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RECOGNIZE THE DISEASE SEVERITY IN PLANT LEAVES USING RESNET

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ABSTRACT:

Agriculture is an important source of livelihood in most parts of the world. The crop cultivation has an apparent issue of crop degradation over the decades, one of the major reasons is being affected by a definite range of diseases. It requires careful examination and appropriate handling to protect the crops from heavy loss in quality. A computational method for the identification of disease severity (DS) in plant leaves at an earlier stage is the key to prevent the losses in the yield and quantity of the agricultural product. Labeling the disease helps in the process of diagnosis of the infection and to provide the required pesticides along with its specified amount. Identifying the plant leaf infection by making use of an artificial neural network model Res-Net is often found to be more economic and effective than other manual methods of recognition. It is determined to detect the level of attack of the disease in plants and to indicate the desired amount of pesticide in line to help the growth. These innovative techniques represent unprecedented tools to render agriculture more sustainable and safer solution. It reduces the impact of the disease from farther outspread, avoiding the excessive use of pesticides in crop protection. Eventually improving the quality of yield and reassuring the upliftment of yield production.

Keywords- Artificial neural network,pre-trained model, RES-NET152, Deep Learning

1. INTRODUCTION:

Life before technology was much more uncomplicated and less tricky. Technology is the barrier that connects humans and the cure to various complex disorders of structure and capacity in living organisms. All living beings experience the same habitat and interact with each other. The Neural network is a conspicuous part of the very immeasurable field of technology especially known as Artificial Intelligence. The impact that neural network along with Artificial intelligence has conquered numerous things in the society. It has allowed us to collect implied and obvious knowledge from the human brain to a digital form which is understandable as the natural-processing language by computers.2 It is not only made it possible to reconstruct the ability of competence with humans but also understanding the patterns along with behavioral aspects for further knowledge.

Agriculture is an exceptional way of life that includes crop cultivation, afforestation and livestock production, etc. India is one of the top countries in several crop production. Despite the fact of having profoundly plentiful resources, the potentiality of high yield production is less as compared to developed nations over the world. Agri-industry uncovers a vital role in concluding the economic condition of a developing country and provides raw resources that are rendered for industrialization. The surplus production and its supply have a close increase in commercial and technological growth. In the field of agriculture, the farmer confronts a major challenge of sustaining the quality of the yield produced. One of the reasons which make the aforementioned process hard transpires being affected by the infinite variance of infections in plants.

AI, with its emerging new systems, shows an enormous amount of assistance for the traditional challenges in the agricultural sector. The deeper you go, the more you explore that proved to be an adequate acquaintance by knowledge. The extended depth of complexity increases the accordance of determining an effect using deep learning classing models. Deep learning is a subrange of machine learning where the artificial neural network algorithms stimulated by human brains. Enhances the better understanding and subsist the data. Agricultural fields modernly approach the invasion of AI-based guidance. Farmers are lately in the state of ecstasy to amend with the increase in production.

Diseases play a vital role in damaging the quality and harshly affect the health of the plant. There are several ranges of diseases that make it likely to stop the proper functioning in the growth of plants. The detection of diseases and advising the proper amount of pesticides may help in reassuring the health of plants. Negligent and excessive usage of pesticides causes unpleasant critical health conditions among the living.

Therefore, in this effort, we propose a Res-NET-152(Residual Neural Network) model of artificial neural networks for the early diagnosis of the diseases. The spread of disease on plants settles the specification of the stages. The performance of the model is developed by the images in real circumstances. The images are preprocessed to eliminate unwanted falsifications including the noise and illumination equalization. Then, the RES-NET 152 based classification model is trained and tested for the identification of the diseases of different plants acknowledging the following major points:

1. The diagnosis of disease in plants at an early stage ensures in determining the vulnerability among them.
2. This also helps to accommodate in specifying the disease severity (DS) level for efficient and effective timely treatment beforehand.
3. On that account, this work proposes a deep learning model named as RES-NET12 for the diagnosis of diseased plants (Pepper Bell, Tomato, potato) and at distinct severity level for designating the definite value of pesticide.
4. For this work, real provisions of healthy and infected leaf images are concentrated for the plants experiencing from several diseases.
5. The system proposed is automated, computationally effective, and neutrally economic that can help in conveying the significance of the nurtured plants and its yields both ecologically and economically.

The article is organized as follows. In Section 1, a detailed review of the significance of the AI-based approaches in agricultural sector along with impact of it and the objective of this article are presented. The next Section 2, presents the related works with deep learning model classifiers used in plant diseases studies are given, followed by proposed work in Section 3. Results are given in Section 4, whereas section 5 settles the article accompanied by references.

2. RELATED WORK

Davoud Ashouloo et al in [1] have presented the number of studies for the identification of the disease severity and disease stage is absolute to specify the WLR disease caused by *Puccinia triticina fungus*. In the review work, the authors specified the methodologies associated with the detection of five different stages of the disease, including techniques to develop a Spectral Data Index (SDI), challenges, advantages, disadvantages, etc. Uday Pratap Singh et al. [2] have presented various studies of the convolutional neural network methods used for the identification and the classification of leaves infected by the Anthracnose disease among Mango trees. The authors introduce a deep learning model named as MCNN (Multilayer Convolutional Neural Network) for this perception. Jia Shijie et al. in [3] has constructed the convolutional neural network model to detect tomato pests and diseases based on VGG16 and transfer learning. It has been trained with 1000-category images, while the objective task is to classify 10-category leaf images of tomato pests and diseases. Transfer learning technology engages with fine-tuning to transfer the original task and data domain to the objective task and data domain. Peng Jiang et al. [4] used not only apple leaf images with uniformity and complex backgrounds in the laboratory but also under real field conditions. A novel real-time detection model is based on a single-shot multibox detector. the authors indulged in various techniques, models, mechanisms, and classifiers. A deep convolutional neural network is built up for real-time detection of apple leaf diseases. Jun Sun et al. [5] has introduced various studies of the convolutional neural network model that is applied to detect the blight in leaves of maize. This study compromises a new model that befits certain improvements in the efficiency and detection of maize leaf blight in a complicated environment. Too et al. [6] have used four different deep convolutional neural network architectures including VGG 16, Inception V4, Resnet, and DenseNets for the classification of disease from an image. The images are taken from plantVillage dataset consists of 38 diseased classes and 14 healthy classes. The DenseNets are considered to have higher accuracy and lesser computational time. A system of identification of maize leaf diseases based on two different improved deep convolutional neural networks was proposed by Xihai Zhang et al. [7]. Nine different types of maize leaf disease were examined by this method. This work shows that it is possible to engage differences in operations, mechanisms, and reasonable addition of functions along with various parameters to increase the recognition of accuracy. In [8] Robert G. de Luna proposed a detection network and recognition network built utilizing transfer learning in Alexnet. The detection network was re-trained by faster RCNN architecture. As for the detection network, layers 23 and 25 modified for 2 achievable results while for the recognition network, layers 23 and 25 also modified for 4 achievable results.

3. PROPOSED WORK

A. DATASET

The significance of datasets in the field of artificial intelligence has a higher demand in accordance with other fields. The role-play of digital datasets is highly magnified in the process of long-term preservation and an essential component of scientific infrastructures.

The dataset is gathered in order to classify them into different objectives. The initial step is to collect data from all possible sectors and analyzes their characteristics. This process includes the authenticity of the dataset used as the trained data. The next step involves facilitating the publication of data and the very next step is to preserve the data gathered in order to avoid inconsiderable situations.

Working with images is quite reasonable as it is two-dimensional along with one- or three-color channels. Therefore, we need to reshape it as an array to size it up. Considering images are numeric values, they indeed needed to be scaled by dividing each with the maximum value of the pixel. To reduce the engagement of time with the process of preprocessing techniques, we have used preprocessed and regulated images verily collected from the plantVillage dataset consists of 12 different diseases and 3 healthy classes about three different plants to be essentially cultivated.

Fig 3.1 Pepper Bell Bactorial Spot

Fig 3.2 Potato Early Blight

Fig 3.3 Potato Late Blight

Fig 3.4 Tomato target spot (1), Tomato mosaicvirus (2), Tomato yellow curl virus(3), Tomato Early Blight (4)

Fig 3.5 Tomato bactorial spot(1), Tomato Leaf Mold(2), Tomato septoria leaf spot(3), Tomato Spider mites (4)

Fig 3.6 Pepper Bell healthy leaf (1),Potato healthy leaf(2), Tomato Healthy leaf(3)

B. TRAINING AND VALIDATION

The intact dataset is subdivided into two parts training and validation. For the training process, it is required to apply transformations like random scaling, cropping, and flipping. It ensures network generalization for a better understanding of data and accurate decisive predictions. In the pre-trained network, it is needful to change the input data size to (224x224) pixels as required by the networks. The validation set is to resize the input data into its appropriate size to perceive the model's performance of the data it hasn't seen yet. The pre-trained networks accessible from 'torchvision' were trained on the ImageNet dataset where each color channel was normalized separately. For both sets, it is necessary to normalize the means and standard deviations of the images to what the network requires. For the means, it's ' [0.485, 0.456, 0.406]' and for the standard deviations "[0.229, 0.224, 0.225]' , calculated from the ImageNet images. These values will shift each color channel to be centered at 0 and range from -1 to 1. A file cat_to_name.json gives a dictionary mapping the integer encoded categories to the actual names of the plant diseases. Now the data is ready, using one of the pre-trained models from torchvision models to get the image features. Develop and train an innovative feed-forward classifier using those features. Resnet-152 trained model is practiced for this image classifier. After this process, validation is carried on the test set to ensure better performance of the model defined.

C. APPROACH TO DEVELOP A MODEL CLASSIFIER

A new untrained feed-forward network as a classifier using Relu activations and our input-size matches the pre-trained model. The class nn.linear includes the in_feature (each input size of the data), out_features(each output size of the data), and bias set as True(if set as false it won't add additives).nn. sequential takes as argument the layers separated as the sequence in which the keys are added. Here is the sequence that is inserted to function (fc1, nn.linear(2048,512)),(relu,nn.Relu()),(fc2,nn.linear(512,39)),('output',nn. LogSoftmax(dim=1)). The log of the softmax function probabilities returns values between [-inf, 0], since log(0) = -inf and log(1) = 0. Then train the model to function adding the model, criterion, optimizer, scheduler, num_epochs. Set the num epochs=10 which is a hyperparameter that works on the number of times the learning algorithm goes through the dataset. Each epoch has its training and validation phase. Iterate the data over, use the optimizer to set zero the parameter gradients, forward and track history if only in the training phase, and backward and optimize only in the training phase as well. The statistics interpreting the loss value and if the epoch accuracy is better, then deep copy the model. Then, train the model with the pre-trained network. NLLLoss depicts the (output, target). The output is the model prediction that the model predicts on giving data and the target is the exact label of the given image. This criterion of NLLloss uses log probabilities as we are using Logsoftmax for the output. The optimization phase intakes Adam with Learning Rate which can handle the scattered gradients and noisy problems. The adam with learning rate decay is helpful when setting the factor by 0.1 for every 5 epochs very small so the loss won't begin to change after decrease to a point.

4. RESULTS

The proposed model including the training and validation process was implemented using Facebook's deep learning platform: PyTorch. The learning rate is set to 0.001 and the decay LR by a factor of 0.1 for every five epochs. The training process quite took approximately 2 days and the validation was completed in a few hours. The results of the presented procedure focus on:

1. The initial step is the diagnosis of the disease in specified plants i.e(Pepperbell, Tomato, Potato) by recognizing respectively. It includes the identification of the leaf diseased or not and followed by which disease.
2. The next step involves the identification of how much the leaf is been affected which is determined by the spread of the disease estimated by percentage. A certain amount of pesticides to be recommended.
3. The training process and validation process involves the determination to know the performance and accuracy rate of the proposed model.

Fig 4.1 shows the accuracy rate of the proposed model and Fig 4.2 shows the curve loss in the system. The loaded images are preprocessed to enhance. The selection process of the loss functions is notable in the neural network.

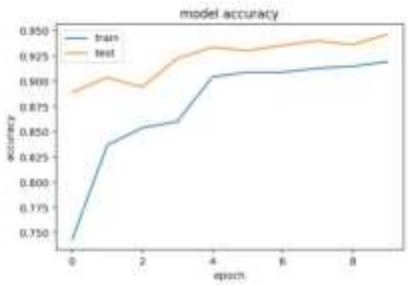

Fig 4.1 Model Accuracy

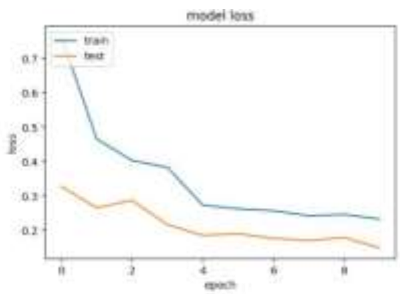

Fig 4.2 Model Loss

The accuracy of the model proposed is computed to be 95%.

5. CONCLUSIONS AND FUTURE WORK

The primary aim of this study is to develop an automatic detection and classification of plant leaf disease and the indications of the level of severity of the disease in plants. The usage of pesticides to overcome the disease at different levels is variant. The treating of diseases may leave a trace that can lead to other side effects too. That is why to overcome the unpleasant conditions in human health, so pesticides are to be given in a required amount so that it doesn't make the crop have the residue which can be toxic for humans if the limit is exceeded. Plants are prone to diseases that affect the growth of the plant which in turn affects the ecology of the farmer. These diseases remain a major threat to this supply, and a large fraction of crops are lost each year to diseases.

This work proposes a computational model that is trained with a pre-trained network of Res-Net152 intended to help to lessen the delay in identifying the plant leaf disease stages and overcoming the disease in order to accomplish the goals to restrain the amount of excessive use of pesticides on fields. The higher performance of the proposed work is with an accuracy of 95%.

Some of the future works:

1) Use of some other activation function instead of Logsoftmax to enhance the performance and compatible in identifying different diseases.

2) Achieving with other plants that have more high importance in the agricultural fields and essential in economic condition.

3) To build a real-time disease severity monitoring and pesticide suggesting system.

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