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An Offline Bilingual Crop Recommendation System with Fertilizer and Pesticide Advisory Using ANN

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Abstract: ***Agriculture is the foundational occupation for human survival. Selecting the right crops is important to improving yield, and increasing farmer income. Old farming methods are heavily depend on guesswork or experience. Choosing wrong crops can give farmers low yields and waste their money. To solve this problem, this research introduces a deep learning-based crop recommendation system that helps farmers to select the suitable crops. The system uses an Artificial Neural Network (ANN) model. It considers soil nutrients, pH levels, weather conditions, soil types and season type. Based on all that, it recommends best crops to grow. It also gives suggestions for fertilizers and pesticides. The system offers both organic and chemical farming. To make it easy, the app works in two languages, has voice support and doesn't need internet. This system reduces dependency on old methods and supports sustainable farming.***

Keywords: Deep Learning, Crop Recommendation, Fertilizer and Pesticide Suggestion, Voice Output Assistance, Offline Application, Bilingual, Sustainable Agriculture.

I. INTRODUCTION

Agriculture is an important sector of the Indian Economy. Agriculture depends on choosing right crops. Farmers often face challenges in selecting suitable crops due to changes in soil conditions, climate, and lack of proper guidance. Old methods mainly depend on experience, which may not always ensure high productivity. This research presents a bilingual offline crop recommendation system, which uses the Artificial Neural Network algorithm to recommended crops along with suggestions for fertilizers and pesticides. The system operates in English and Telugu, thus providing accessibility to a large number of people. It can be used in the absence of any internet connection. The main objective of this research is helping farmers take decisions about crop cultivation and sustainable farming.

A. Research Contribution

The main contribution to this research are -

- Develop a Crop recommendation system for sustainable Agriculture.
- It utilizes multiple parameters such as soil nutrients, atmospheric conditions, season and soil type to deliver precise recommendations.
- Implementation of Deep learning model (Artificial Neural Network) to provide accurate and practical agricultural guidance.
- Integrating the model into an Android mobile app.

B. Background

The agricultural sector acts as an important role of any economy, particularly in the case of developing nations like India. The process of selecting crops by farmers might not always be accurate due to several factors such as weather changes and poor soil conditions. In today's technological world, we have Machine Learning and Deep Learning techniques that help us analyse agricultural data and provide appropriate suggestions. But unfortunately, many of these techniques are internet dependent or lack the ability to provide to specific regions.

C. Problem Definition

It is common for farmers to find it hard to choose crops and farm inputs because of the differences in soil composition, weather, and seasons. Low knowledge of contemporary methods results in poor decisions and low agricultural productivity.

The current agricultural recommendation systems require the internet and cannot be readily adopted by farmers in rural areas. Language becomes an additional problem for such systems. Thus, there is a need for an agriculture recommendation system using machine learning and deep learning in native languages.

D. Problem Purpose

The main purpose of this project is to develop an intelligent, user-friendly, and offline system that recommends suitable crops, fertilizers, and pesticides based on input conditions. The system provides bilingual support between English and Telugu languages and helps farmers take decisions through data analysis even in the absence of the internet.

E. Scope of the problem

This research aims at the implementation of an offline crop recommendation system which uses an Artificial Neural Network model to recommend crops depending on soil and weather conditions. This recommendation system further gives advice regarding the fertilizer and pesticides required for each crop in terms of organic and inorganic agriculture. In addition, the proposed system can communicate in both English and Telugu languages and does not require any internet connection.

F. Problem Features

The difficulty in this case is finding crops that suit the changing conditions of soil and environment, including seasonal changes, soil type, NPK value, pH, temperature, rainfall, and humidity. Another difficulty would be to provide proper information regarding fertilizers and pesticides specific to a particular crop whether it be organic or inorganic agriculture. Multilingual of English and Telugu is also one difficulty that needs to be considered as well as offline processing capability.

II. LITERATURE REVIEW

Various studies have been conducted on the implementation of different methodologies on crop recommendation systems. The literature survey (2024) has compared different models such as Logistic Regression, Decision Tree, KNN, SVM, Naive Bayes, Random Forest, and XGBoost. Among these, the use of advanced models such as TCN is more accurate in predicting the crops. Likewise, another piece of research (2023) used TCN classifiers to recommend appropriate crops by feeding the model with soil nutrients such as N, P, K, pH, and climatic conditions. Another set of research studies uses modern technologies along with machine learning models. One such technology is IoT sensors that can collect data about soil nutrients and climatic conditions from the field. Such a smart agriculture system (2022) was designed using IoT and machine learning algorithms such as SVM and Random Forest. The early implementation of crop recommendation systems (2021) made use of Decision Tree and Naive Bayes algorithms to predict crops based on soil nutrient data. Although these systems provide significant assistance in implementing smart agriculture, there are many limitations associated with them, including Internet dependency, inability to function offline, less number of data sets, no fertilizer and pesticide suggestions, and non-support for regional languages.

III. METHODLOGY

This proposed system is an offline-based bilingual crop recommendation system using Artificial Neural Networks (ANNs) to recommend appropriate crops, fertilizers, and pesticides according to agricultural data.

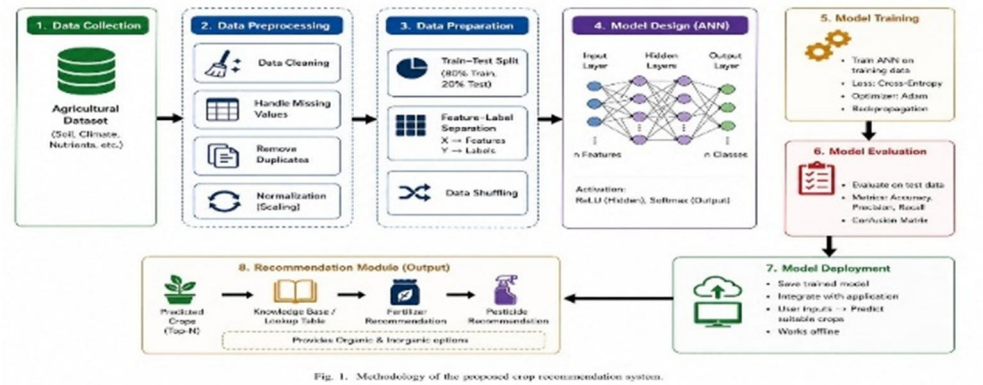

Fig. 1. Methodology of the proposed crop recommendation system.

The methodology involved in this proposal has several steps:

1) Data Collection: The dataset used in this research was collected from kaggle. It includes important factors such as season, type of soil, temperature, rainfall, humidity, pH level, and Nitrogen, Phosphorous, and Potassium. Apart from these attributes, the dataset also includes crop labels. We combine the fertilizer, pesticide, and crop data into a single dataset. The dataset was expanded to support both English and Telugu languages.

2) Data Preprocessing: Data preprocessing involves improving the quality of the data. Imputation methods are used to handle missing values whereas inconsistent data entries are removed. Categorical data such as soil type and season are converted to numerical form through techniques like label encoding or one-hot encoding. The objective is to prepare the data in a way that allows it to be used for training our neural network model.

3) Data Preparation: The current stage involves preparing the dataset for use by defining the inputs and outputs from it. Inputs are weather and soil conditions while the outputs are the recommended crops and crop specific fertilizers and pesticides. Scaling techniques are used to normalize the data set so that all data values are consistently distributed. Training and test data sets are created for evaluating the performance of the model.

4) Model Design (Artificial Neural Network)

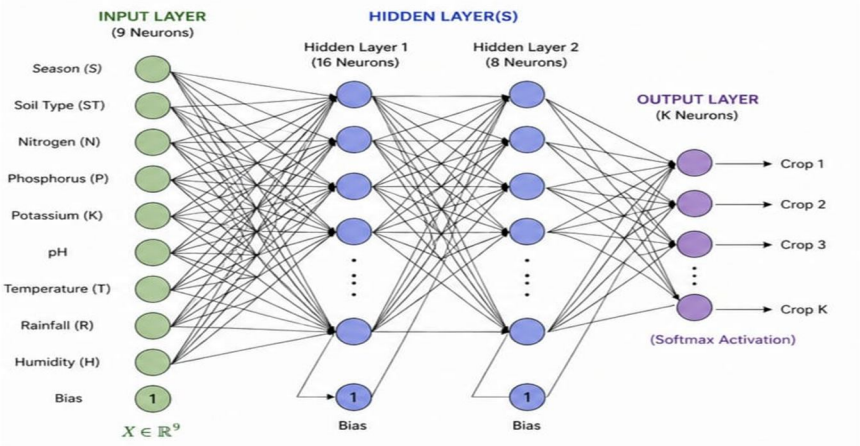

Fig. ANN Architecture

An Artificial Neural Network (ANN) is designed for multi-class classification purposes. The model design involves an input layer with neurons equal to the number of features, several hidden layers to learn patterns from data, and an output layer comprising nodes for various crop categories. ReLU activation functions are utilized in the hidden layers for adding non-linear properties to the neural network model. On the other hand, the output layer uses Softmax activation functions to create probability distributions.

5) Model Training: The ANN model is trained on the given dataset. In this process, the model identifies a relationship between input variables and output classifications through learning weights using backpropagation. An optimizer function like Adam is utilized to minimize the error between predicted and actual outputs.

6) Model Evaluation: The accuracy of the model is evaluated based on the performance obtained from the test dataset. Accuracy, precision, recall, and F1-score are some of the performance measures used to evaluate the performance of the model. It guarantees that the model works effectively for new data and provides accurate results.

7) Model Deployment: The next step after evaluating the model is its integration into the user-friendly Android mobile app application interface. The application is developed as an offline application that does not require internet connection to obtain recommendations. Users have to provide various input parameters through the interface, and the system generates recommended crops with corresponding fertilizers and pesticides in English and Telugu.

IV. RESULTS

The developed system provides crop recommendations based on the inputs given by the user. The user enters inputs like season, soil type, and values such as nitrogen, phosphorus, potassium ,temperature, humidity, pH, and rainfall. After entering all the inputs, the user clicks on the “Get Recommendation” button.

Fig. Recommendation system Interface

Fig. Recommendation system result

After that, the system displays the results. It shows the three crop recommendations, where one is the best option and the other two are alternative choices. It also suggests crop-specific fertilizers and pesticides for both organic and chemical farming. The results are shown in both English and Telugu, making it easy for users to understand.

V. DISCUSSION

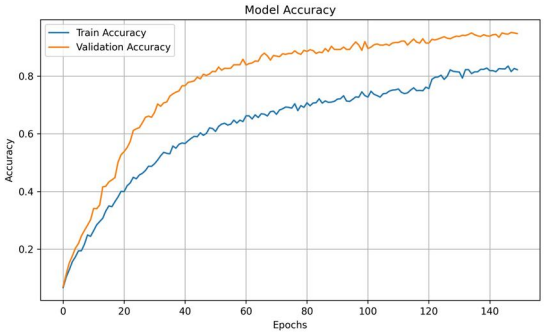

Fig. Model Accuracy Graph

The crop recommendation system built using an Artificial Neural Network (ANN) performed very well during testing. It was able to suggest the right crops with about 94% accuracy, which shows that it works well for different types of soil and environmental conditions. The system can recommend more than one suitable crop based on the inputs and also provides the right fertilizers and pesticides for each crop. This gives farmers complete guidance in one place.

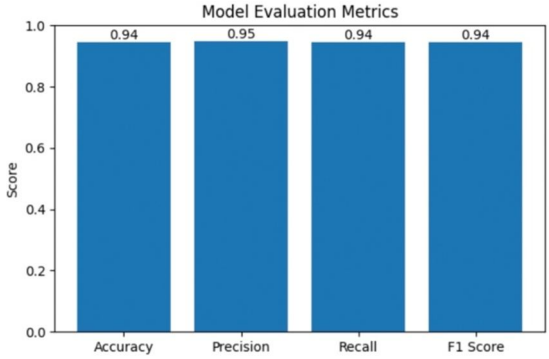

Fig. Evaluation Metrics

But there are some limitations. The system depends on the dataset used for training, so smaller datasets cannot provide accurate results all the time. Also, it does not use real-time weather data, that make the results even better. It doesn't provide multilingual support.

VI. CONCLUSION

This project is a smart app that helps farmers select suitable crops based on soil and weather conditions. The system uses an ANN model to give accurate results. It also suggests fertilizers and pesticides for better farming. The app works without internet and is available in two languages (English & Telugu). Overall, the system helps farmers make better decisions. It can be improved further in the future with more data and advanced features like real time data, different languages, images, voice input.

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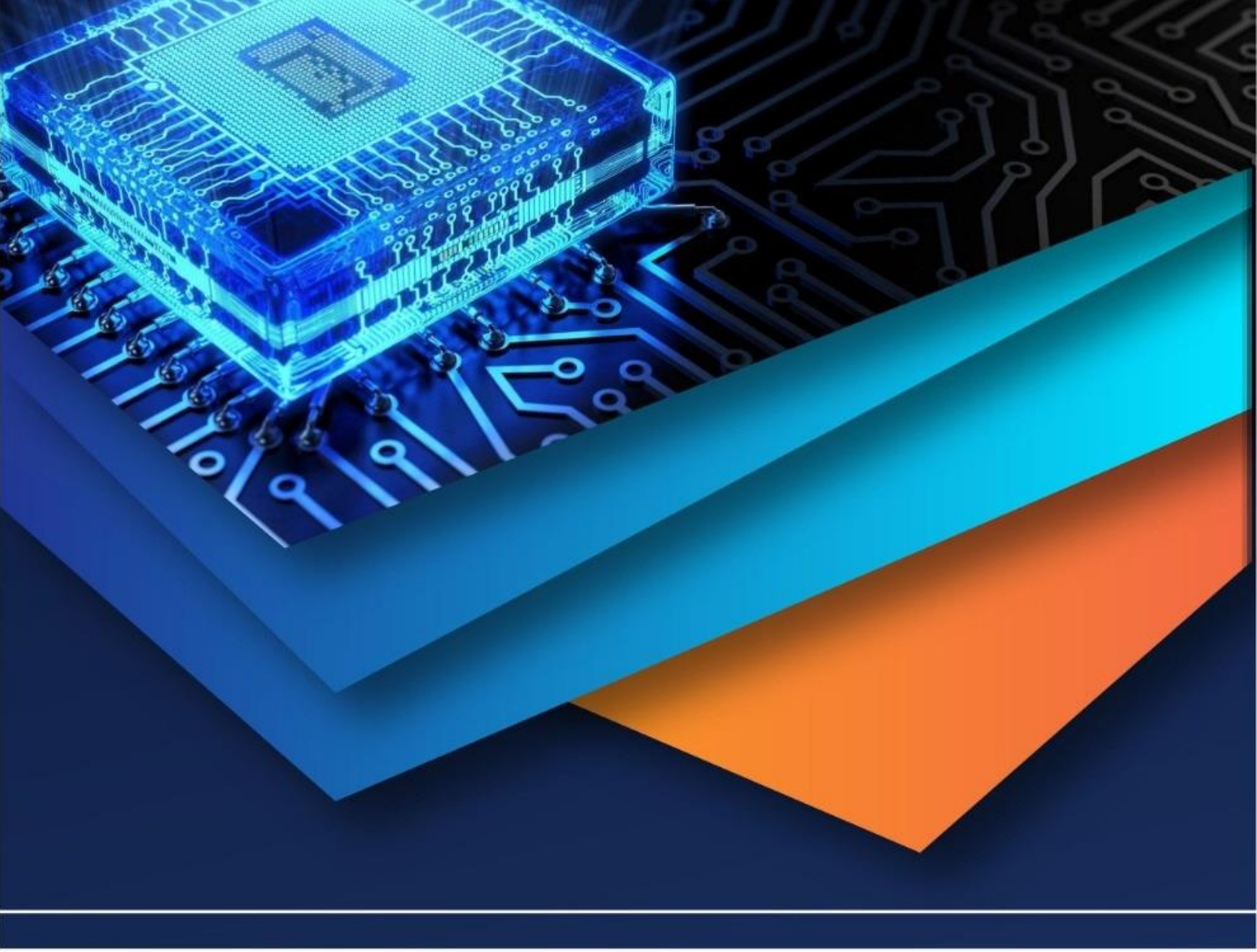

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