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Detection of Plant Diseases Using Convolutional Neural Networks

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Abstract: Introduction of various technologies like Artificial Intelligence, Image Processing, etc. there has been a significant improvement in the growth of various sectors. They have automated a lot of existing tasks that happen to be difficult to be handled manually thereby reducing the load simultaneously providing precision, efficiency and productivity. This research provides various ways to improve the agricultural sector in terms of productivity and also in terms of efficiency. Image processing of crops for analysis, crop disease detection, etc. are some of the various applications of technology in agriculture. This also provides an effective way of monitoring various internal and external factors like soil fertility, water logging capacity, temperature, etc. Providing a much more cost-effective way of increasing agricultural output and improved efficiency, the implementation of modern technologies improves agricultural sector in various ways. Technological improvements provide the farmers security of their crops getting infected by any pests, being impacted by climate changes, etc. These improvements also reduce the time the farmer needs to spend on the farm by utilizing the concept of deep learning and neural networks. There are various other ways in which technology can benefit the agricultural sectors.

Keywords: Agriculture, Artificial Intelligence, Deep Learning, Image Processing, Neural Networks.

I. INTRODUCTION

Agriculture is the backbone for the world. With the exponential increase in human population recently, the issue of world hunger is becoming much more serious. Being accustomed to the traditional ways of agriculture the farmers are not able to meet the requirements. Depending on the weather for irrigation because of belief in their ancestral ways, agriculture in rural areas is turning out to be non-viable causing a lot of farmers to look for other professions thereby reducing agricultural outputs. With the seasonal cycle being impacted by the pollution, the environmental conditions have reached to such a state that they are becoming harsh for crop growth. Land being allocated to the increasing human population, there is also the scarcity of fertile land to be noted. This requires much more smart ways of agriculture using the least amount of land available in the most productive of ways possible. Implementation of modern technologies like Artificial Intelligence, Internet of Things, etc. there can be a significant growth in the agricultural sector. Utilizing IoT for connectivity among various agricultural equipment with AI for an autonomous system increases the output by a significant amount for example. With the use of the technology, the weather conditions can be analyzed and with the data obtained appropriate measures can be taken by the farmer to ensure a healthy growth of the crop. Our paper’s goal is to use image processing to make a proper analysis of the growth of the crop and also to monitor the environmental condition and to provide a detailed description to the farmer so as to take appropriate steps to improve crop growth in any way possible. Maintaining a continuous check on the crop growth is a tedious process to be done in the traditional method, but an autonomous system in place to do so is much more effective. Therefore, with the proper implementation of modern technology, the agricultural sector can be developed to a much better state.

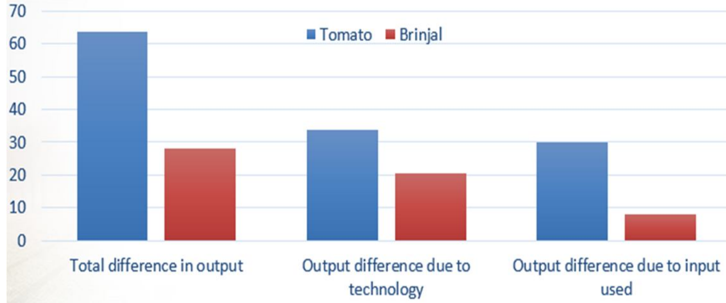

Fig. 1. Difference in yield produced with change in technology used verses change in input used.

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II. LITERATURE SURVEY

With the growing population all over the world, we need to be able to keep up our crop production with the increasing necessity, this means various things, such as having all possible best resources for our purpose and also utilizing these available resources as efficiently as possible to get the most out of the land and the resources to get the best possible yield. This could be done through various methods like we have seen in various other papers but have their own limitations and cons such as

A. IoT connects various devices and manages them as if they are the various components of a singular device. It provides the benefits of a team coordinating within themselves sharing the burden to provide a unanimous effort to accomplish the designated task. But such application of IoT related devices are rather a burden in terms of finance and maintenance, therefore is not practical for small scale deployment.

B. One of the main concerns of farmers is looking after the crops to make sure they are not infected by any pests and their growth is not affected by atmospheric changes. Keeping a look on each and every crop may not be practical for large areas and can be made easy by the use of a Image processing feedback system where the systems keeps a record on the condition of each crop and provides necessary feedback to the farmer. But the use of such a complicated system may not be suitable for a farmer and also the setup for such a system is not always feasible.

C. Analysing the Hyperspectral information provides required data that is to be processed by Machine Learning algorithms to provide suitable suggestions to the farmer to make the land much more fertile for any crop growth. But such a process requires a lot of data to be collected for proper analysis. Also, the hardware required for such processing power is not practical.

D. Structure visualization provides a basic layout of the area being used to agriculture for any computing purpose of any algorithms to be applied henceforth. This has been made possible with the Remote Sensing techniques but the drawback happens to be the complex infrastructure and complicated hardware.

E. A network of cameras or a fleet of drones can provide live monitoring system that can be accessed remotely. The major downside is the maintenance and affordability of such sophisticated system.

III. DATASET

The dataset is taken from plant village dataset from Kaggle which consists of approximately 87000 images.
It contains 38 classes of image data as follows:

1) Apple - Scab, black rot, cedar rust, healthy
2) Blueberry – healthy
3) Cherry - Powdery milder, Healthy
4) Corn(maize) - Cercospora leaf with Gray spot, common rust, Northern leaf blight, healthy
5) Grape - Black rot, Esca (Black Measles), Isariopsis spot, healthy
6) Orange – Haunglongbing
7) Peach - Bacterial spot, healthy
8) Pepper bell - Bacterial spot, healthy
9) Potato - Early blight, late blight, healthy
10) Raspberry – healthy
11) Soybean – healthy
12) Squash - Powdery mildew
13) Strawberry - leaf scorch, healthy
14) Tomato - Bacterial spot, early blight, late blight, leaf mold, Septoria spot, spider mites, target spot, yellow leaf curl virus, mosaic virus, healthy

IV. MODEL

The approach that Deep Learning follows to perform analysis on image inputs and being able to differentiate the various objects present in the image is what is termed as Convolutional Neural Networks or CNN in short. This neural network requires less pre-processing than most of the other existing algorithms. It also can be improved by imparting the proper training to the model. The architecture of the CNN model is kindred to the arrangement of neurons in the brain, but the neural network draws inspiration from the design of the visual cortex.

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We have constructed a CNN based model for the detection of diseases in plants which takes images as input of the leaves of a plant and classify whether that particular plant has contracted disease or not. The below figures are the model's loss and accuracy charts for training and validation.

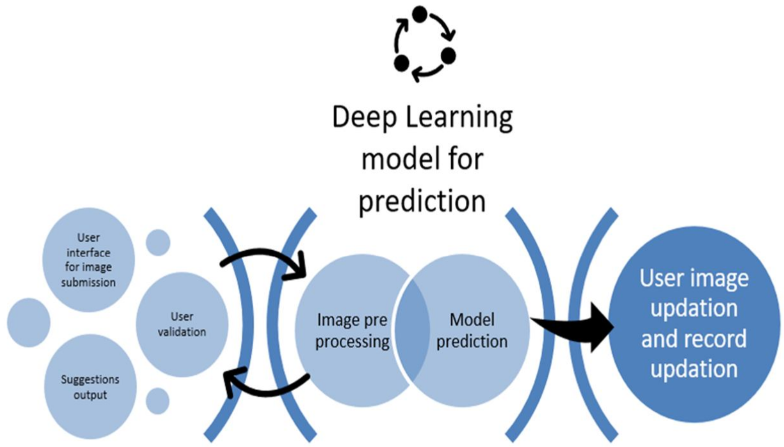

Fig. 2. Model Visualisation.

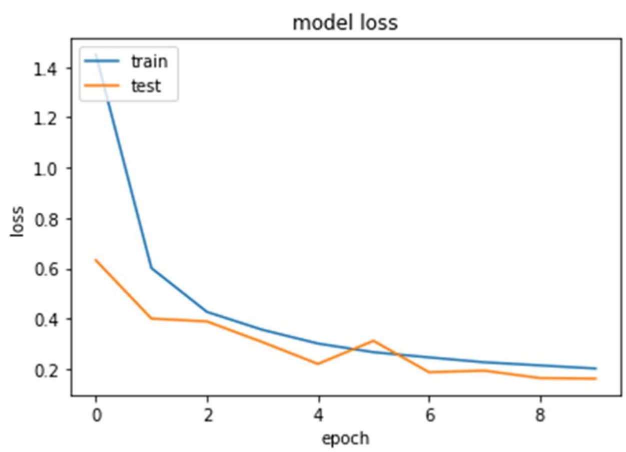

Fig. 3. Loss across epochs.

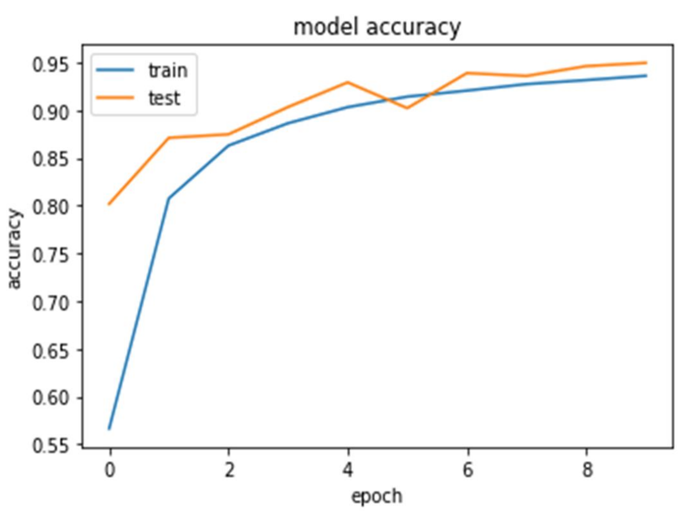

Fig. 4. Accuracy across epochs.

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V. RESULT AND ANALYSIS

The model is executed with 10 epochs with minimum learning rate of 0.000001 and a batch size of 32. The optimizer chosen was Adam optimizer with loss calculation as categorical cross entropy. After recording the history of both loss and accuracy for 10 epochs, we obtained approximately 94% validation accuracy which determines the correct combination of the CNN model. The fig 3 and fig 4 describes the recorded loss and accuracy of the model and helps us in better prediction of crop disease.

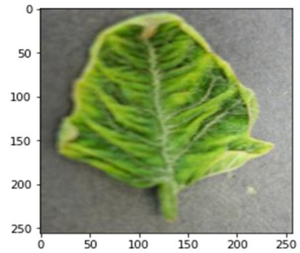

Fig. 5. Tomato Yellow Leaf with Curl Virus.

Prediction is done on tomato leaf which has Curl Virus in it. The data is inputted as an image to the trained model. It successfully predicted the outcome by providing the correct class label.

VI. CONCLUSION

Adoption of modern technology can be efficient only when applied to larger areas of agricultural in general sense, but proper application of technological improvements in the appropriate scenarios always provides improved results. Improvements in visual devices, notably mentioning smartphone cameras and sensors, paved a way for various technologies to be incorporated into a small yet sophisticated device. With the processing power provided by the smartphone hardware, the image inputs captured through the high-resolution cameras can be processed in real-time and provide actionable results. The utilization of smartphones and the vast set of features available through the internet will help in making these resources more accessible to the people, in more than one way such as making it easy to use and the price to pay for the usage of these features will also be low. The proposed future works would be implementation of the trained CNN model into mobile devices using TensorFlow Lite framework, which makes deep learning models deployment easy in mobiles.

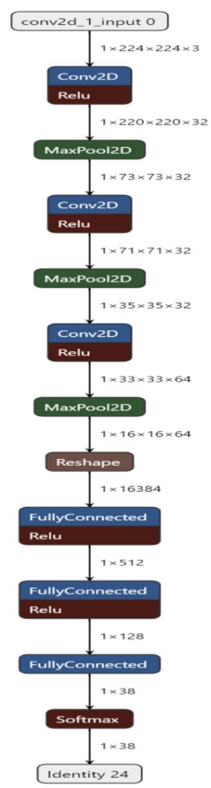

Fig. 6. TensorFlow Lite Model.

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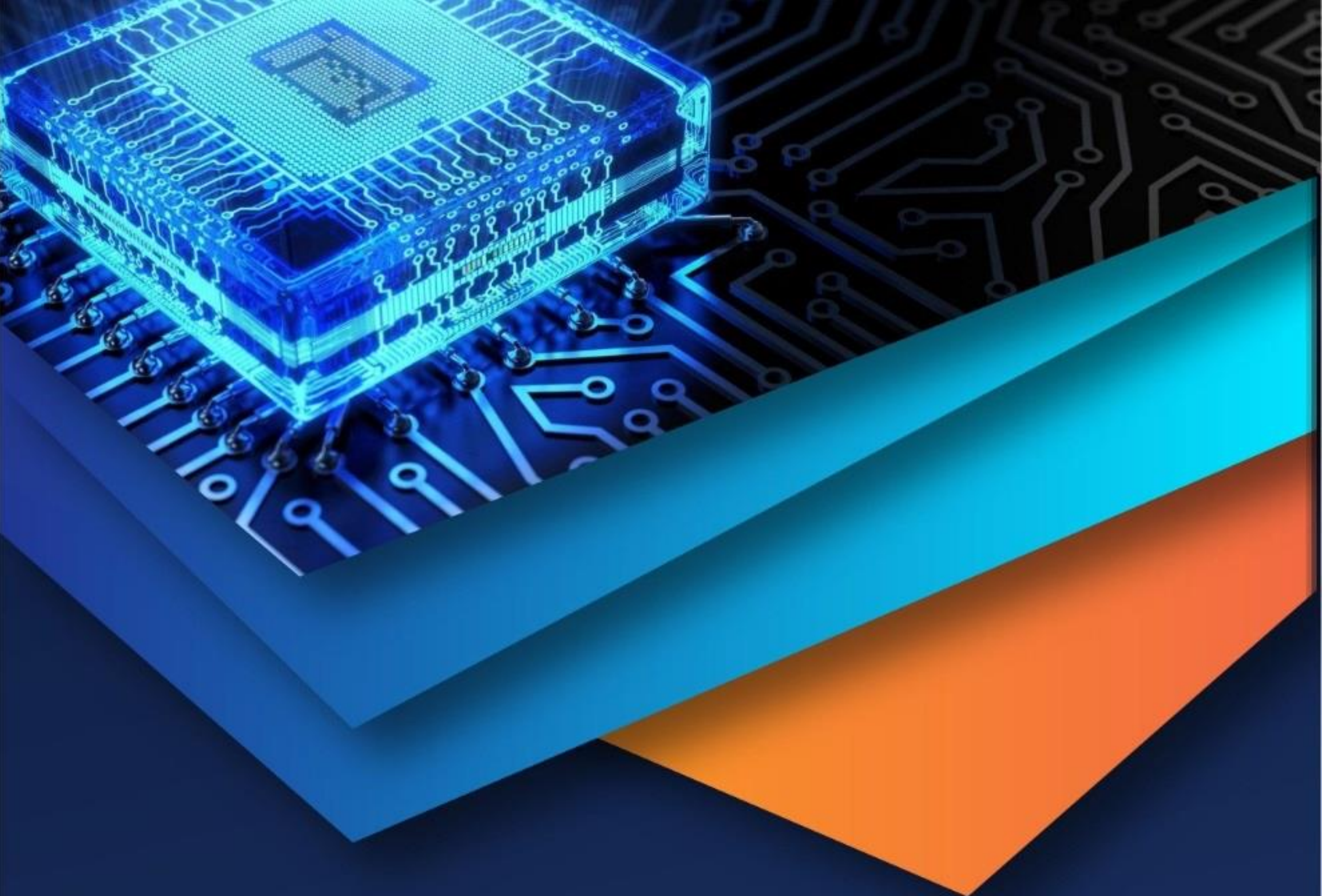

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