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AI Based Crop Identification Application

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***Abstract*: Plants are the most important and primary food resource of many living things like humans, birds, animals, insects, etc. Owing to the increasing world population and decreasing food resources, nature forces us to improve the efficiency in the agricultural fields. Many Modern Computing Technologies are emerged and are get implemented in various domains of agriculture. We know that there are numerous types of plant species available on the earth. Identifying the name of those plants manually is time-consuming. Automating this using a Classification algorithm will help Biologists, Students, environmentalists, etc. in various ways. This system i.e. AI-Based Crop Identification is developed to identify the name of Field Crop Images. Convolutional Neural Network is an Artificial Intelligence algorithm based on multi-layer neural networks that learn relevant features from images, being capable of performing several tasks like image classification, object detection, and segmentation. CNN or ConvNet is implemented in this system to learn the features in the input images by sequentially entering several layers like Convolution, Activation function (RELU), Pooling, and Flattening. Finally, this system classifies new images precisely with just a few examples in the training set. Agriculture crop images from the Kaggle dataset are used to train this algorithm.**

***Keywords*: Image classification, Convolution Neural Network, Crop prediction.**

1. Introduction

Manually gathering information like medical value, genus and species name, place of origin, etc., of unknown crops is a challenge for the 21st generation. Because going to nursery, reading books, or searching on the internet, is time-consuming. An automatic crop identification system is of great importance to facilitate and speed up this process. Dimension, leaf shape, flower, seed, or fruit type are the various plant properties used to identify the species. Among these, leaves are one of the most important properties because they remain on plants for several months in a year. In contrast, Flowers, seeds, or fruits remain for a shorter period in the plant. So many automation tools use leaves as their primary resource for the identification process. However, the crop identification process still remains challenging because of the following reasons: Real-world photographs of field crop images have various dropouts like scaling, rotation, color, background noise, etc… Members of within same families have multiple feature resemblance and are difficult to distinguish. Few studies have been undergone taking individual plant leaves for classifying plants. Leaf snap by Satti et al, have employed leaf images of the Flavia image dataset and applied k-Nearest Neighbor (k-NN) and Artificial Neural Networks (ANN) classifiers to classify plants. This system deals with a single leaf image of a plant. Obtaining plant leaves is not as easy because of occlusion and some plants not even have recognizable leaves. All these issues can be resolved by using deep learning algorithms like ConvNet. This algorithm learns features from the input image and classifies the new one precisely. The main objective of this system is to develop an application that identifies crop names for the given image and to expose the key capabilities of this system as a web service to facilitate faster future development across platforms.

2. Literature Survey

A. Recognition of Plant Using Single Leaf Image

Plant identification provides information for research and development on plants, and also has impact on environmental protection and exploration. Automatic crop identification system is of great importance to facilitate and speed up the identification process. LeafSnap [1] is a mobile application implemented using K-Nearest Neighbor algorithm to identify the information of plant by capturing leaf image alone. This system depends on computer Vision for several key aspects, such as extracting scale and rotation invariant feature set from the image, and preprocessing the image by removing noise from the image.

B. Analysis of CNN for Image classification using Different Models

Resnet50, Vgg16, and Vgg19 are the various models of CNN. VGG16 and VGG19 are grouped under VGGNet. 16 and 19 in VGG16 and VGG19 are nothing but the total number of layers. VGGNet was introduced to improve training efficiency by reducing the parameters count in convolutional layer. Instead of having a large number of hyper-parameters, VGG16 uses convolution layers of 3x3 filter with a stride 1 and maxpool layer of 2x2 filter of stride 2. VGG19 consist of 19 layers i.e. 16 convolutional layers, 5 Maxpooling layers, 3 fully connected layers and 1 softmax layer. ResNet50 has increasing number of layers for achieving better performance. Comparing Vgg16, Vgg19 and ResNet50, better accuracy is gained by ResNet50. But in ResNet50 when we increase the no of layers, initially accuracy grows and then decreases.

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C. Deep learning for Image Classification

Deep learning models are useful when huge number of neurons are to be handled. Deep learning algorithms like CNN, ANN, KNN learn many features from the images by passing through multiple layers of the network. In DL, convolutional neural network (CNN) is a class of deep neural network mainly used for analyzing visual images. It consists of an input layer, output layer and multiple hidden layers. In the input layer, all images are converted into gray scale, where the computer assigns a value to each pixel based on the pixel value. Then pixel values are put into an array and following operations are performed on the array for classification. Every layer is composed of bunch of neurons and every layer is connected to all the neurons of previous layer for feature sharing. The output layer classifys the image. Convolution layer gets image as an input and gives feature map as output. Feature extraction and Classification are the two components of CNN. In feature extraction, features are identified while performing series of convolutional and pooling operation. In Classification, identified features are inputted to fully connected layer for classification purpose.

D. Deep Learning and Tensorflow for Classification

This System is about image classification by using deep learning via framework TensorFlow. MobileNet is used as the 'trainer' as it consists of small efficient of deep neural networks (DNN). There are two ways to configure MobileNet which is the size of the model within MobileNet and the input image resolution. The role of epochs is to prevent overfitting and control the accuracy. Python has been used as the programming language throughout this system because it comes with framework TensorFlow which leads to designing of the system involved Python from start until ends.

E. Evaluation Metric and Effective Extraction of Feature from Images

This System explains the effective extraction of features and matching of images in the compressed domain along with the evaluation metrics. Features are extracted from images in pixel and compressed domains. To extract the low-level features from the compressed images, first, the images are decoded from the compressed domain to the pixel domain. After that, image processing and analysis methods are applied to images in the pixel domain. This process is inefficient because it involves more computation. Therefore, features can be extracted from images in the compressed format by using DCT (discrete cosine transformation) which is a part of the compression process. This process involves the following process DCT block transformation, histogram quantization, feature extraction, and similarity measurement. The evaluation metrics include precision, recall, and f1 score. Precision is out of all samples my classifier labeled as positive, what fraction are actually correct. A recall is out of all actual positive values; what fraction did my classifier correctly pick. F1 score is the harmonic mean of precision and recall. F1 score indicates the overall effectiveness of the model.

3. Existing System

This system helps users to identify plants from photographs of their leaves. The recognition engine consists of a backend server that accepts input images from various front-end clients. The data exchange between the clients and web service is ensured via HTTP protocol. Web service consists of a library called leaf core that implements leaf identification logic and a file system that stores leaf data set. The leaf core logic web service then processes the input image and extracts its relevant features. Identification is done by running a weighted K nearest neighbors search on database images.

4. Proposed System

Convolutional neural network (CNN) is one of the main categories to do images recognition, images classifications, etc., If once the user opens the web application and upload the image.

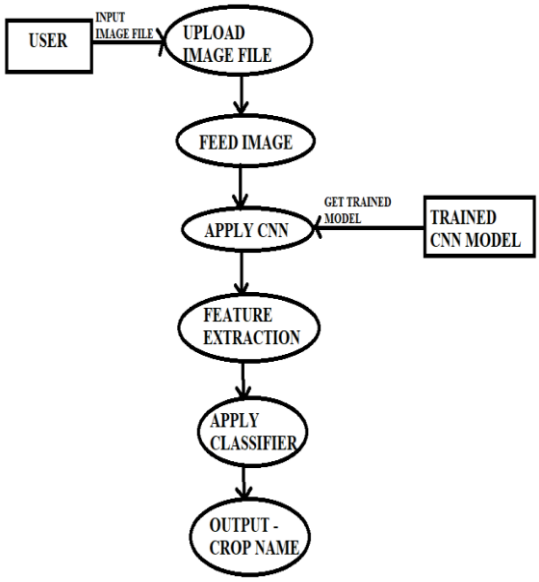

Fig. 1. Block diagram of proposed system

The CNN classifier process it and classify it under certain categories (Eg., Rice, Sugarcane, Maize, Wheat). Classifier sees an input image as an array of pixels and it depends on the image resolution. Based on the image resolution, it will see h x w x d (h = Height, w = Width, d = Dimension) array of the matrix of RGB and an image of 4 x 4 x 1 array of a matrix of the grayscale image. Each input image will pass through a series of convolution layers with filters (Kernals), Pooling, fully connected layers (FC) and apply Softmax function to classify an object with probabilistic values between 0 and 1. The above flowchart (fig. 1) is a complete flow of CNN to process an input image and classifies the objects based on values.

5. Module Description

A. Gathering Data

The most important component in crop identification is the dataset i.e. input images. The dataset should consist of images with various resolutions, light conditions, and climatic

conditions. To prevent our model being confused between old and dried leaves, the dataset should consist of old and dried crop images at different plant growth stages in order to achieve better accuracy. In this System, Agriculture Crop Images from the Kaggle dataset has been used as the primary resource of data. Real-world images that are captured through a camera are considered as Secondary resource. Fig. 2, 3, 4, 5 represents the sample images of dataset of crops like maize, rice, sugarcane and wheat which are used for training purpose.

Fig. 2. Sample Dataset images of Crop Maize

Fig. 3. Sample Dataset images of Crop Rice

Fig. 4. Sample Dataset images of Crop Sugarcane

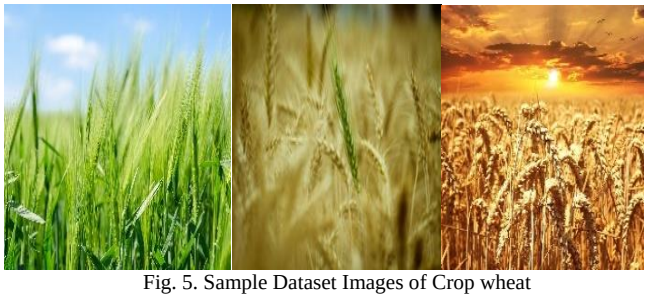

Fig. 5. Sample Dataset Images of Crop wheat

B. Building CNN

1) Convolution Operation

In ConvNet, the Classifier sees the input image as an array of pixels. Based on the image resolution, it will see image as h x w x d (h = Height, w = Width, d = Dimension) array of matrix of RGB. Convolution is a linear operation that involves the multiplication of a set of weights (i.e. multiplication of input matrix and filter matrix) then sums up the multiplication output and enters it into a resultant matrix, called Feature Map. Thus, the network learns filters that get activated when some specific type of feature is detected at some spatial position in the input. CNN learns the importance of filters during the training process. For different values of the filter matrix, a different feature map is produced for the same input image. We need to specify parameters for filters such as no of filters require and filter size.

2) ReLU

ReLU is an activation function used after every convolution step. The purpose of ReLU is to introduce non-linearity to CNN. It takes a value x and returns 0 if x is negative and x if x is positive. The resultant feature map will have no negative values. The output is $f(x) = \max(0, x)$.

3) Pooling

Pooling is to reduce the number of parameters and speed up the computation. Each feature map is operated by pooling layer independently. It retains the valuable information in the feature map for further process. Max Pooling is used here to take maximum values from the feature map. This layer helps to control the overfitting of the model.

4) Flattening

Flattening is deriving a 1-dimensional array using data received from the previous layer for inputting it to the next layer. The output of the convolutional layers is flattened into a single long feature vector. And it is connected to a fully-connected layer.

5) Fully Connected Layer

Fully connected layer is the last layer in the neural network. It uses softmax as the activation function to classify output. Because softmax activation function is preferred for multi class classification. For each node in the output layer there will be one output generated by the function. For each value in the node, the softmax value is the exponent of the individual node divided by a sum of the exponents of all the nodes. The output values will represent probabilities and the values sum to 1.0.

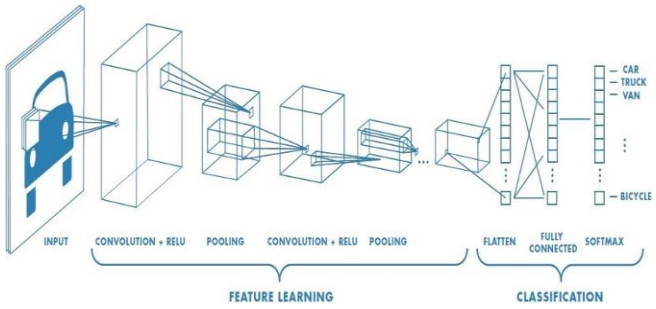

Fig. 6. Architecture of Convolutional Neural Network

C. Training and Testing

Training is set is used to train a network, where loss values are calculated by forward propagation and learnable parameters are updated through back-propagation. 80 – 20 Principle is used to train and test the model. 80% of images from the dataset are used to train the model and the rest of 20% from the dataset and real-world images are used for testing purposes. Testing is usually done at the end of the system in order to evaluate the models performance.

D. Development of User Interface for Web Application

After compiling model, convert the source code to .h5 file. Create a python file by loading the .h5 file using Flask framework. Flask framework is a micro web framework written in python. This can be used to create and share beautiful, custom web apps for machine learning and data science.

6. Evaluation Metrics

The accuracy achieved is 80%. The classifier should be in best fit to obtain better prediction result in test data. To evaluate the models performance training error (bias) and testing error (variance) are used in case of balanced dataset. Low Bias and High Variance indicates that the model is Overfitting. High Bias and High Variance indicates that the model Underfitting. Low Bias and Low variance indicates the Best Fit. Fig. 7 and Fig. 8 Shows the Loss and Accuracy obtained by the Classifier during training and testing.

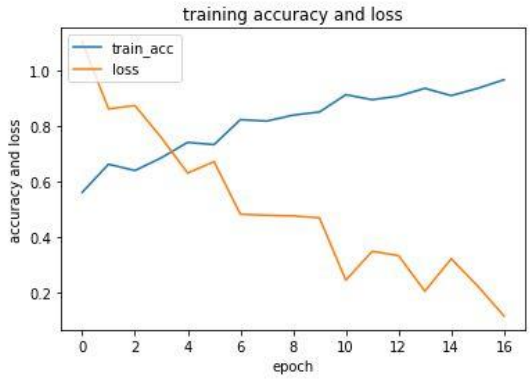

Fig. 7. The accuracy and loss obtained during the training process

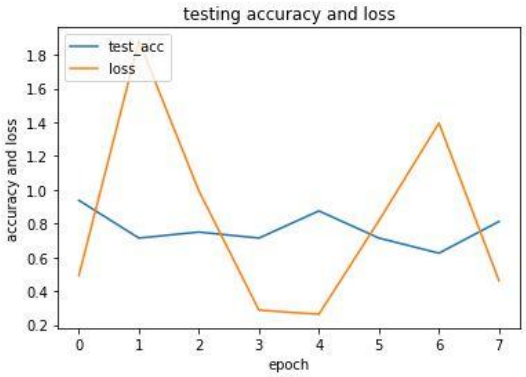

Fig. 8. The loss and accuracy obtained during the testing process

7. Result and Discussion

The proposed approach for crop identification considers the pixel of entire image including edges for learning purpose of model and accurate prediction of images. The images were taken from Kaggle, where it consists of nearly 160 labelled images for crops like Wheat, Sugarcane, Rice and Maize. Jupyter Notebook is a platform where classifier is trained by uploading images from local machine. We have compared the result of CNN with other classifiers like KNN. It is observed that CNN shows better results comparing the other one.

8. Conclusion

In this System, a deep learning convolutional neural network based on Keras and Tensorflow is deployed using python for image classification. The system works on the principle based on detecting a part of image and extracting CNN features from multiple convolutional layers. These features are aggregated and then given to the classifier for classification purpose. On basis of the results which has been produced, the system has provided the 80% accuracy in prediction of finding bird species.

9. Future Work

1. Implementing the system using Cloud to store large amount of image data i.e. Data Gathering which can be used to Train and Test the model.
2. Develop an android or ios application which is convenient for the user rather opening a website.

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