Estimation of Agri-Produce Using Deep Learning and Smart Vision by Using Prominent Feature Extraction

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Abstract - Agriculture needs a very high degree of physical as well as financial support. It is also an important occupation for people all over the globe. Due to a lack of crop estimation, countries like India have various issues such as storage, transportation, selling of crops, etc. Accurate and early estimation of grains is essential for the farmers to easily manage all these problems. Estimating crop yields may be used for crop insurance, delivery management, storage requirements, and cash-flow budgeting. Farmers can benefit greatly from early and accurate crop yield predictions, which have completely changed how they approach their agricultural practices. The area of planning offers one of the biggest benefits. With accurate predictions of future crop yields, farmers can plan and make wise decisions. The best crop varieties should be chosen, planting and harvesting times should be optimized, and specialized cultivation methods should be used. The better allocation of resources is yet another benefit. Farmers can use labor, water, fertilizer, and other resources more effectively and minimize waste by having a clear understanding of the expected yields. Additionally, by enabling farmers to participate in crop insurance programs based on precise yield projections, early forecasts can help them manage financial risks. This paper represents a model based on AI and ML for easily estimating the production of crops before growing by analyzing the current weather conditions, location-wise soil conditions and seasons, etc. This prediction system will be able to predict the production of crops before harvesting.

Keywords: Rice yield, Estimation, CNN Model

I. Introduction

Rice is one of the important crops in many countries. It can fulfill the needs of more than three billion people worldwide. So it is the primary source of food. Due to the changing environmental condition, un predicted seasons and various factors, some of the grown parts are wasting now a days. Estimation of the production before harvesting is very crucial, mainly in areas where climatic uncertainties. Planning before forecasting can play very important role for the food security in terms of shortfall or surplus.

Estimation of production can also helpful for the government to put in place strategic unforeseen event plans for re-distribution of food during times of food crisis. Therefore the crop estimation and crop growth and early prediction are very important.

Estimation of crop production in various countries doing by conventional techniques that depends upon collecting of data directly from the ground fields by visiting and preparing reports. These types of data collections and documentation are very costly now days. We can use the modern tools and techniques by which we can collect data very accurately in very efficient way [25].

Early estimation of crop production can be achieved by use of various modern tools and techniques such as machine learning, AI based system, IoT devices, block chain etc., In current time peoples having good knowledge and better use of electronic gadgets powered with artificial intelligence system can be used to predict the early production of crops yields[1].

This paper represents a model that can predict early production of rice crop using CNN by selecting the area of paddock, numbers of grains in a pods on the basis of computer vision.

The proposed model is based on the use of computer vision to predict the production of crops before harvesting.

Traditional method used by various formers for estimation of crops production is relatively less time consuming and easy. This method involves area of paddock, average of crop in one meter square area(X), average number of grains in at least 10 pods(Y), grain weight for the crop concerned(Z). The formula for estimation of crops production in tons per hectare is[26]-

$$P=(X*Y*Z)/10000 \qquad (1)$$

These models now require more time and effort. Following the development of new technologies like machine learning, data science, and sensor technology, producers now have a better approach to determine how to increase productivity while also estimating crop production. Models based on AI/ML and neural networks are more suited for these types of prediction since they have superior learning capabilities and perform and accurately. Due to its innate capacity for various feature learning, deep learning models are preferred over machine learning models. We can automatically extract the features from the row data and produce the features for higher layer using deep learning models. Deep learning models' extensive hierarchical structure and strong capacity for learning enable them to implement categorization and prediction in a simple and precise manner. The numerous elements that make up the deep learning model's base architecture, including activation functions, pooling, fully connected layers, convolutions, memory, gates, and encoding, among others, can be used to extract features more effectively. The need for early and precise crop production estimation is more crucial than ever in the context of modern agriculture, where shifting environmental conditions and unpredictable seasonality pose serious challenges. The assurance of a steady supply of rice is crucial because it is a staple food for more than three billion people worldwide. In areas where precise planning is necessary for food security, unanticipated climatic variations, environmental factors, and other uncertainties can result in food waste. Notably, early crop production estimation has the power to fundamentally alter how we approach these problems. We can open the door for more effective, affordable, and trustworthy data collection techniques by leveraging the power of cutting-edge technologies like machine learning, artificial intelligence, IoT devices, and blockchain. In order to predict rice crop production well in advance of harvest, the model presented in this paper makes use of computer vision, AI, and machine learning. By taking into account a number of crucial factors, the proposed model not only simplifies the estimation process but also increases its accuracy. These modern approaches usher in a new era of precision agriculture, ensuring food security, effective resource allocation, and informed decision-making for farmers, agricultural authorities, and governments alike. Traditional methods still have their advantages.

II. Related work

The results of several studies using machine learning techniques to forecast crop production are very positive. Gonzalez Sanchez, Frausto Solis, and Ojeda Bustamante claim that this paper presents a comparative analysis of different machine learning (ML) techniques for the crop yield estimation of ten different types of crops, including support vector, M5-Prime regression tree Multiple linear regression, perceptron multilayer neural networks, and k-nearest neighbor[8].

In this work, wheat, potato, and maize crop yield estimates were made using the Random Forest (RF) model and multiple linear regression (MLR) technique for comparison [11].

According to this study, sensor technology can boost the efficacy and precision of machine learning models. Artificial neural networks were one of the machine learning models used for crop yield estimation that were the most successful [1, 25].

The most accurate method for estimating nitrogen was the least square support vector machine, and the most accurate method for estimating crop yield was the M5-Prime regression tree. Using a SVM based model with weighted data, accurate predictions have been made. In order to promote sustainable agricultural practices that have little negative impact on natural resources and the environment, researchers have done study and evaluate the effectiveness of machine learning methods for estimating crop yields and nitrogen level using remote sensing data is given by Welan, Sukkarieh, and Chlingaryan [2].

Time series data can be handled very effectively by recurrent neural networks (RNN) and LSTM. In the area of predicting crop yields, a number of deep learning models have been compared for their effectiveness and efficiency. Crop yield prediction fits into the ideal category of issues that RNN can successfully handle because it is a field that is entirely dependent on time series data. A few recent studies have already examined the method used in the aforementioned area, and the results are very positive. In one study, CNN-LSTM model fusion and unprocessed imagery data were used to estimate the yield of a wheat crop [21].

With conventional methods, this model accurately predicts crop yields to the tune of 74%, and with other deep learning models, to the tune of 50%. In another study, Sivanandhini, Scholar, and Prakash [24] compare and find the performance of the feed-forward neural network and the RNN model for predicting wheat crop yield.

The Random Forest model's yield prediction accuracy is the highest (67.8%). The LSTM and Simple RNN models provide accurate temperature and rainfall predictions. In order to predict crop yields, a different researcher compares the three methods—ANN, CNN, and RNN with LSTM [4]. With an accuracy rate of 89%, LSTM outperforms all other techniques, while CNN model accuracy outperforms ANN and RNN.

This paper used the Normalized Difference Vegetation Index (NDVI) of Landsat Enhanced Thematic Mapper plus (ETM+)to predict the correct crops to grow on the basis of important parameters. This can be help farmers to select the right crops [27].

In this paper, an author uses Naive Bayes Classification and Web Scraping to predict the suitable crop. In this model a chatbot is used by the formers to enter some specific parameters then they can get the production of crop with real time data through web scraping [28].

This study proposed a model that is based on Gaussian kernel regression for rice crop production estimation with the use of optical and SAR imagery with limited ground truth data. It gives the maximum accuracy when combine RDVI1 with interferometric coherence [29].

A. Deep Learning

A subset of machine learning called "deep learning" uses artificial neural networks as its foundation. In order to learn about complex issues and relationships within datasets, deep learning techniques are used. To solve some complex problems without requiring human intervention, it essentially uses a neural network with more than two layers. The architecture of deep learning models, illustrated in Fig. 1, comprises input layers, hidden layers, and output layers. The depth of these networks allows them to perform intricate tasks, from image classification to language translation, with high accuracy. These networks are particularly adept at feature extraction, data representation, and making predictions, making them a powerful tool for solving complex problems and automating tasks that previously relied on human intervention.

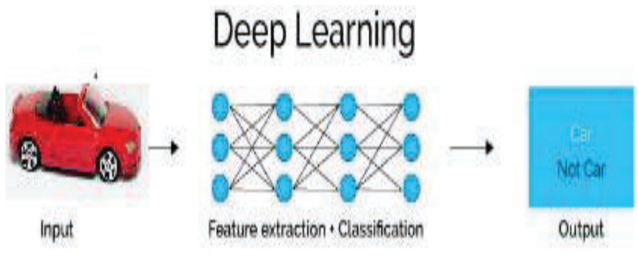

Fig. 1. deep learning

B. Recurrent Neural Networks

RNNs are a unique class of neural networks that can store the output of one pace and use it as the input for the next pace. The processing of time series data with long-term dependencies primarily makes use of these special features. When compared to algorithms, this feature aids RNN in understanding sequential data and its context better. RNNs can comprehend both the current data point and the entire history of previous inputs thanks to their temporal memory. As a result, they are incredibly effective in tasks like text generation, language modeling, and speech recognition, where context and continuity are crucial. RNNs are the preferred option for sequential data analysis and prediction because they have a dynamic and adaptive memory that can capture long-range dependencies, in contrast to traditional feed forward neural networks that have no memory of previous inputs.

C. Performance Metrics

A variety of performance metrics are used to validate the results produced by any machine learning model. We use a number of performance metrics in the suggested model, such as Mean Squared Error, Mean Absolute Error, and Root Mean Squared Error (RMSE). The average value of the total absolute error is known as mean absolute error. The average of squared errors with the root taken out is what Gonzalez Sanchez, Frausto Solis, and Ojeda Bustamante [8] define as the mean square error.

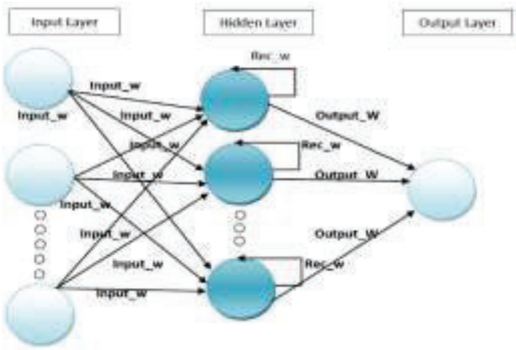

Fig. 2. RNN Architecture

III. PROPOSED MODEL

In this paper, a AI/ML based model is used to predict the production of crop before harvesting is shown in fig. 3 and fig 4. This model uses the deep learning techniques and computer vision to generate the frames of a crop from captured video of the crop. Apply CNN model for extracting the various features from the generated frames and store the features of the frames in terms of various parameters.

a) High Level view of proposed prediction System

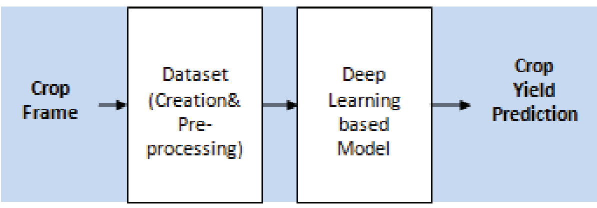

Fig. 3. High Level View of proposed system

Crop frame images can be used as an input for the preparation of dataset and then this tabular dataset is used by any Deep learning algorithm to predict the production of crop. Crop images or frames can be prepared from a short video of crop.

b) Architectural View of Proposed System

Fig. 4 shows the architectural view of the proposed system. It starts from capturing a short video of any crop and extracted frames. After preparing the frames CNN model is applied to extract the important features on which we can apply a deep learning algorithm to predict the expected production of any crop.

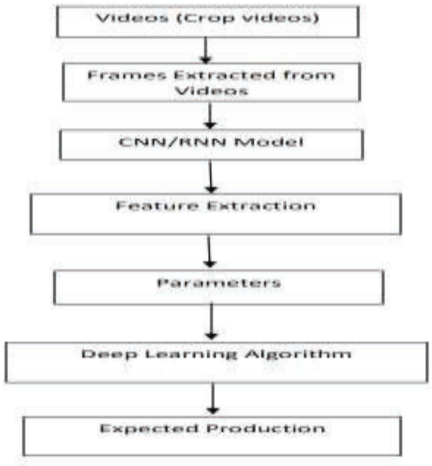

Fig. 4. Architectural Flow Diagram of the Prediction System

A. Prediction model has following steps-

Step 1: Data Processing

Application of deep learning models needs data for the prediction, so we can collect data in the form of video directly from the paddock. After making a video, we can generate various frames of the crop. Each frame has some features/parameters for deep learning model.

Step 2: Model Training

Using the processed data from step one, a deep learning prediction model is fed to forecast crop production. The quantity of iterations will be determined with an eye towards minimizing losses.

Step 3: Prediction Model Validation

The predicted output of the test data from step two and the actual production of crop yield were compared. RMSE, MAE, and MSE are the three performance metrics used to evaluate how well the prediction model performs.

The proposed model can be used to predict the early estimation of crop production prior to harvest.

B. Advantages of the Model

This model is very suitable for all the formers, insurance companies, government body and the entire shake holder related with agriculture. It takes less amount of time to predict the production of any crop just capturing a small video. The accuracy of proposed model is better than theoretically calculated model.

C. Disadvantages of the Model

It has some disadvantages like the complexity this proposed model is sometimes high. It is completely depends upon the quality of fames that can be extracted by CNN model.

Fig. 5. Frame of Rice Pod

IV. DISCUSSION

This model gives us very good accuracy as tested in theoretical way. Using fig. 5, we can easily count the number of grains in rice pod. After counting the number of grains in a pod, number of pods in one meter square area and grain weight for the crop concerned. We can put these values in the equation (1) and get the production of crop in tons per hectare. This innovative approach, which seamlessly integrates computer vision and deep learning with agricultural data science, streamlines the estimation process of crop yield as shown in fig.4. This proposed model automates the process of crop yield prediction. The use of this equation-1, is to predict the crop yields and estimates production, expressed in tons per hectare. This model not only simplifies the estimation process but also enhances its accuracy, promising to revolutionize the way farmers, agricultural authorities, and governments to plan and manage food production in an era of evolving agricultural challenges and technological advancements. Using the predicted result we can compare with manually computed result and then we can check the accuracy of the proposed prediction system. The proposed model is very simple to use by formers, it needs a short video of the crop paddock. After capturing a video it automatically extract frames from supplied video. A CNN model is used to extract features from the frame and converted into parameters. These parameters are further used by the deep learning algorithms to predict the crop yield production. Experimental purpose we have selected a rice paddock, captured a short video. In this model Opencv, a python library is used to make various frames from captured video. Fig 5, shows a manually captured frame on which we have applied a manual method to calculate the production of crop yield. For example calculation of rice crop yield production in tons per hectare for the data [26] is based on manually captured frame as shown in fig 5-

a) Average number of pods per meter square is 25(X)

b) Average number of grains per pod is 234(Y)

c) 100 rice grains weight in gram is 5.5 gram

Rice Yield in Tons/Hectare = (X*Y*Z)/10000

= (25*234*5.5)/10000

= 3.2175

This calculated value has been used as the reference value for the proposed system. If the predicted value from the proposed system will be same as the manually calculated value, then this model will gives us good and efficient result with high accuracy in very short span of time.

V. FUTURE SCOPE

After calculating the production of crop, we will apply deep learning model for estimating the prediction of the crop production. These predictions will be a great help to farmers, but they will also have significant ramifications for larger agricultural plans and initiatives to ensure food security. A crucial advantage in planning, resource allocation, and risk management is the capacity to predict crop production in advance. Furthermore, it opens the door to cutting-edge techniques like precision farming, dynamic logistics in the supply chain, and proactive government regulations to guarantee a resilient and sustainable food ecosystem. The future scope of this research goes beyond agriculture. It has the potential to have an impact on many sectors, including the global food trade, insurance, and agribusiness. The use of deep learning models in crop production prediction represents a significant step towards more effective, secure, and sustainable food production and distribution systems as we advance in the fields of artificial intelligence and data science. Deep learning techniques can play very important role in prediction of any crop yields.

VI. CONCLUSION

This paper objective is to find efficient deep learning techniques that give the better crop production prediction. This whole study is targeted in east Uttar Pradesh and based on rice crop. Next target of the study is the selection of more crops and other deep learning techniques for the better accuracy during analysis. The objective is to create a flexible and adaptable framework that can accommodate the varied agricultural landscape, ensuring regional food security and sustainable farming methods. This research advances precision agriculture by pushing the boundaries of technology and data science, laying the groundwork for creative and data-driven solutions that can address the changing problems that the agricultural community faces.

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