DEEP LEARNING FRAMEWORK FOR MONITORING AND PREDICTING PLANT GROWTH IN SMART GREENHOUSES

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ABSTRACT

Agriculture is one of the major and the least paid occupation in India. Machine learning can bring a boom in the agriculture field by changing the income scenario through growing the optimum crop. This paper focuses on predicting the yield of the crop by applying various machine learning techniques. The outcome of these techniques is compared on the basis of mean absolute error. The prediction made by machine learning algorithms will help the farmers to decide which crop to grow to get the maximum yield by considering factors like temperature, rainfall, area, etc.

Index Terms:Machine Learning, Crop Yield Prediction, Agriculture, Mean Absolute Error, Temperature, Rainfall, Data Analysis, Decision Support, Smart Farming, Precision Agriculture

1.INTRODUCTION

1.1 MOTIVATION

The history of agriculture in India[1] dates back to the Indus Valley Civilization Era. India ranks second in this sector. Agriculture and allied sectors like forestry and fisheries account for 15.4 percent of the DP (gross domestic product) with about 31 percent of the workforce. India ranks first globally with the highest net cropped area followed by US and China. Agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. Due to the revolution in industrialization, the economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth.

1.2 PROBLEM DEFINITION

The problem that the Indian Agriculture sector is facing is the integration of technology to bring the desired outputs. With the advent of new technologies and overuse of non-renewable energy resources patterns of rainfall and temperature are disturbed. The inconsistent trends developed from the side effects of global warming make it

cumbersome for the farmers to clearly predict the temperature and rainfall patterns thus affecting their crop yield productivity. In order to perform accurate prediction and handle inconsistent trends in temperature and rainfall various machine learning algorithms like RNN, LSTM, etc can be applied to get a pattern. It will complement the agricultural growth in India and all together augment the ease of living for farmers. In past, many researchers have applied machine learning techniques to enhance agricultural growth of the country

1.3 OBJECTIVE OF PROJECT

This paper focuses on predicting the yield of the crop by applying various machine learning techniques. The outcome of these techniques is compared on the basis of mean absolute error. The prediction made by machine learning algorithms will help the farmers to decide which crop to grow to get the maximum yield by considering factors like temperature, rainfall, area, etc.

2.LITERATURE REVIEW

Agriculture plays a pivotal role in the growth of a nation's economy, and climate change has emerged as a significant threat to agricultural productivity. Machine learning (ML) and data mining techniques have become essential for developing practical and effective solutions in predicting crop yield. P. Priya, U. Muthaiah, and M. Balamurugan utilized real data from Tamil Nadu and implemented the Random Forest algorithm to accurately predict crop yields based on weather, soil, and historical data, thereby enabling farmers to make informed decisions before cultivation. Similarly, Mishra S., Mishra D., and Santra G.H. reassessed various ML techniques in crop production, emphasizing the need for objective and statistically sound yield forecasts for policy-making. Their study reviewed methods like neural networks, fuzzy systems, decision trees, and support vector machines for agricultural applications. Manjula E. highlighted data mining as a promising field for yield prediction, presenting a system based on association rule mining that effectively forecasts crop yield using historical agricultural data. In another study, Dahikar S.S. and Rode S.V. employed Artificial Neural Networks (ANN) for crop prediction by analyzing numerous atmospheric and soil parameters such as temperature, humidity, rainfall, pH, and nutrient content. Lastly, González Sánchez A., Frausto Solís J., and Ojeda Bustamante W. compared multiple ML models—including M5-Prime regression trees,

multilayer perceptron neural networks, and k-nearest neighbors—with linear regression across ten crop datasets in Mexico. Their findings showed M5-Prime and k-NN as the most accurate techniques based on metrics like RMSE, MAE, RRSE, and correlation factor. Collectively, these studies reinforce the potential of ML and data mining for accurate and scalable crop yield prediction, supporting both farmers and policymakers in effective agricultural planning.

3.SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Due to the revolution in industrialization, the economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. The problem that the Indian Agriculture sector is facing is the integration of technology to bring the desired outputs. With the advent of new technologies and overuse of non-renewable energy resources patterns of rainfall and temperature are disturbed. The inconsistent trends developed from the side effects of global warming make it cumbersome for the farmers to clearly predict the temperature and rainfall patterns thus affecting their crop yield productivity. In order to perform accurate prediction and handle inconsistent trends in temperature and rainfall various machine learning algorithms like RNN, LSTM, etc can be applied to get a pattern. It will complement the agricultural growth in India and all together augment the ease of living for farmers. In past, many researchers have applied machine learning techniques to enhance agricultural growth of the country.

3.1.1 DISADVANTAGES

- Fails to consider multiple influencing parameters simultaneously.
- Struggles with handling noisy and inconsistent environmental data.

3.2 PROPOSED SYSTEM

This paper focuses on the practical application of machine learning algorithms and its quantification. The work presented here also takes into account the inconsistent data from rainfall and temperature datasets to get a consistent trend. Crop yield prediction is determined by considering all the features in contrast with the usual trend of determining the prediction considering one feature at a time.

3.2.1 ADVANTAGES

- Considers multiple environmental parameters for accurate crop yield prediction.

- Effectively handles inconsistent data patterns using advanced ML algorithms.

4.SYSTEM DESIGN

4.1 SYSTEM ARCHITECTURE

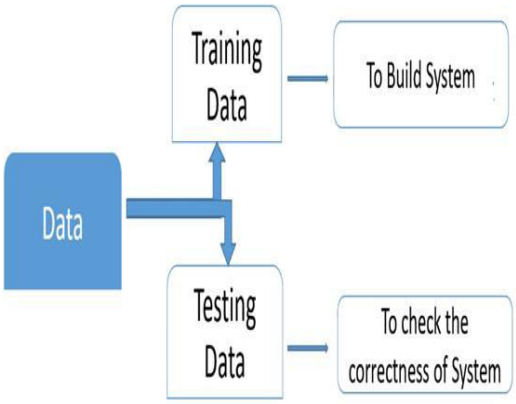

Fig 4.1 System Architecture

5.IMPLEMENTATION

MODULES:

Upload Crop Dataset

The crop production dataset that is used to predict the name and yield of the crop is fed into classification and regression algorithms.

Preprocess Dataset

Experiments were conducted on Indian government dataset and it has been established that Random Forest Regressor gives the highest yield prediction accuracy. Sequential model that is Simple Recurrent Neural Network performs better on rainfall prediction while LSTM is good for temperature prediction. By combining rainfall, temperature along with other parameters like season and area, yield prediction for a certain district can be made.

Train Machine Learning

This focuses on district wise yield prediction according to the crop sown in the district. Yield is being predicted for given crops district wise and crops with best yield.

Upload Test Data &Predict Yield

Results reveals that Random Forest is the best classifier when all parameters are combined. This will not only help farmers in choosing the right crop to grow in the next season but also bridge the gapbetween technology and the agriculture sector.

6.OUTPUTSCREENS

To run project double click on ‘run.bat’ file to get below screen

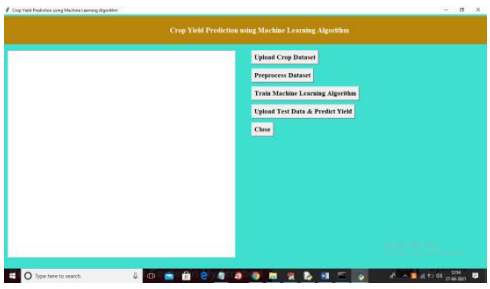

Fig 6.1

In above screen click on 'Upload Crop Dataset' button to upload dataset

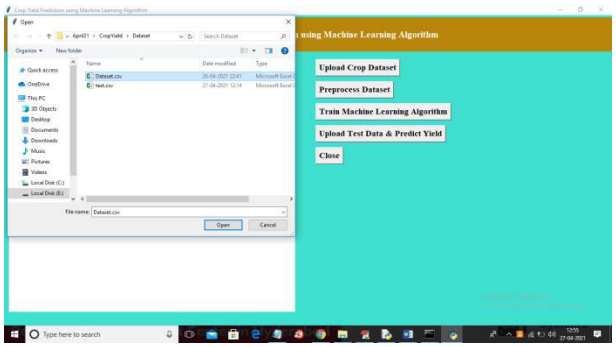

Fig 6.2

In above screen selecting and uploading 'Dataset.csv' file and then click on 'Open' button to load dataset and to get below screen.

Fig 6.3

In above screen dataset loaded and we can see dataset contains some non-numeric values and ML will not take non-numeric values so we need to preprocess dataset to convert non-numeric values to numeric values by assigning ID to each non-numeric value. So click on 'Preprocess Dataset' button to process dataset

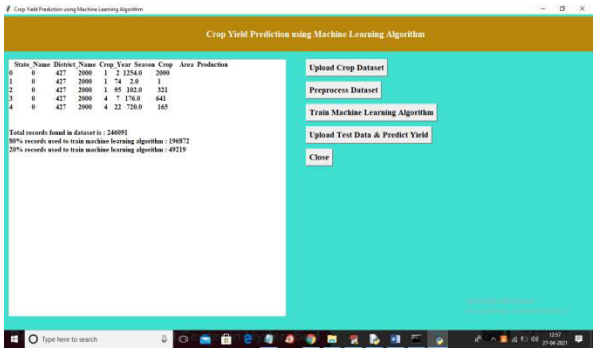

Fig 6.4

In above screen all non-numeric values converted to numeric format and in below lines we can see dataset contains total 246091 records and application using (80%) 196872 records to train ML and using (20%) 49219 records to test ML prediction error rate (RMSE (root mean square error)). Now click on 'Train Machine Learning Algorithm' button to train Decision Tree Machine learning algorithm on above dataset and then calculate prediction error rate

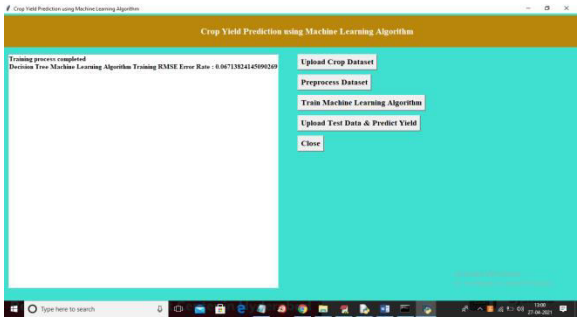

Fig 6.5

In above screen ML is trained and we got prediction error rate as 0.067% and now Decision Tree model is ready and now click on 'Upload Test Data & Predict Yield' button to upload test data and then application will predict production

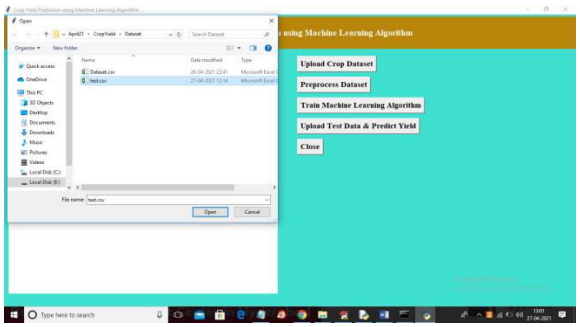

Fig 6.6

In above screen selecting and uploading 'test.csv' file and then click on 'Open' button to load test data and then application will give below prediction result

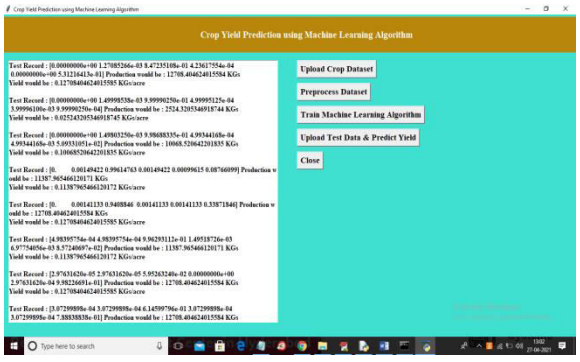

Fig 6.7

In above screen each test record is separated with newline and in above screen in square bracket we can see test data values and after square bracket we can see predicted production and after that we can see predicted YIELD per acre. So each test record and its prediction is separated with newline. You can scroll down above text area to view all records.

7.CONCLUSION

The paper presented the various machine learning algorithms for predicting the yield of the crop on the basis of temperature, rainfall, season and area. Experiments were conducted on Indian government dataset and it has been established that Random Forest Regressor gives the highest yield prediction accuracy. Sequential model that is Simple Recurrent Neural Network performsbetter on rainfall prediction while LSTM is good for temperature prediction. By combining rainfall, temperature along with other parameters like season and area, yield prediction for a certain district can be made. Results reveals that Random Forest is the best classifier when all parameters are combined. This will not only help farmers in choosing the right crop to grow in the next season but also bridge the gap between technology and the agriculture sector.

8.FUTURE SCOPE

Predicting plant growth and yield in greenhouses involves monitoring environmental factors like temperature, humidity, light, and CO2 levels. Plant physiology indicators such as growth stage, leaf area, biomass, and root morphology provide insights into plant health. Disease symptoms, pest populations, and cultural practices like irrigation, fertilization, and pruning influence growth and yield. Environmental control systems and remote sensing technologies help optimize growing conditions and monitor crop health. Integrating these features into predictive models enables growers to make informed decisions and maximize productivity sustainably. Plant physiology also plays a critical role in determining growth and yield outcomes. Features such as growth stage, Leaf Area Index (LAI), biomass accumulation, and root morphology provide valuable insights into the developmental status and health of the plants. Understanding the growth trajectory of the crop enables growers to adjust cultivation practices accordingly, optimizing resource allocation and maximizing productivity. Furthermore, early detection of disease symptoms and pest infestations is crucial for effective management strategies. By monitoring plant health indicators and pest populations, growers can implement timely interventions to mitigate risks and protect yield potential.

9.REFERENCES

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