a particular crop.Put your model into practice using the decision tree.

The stastical model used by lobell and burke in [12] demonstrates the link between climate change and the response of agricultural crops as the main subject of research science.In other words,the crops need for climate change is the subject of their education.Our stastical model is used and results are compares with real data.The findings show that stastical models can be used to predict how change in weather will affect crops.

III. METHODOLOGY

This section presents methods for soil type identification and crop yield estimation.The purpose of crop forecasting is to predict the results of agricultural operations for better crop management and to identify strategies to increase future crop yields. This system have built-in tool that can recommend the optimal crop for a situation by utilizing technology and data mining principles. Based on our review, CNN is a growing algorithm to deal with various problems in computer science [3]. The study is focused on soil type classification using CNN algorithms based on features on datasets consisting of five types of soil. The primary view of provided data is to develop a color-based classification model that uses CNN's algorithm to categorise different soil types. This model examine the data that CNN's algorithm has produced. This technique's goal is to organise the soil type. The algorithms from CNN are frequently used to recognise objects. The CNN algorithm's high level of accuracy makes it suited for dealing with classification challenges.

1 ALEXNET ARCHITECTURE

This is a classical network architecture for the Convolutional Neural Network Algorithm At the end of any provided layer, ReLu activation is performed except for the last one, which outputs with a softmax with a distribution over the 1000 class labels. Dropout is applied in the first two fully connected layers. As the figure above shows also applies Max-pooling after the first, second, and fifth Convolutional layers. The kernels of the second, fourth, and fifth Convolutional layers are connected only to those kernel maps in the previous layer, which reside on the same GPU. The kernels of the third convolutional layer are connected to all kernel maps in the second layer. The neurons in the fully connected layers are connected to all neurons in the previous layer (Fig 5.).

In this architecture there are 9 layers with 7 convolutional + pooling layers, of sizes 64,128,32,64,32,128 and 64, with ReLu activation, followed by one fully connected layer of size 1024, with ReLu activation and one fully connected layer of size 4, with softmax activation. The filter size was kept the same for all convolutional and max-pooling layers obtaining a accuracy of 96.25%.

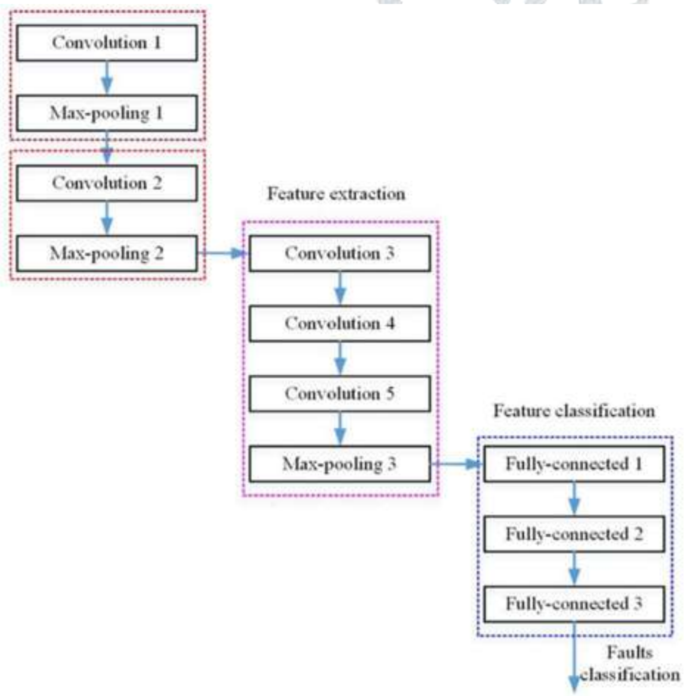


Fig 5. AlexNet Architecture

A. PROPOSED MODEL

For our use case, the algorithm must read a colored image, and every colored image in RGB format has three channels—one for each of the three colors—Red, Green, and Blue. Thus, 300x300x3 pictures are initially created from the original photographs. Then, in order for the model to process the data, the images are transformed into numerical (pixel intensities) arrays.

After the pre-processing phase, we trained the model that retrieved the feature in order to create the soil classification model. We used deep learning to build a model and train it on a dataset of black soil and red soil data. In this study, we used CNN builds the model and analyzes the distribution of soil data.To create the best possible classification model,we adjusted the hyperparameters of the CNN to optmize the training model as shown in fig 1 below.

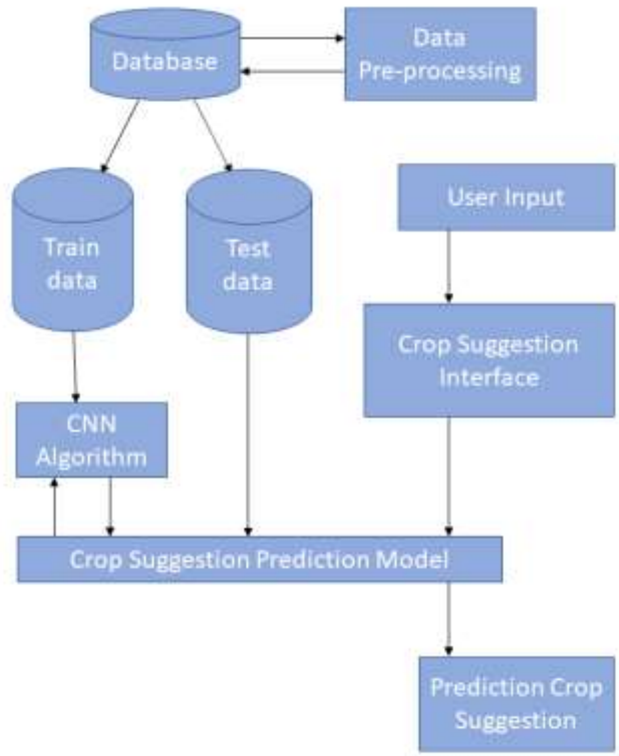
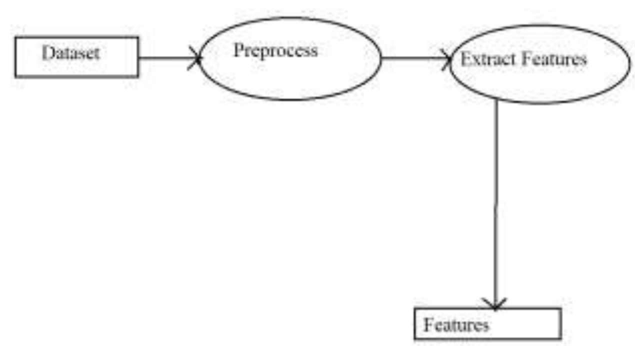


Fig. 1. Block diagram of the model

The proposed model is distributed in three steps:
1.Data Pre-processing - Describes the first stage process of this project, refer Fig 4.3. passing soil image dataset as input to the system will preprocess and extract the important features.



1.

Fig 2. Data Pre-processing

2. Describes the final stage process of this project, refer Fig 4.4. passing extracted features from level 1 by CNN model will detect soil type and recommend crops for that particular soil.

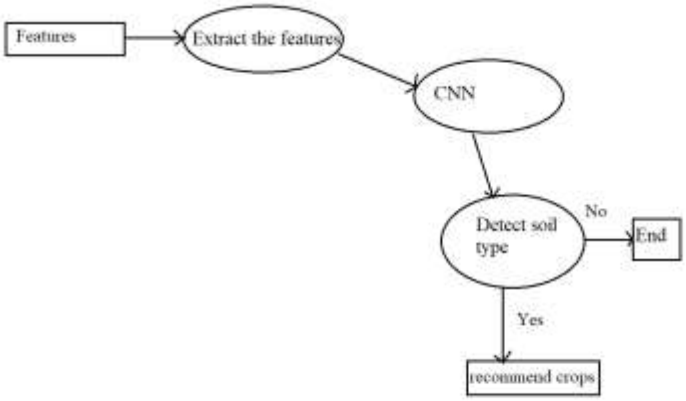


Fig 3. Feature Extraction

3. Final Stage- It describes the overall process of this project, refer Fig. 4.2. passing camera captured image as input the system will efficiently predict the soil type using CNN and recommend the crops based on the soil type.

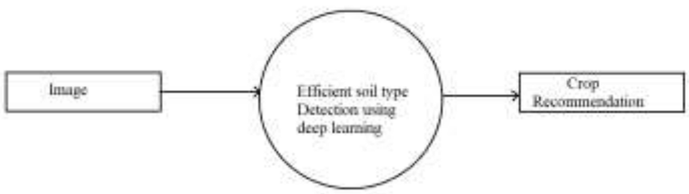


Fig 4. Final Stage

IV. RESULTS AND DISCUSSION

A. DESCRIPTION OF DATASET

The dataset consists of five classes of soil, namely Cinder, Laterite, Black, Peat and yellow soil. The photographs in the dataset are of various sizes and dimensions, and hence need to be changed in terms of size and need to be processed properly to enter in the processing stage. This data is collected and processed and it is taken from the Crop Prediction in India [13] dataset on Kaggle and other online sources such as news articles.

B. WEB PORTAL SYSTEM

Farmers and wholesalers are the two different categories or we can say two important sectors can acccess the website. The two models of the system's inputs can be fed in by farmers, who will then receive crop suggestions based on those inputs Overall, this website idea aims to bridge the gap between farmers and wholesalers by providing personalized crop suggestions, and a platform for collaboration. By leveraging data-driven insights and facilitating knowledge exchange, it seeks to optimize agricultural practices, improve crop selection, and enhance model of the agricultural supply chain as provide in Fig 4 below.

Fig. 4. Web Portal System Flow

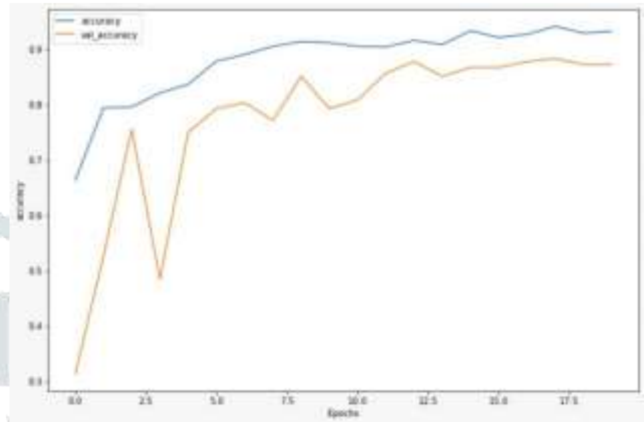


Fig 2: Graph of Accuracy of CNN Vs No. of Training Steps

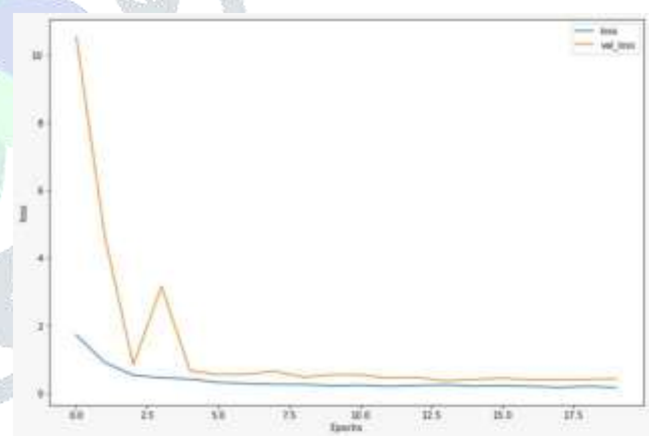


Fig. 3. Graph of Loss Function of CNN Vs No. of Training Steps

The network was trained with the Adam Optimization Algorithm and with the learning rate set to 10ˆ -3 for 20 epochs. The model gave an accuracy of 96.25% on the test set. The training results can for this model shown in the Accuracy and Loss graphs in Fig 2 and Fig 3 respectively.

V. CONCLUSION

In conclusion, Soil classification is a growing research area in the current era.Many studies have performed and some of them have provided similar techniques and some provided different techniques to deal with the issues, including rule-based, statistical, and traditional learning methods. However,classifying the soil type and providing a better crop for that need good efforts provided improved technology. The study used CNN to build a soil type classification model to produce a higher accuracy with tiny loss. Using the proposed model, we used CNN's algorithm because classifying the soil type does not take time and effort to determine classification results. Based on the experiment results, we achieve trade-offs between accuracy

and performance time by adjusting the hyperparameter to optimize model performance. We set epoch = 80, batch size=32, and learning rate=0.6. In the training process, the model can produce an accuracy = 96.25% and loss = 0.1606.

The classification model can be a promising solution to address soil type classification. By taking into account the composition of the of the soil mixture, size of the dataset used, future research can modify this method to work with a variety of soil types. By increasing the crop production dataset, the system can be further enhanced to produce more accurate yield forecast results. More research into semantic networks to train nodes could be beneficial. Exploration of picture categorization is essential to generate improved predictions. The next can utilize GAN or GCN algorithm to improve the classification result.

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