Identification of Plants using Deep learning: A Review

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Abstract

Identification of plants is a very important field in the earth's ecology to maintain a healthy atmosphere. Certain of these plants have significant medicinal properties. Nowadays of finding a plant is not easy by looking at its physical properties. This paper provides an academic database of literature between the duration of 2015–2020. It has been observed that the new generation of convolutionary neural networks (CNNs) in the space area of image recognition has produced remarkable performance. In this paper, techniques are discussed the concepts of Deep learning and different leaf recognition methods.

Keywords

Machine Learning, Artificial Intelligence, Fully Connected Neurons, Convolutional Neural Network, Deep Learning, Image Processing.

1. Introduction

Nowadays, Artificial Intelligence (AI) is the most important part of our lives, it is used in the field of Computer Vision, Robotics, Digital Marketing Transformation, Medical field, Banking, and business sectors. Artificial Intelligence (AI) has been mainly designed to make machines for thinking and acting like a human being and machine learning would be a sub-part of Artificial Intelligence (AI), as well as a theoretical algorithm analysis and a mathematical model that carries out a particular check without explicit programming, on the basis of the assumption and templates. Some basic forms of artificial learning strategies are Supervised learning, unsupervised learning, and reinforcement learning. The Supervised Learning Algorithms contain data, Unsupervised learning algorithm requires a collection of results; it only includes identification of the data format and unlabelled inputs.

Deep learning offers superior results even on big data. Deep learning, which is used in image identification and computer vision etc, utilizes artificial neurons identical to the neurons of man. Deep neural networks, recurrent neural networks, and deep belief networks are used to speak identification, language processing, translation software, audio recognition, bioinformatics, and drug development. Plants are indeed an important member of every natural life [1] as well as the formal naming of this will ensure that every natural life is preserved and maintained. Plants are essential for our medicinal purposes, as alternative sources of energy such as biofuels, and also used to fulfill our numerous domestic needs such as wood, clothes, food, and makeup. The present extinction trend is primarily the product of overt and indirect human activity. Creating correct identification information and plant geography propagation is key to the survival of ecosystems in the future.

Many countries worldwide are now designing programs to create channel control sys-

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tems for national agriculture [2]. India will have a long tradition of utilizing plants as a therapeutic source. This research is called ayurvedic [3]. Each plant on Earth has a certain medicinal value according to Ayurveda. This is viewed as a worldwide type of substitute to allopathic medicine. one of the big bonuses of this is that it has no adverse effects. Taxonomists systematically classify such medicinal plants, that are susceptible to Miscarriages in certain situations.

Image recognition strategies that have recently started to appear in an attempt to simplify that plant inspection process. With respect to a plant identification research, methods focused by color characteristics were often used to establish a plant recognition method. Color interpretation probably depends on color distributions in such an image, although it is not a safe function because here are certain situations where this feature's temporal accuracy is abused. The Shift of light, leaf movement through waves, camera jitter, changing of focus, sudden shifts of camera parameter contribute to incorrect plant category predictions. Giving numerous researches, the category of plants dependent on digital images is now seen as a difficult issue. Those researches were focused on the study of particular plant leaves for the identification and classification of plants [4]. In subsequent years, many studies were using them to develop a model for a plant leaf recognition system.

Gaber et al. used MCA to derive visual characteristics from plants [5] and linear discriminant analysis. Multiple researchers also have established the ability of broad convolution neural network (CNN) to outperform conventional object recognition or detection strategies centered upon ordinary working light, texture, and shape characteristics. Typically, the CNN systems are using in such big-scale plant recognizing activities consists of a trait extractor accompanied by a classifier. Despite of occlusions collecting plant crop does not usually a straightforward job. In a fact, certain plants cannot even have visible parts of the leaf. On the other side, several research relevant to utilizing machine vision approaches to address such issues were also performed. Aerial image recognition of landscapes that use machine learning techniques is an illustration of computer recognition technologies of agricultural computing.

In Section 2, we did a literature review of various research papers related to plants detection using deep learning and shown a table (Table 1.) of the previous pattern method. In Section 3, we discussed the identification methodology. In Section 4, we discussed in detail about the architecture of CNN. In Section 5, we discussed the process of leaf identification very preciously. At last in Section 6, we gave the conclusion about our paper and discussed future work.

2. Literature Review

The literature on Deep learning is very wide. The work done by various researchers in the field of plant identification using Deep learning is described in this section. Sapna Sharma. (2015) used principal component analysis (PCA), Hu's moment invariant method, and morphological features for classification and they have used sixteen different classes of the leaf. This Matlab measures the circumference by measuring the gap in each connected number of pixels along the area's boundary [1]. T. Gaber. (2015) suggested a plant recommender method that uses 2D visual photographs of plants. This program used the methodology of attribute fusion and the process of multilabel classification. The experimental findings revealed that the function fusion method's accuracy was much higher than other individual applications. The tests showed their robustness in providing accurate recommendations [2]. T. J. Jassmann. (2015) designed a new

CNN they tested the usage of the newly implemented Exponential Linear Unit (ELU) rather than Rectified Linear Unit (ReLU) as CNN's non-linearity method [3].

Hulya Yalcin (2016) suggested an architecture of the CNN to identify the form of plants from the picture sequences obtained from smart agro-stations. the design is used as a preprocessing stage to remove the picture properties. Configuration of the CNN design and breadth are important points that should be highlighted because they impact the recognizing capabilities of neural network architecture. They used 16 kinds of plants and compared them with other approaches; preliminary findings show that the CNN centered approach's classification performance outranks other approaches.[4]

Amala Sabu (2017) depicts that Universal Leaf Identification is a difficult Computer Vision issue. Efficient leaf recovery method for Ayurvedic plant beneficial for other aspects of society including Medicine, studies in Botany. Recognize the photographs of the leaf. The study of the Different approaches and classifications for leaf identification [5]. Lee, S.H., (2017) gathered one of the pictures of plant leaves has also been discussed based upon the leaf characteristics use as an input and convolution neural network is being used to identify patterns for each plant depth information. CNN was mainly utilized here just for the improved portrayal of the characteristics and for effective studies of Leaf organisms DN (Deconvolutional Network) used. It enables greater recognition of plant leaves and their populations [6]. Ghazi, M.M., (2017) implemented three models of transfer learning to describe the identity of the various plants. The Network was evaluated using LIFECLEF 2015. These three-model used GoogleNet, VGGNet, and AlexNet for their suggestion here [7].

Barbedo, J.G. (2018) discussed the analysis of the key factors influencing the architecture and efficacy of deep neural networks applied to plant pathology and the in-depth study of the topic, which illustrates the benefits and disadvantages, will contribute to more concrete findings on plant pathology [8]. Barbedo, J.G.A., (2018) explored the implementation of issues in transfer learning and the use of deep learning. They found that CNN is a method used to classify plant biotechnology issues [9]. Zhu, X., (2018) uses CNN (Complex Background) to recognize the small objected plant leaves. The designed methodology implemented sample-normalization founding V2 which enhances the accuracy of Region CNN. For processing, the quality photos sub-samples are split into a hundred and the residual images are returned to final production. The approach suggested that it could be faster than conventional region convolutional neural network [10]. Garcia-Garcia (2018) A writer of this paper used deep learning techniques to focus on high occupancy classification. They presented short information on the topics of deep learning. Which offers the required relevant information on deep learning for the mission ahead [11].

Kaya, A., Keceli. (2019) suggested the concept of Transfer Learning for Plants Classification focused on Deep Learning. This paper indicates the impact of four separate transference training models on plant classification deals dependent on DNN for four available databases. Finally, their theoretical research reveals that Transfer Learning offers a basis of plant classification self-estimating and analysing. They use certain common formats including End-to- End, Fine modulation, Fine modulation Cross Dataset, Deep Integrated Finetuning, Classification by RNN-CNN [12].

Table 1
Previous pattern recognition methods

Author	Technique used	Dataset Size	Results
Sapna Sharma, Dr. Chitvan Gupta (2015) [1]	GLCM (grey level co-occurrence matrices: GLCM is a histogram at a given offset over an image with co-occurring greyscale values.) and Principal component analysis (PCA): the method measuring the principal component and to perform on the data basis of change, Super Vector Machine (SVM): uses for classification problem methods.	16 different classes of the leaf.	Review
T. Gaber (2015) [2]	Bagging classifier,2D based technique	using Flavia a dataset which 1907 colored images.	Accuracy: 95%
T. J. Jassmann (2015) [3]	Rectified Linear Unit (ReLU): is an activation functions and ReLu is the most used activation function in the neural network, moreover in the CNNs.	Flavia dataset contains leaves of 32 plants.	Accuracy: 60%
Hulya Yalcin (2016) [4]	Convolutional Neural Network (CNN) model.	16 plant species.	Accuracy: 97.47%
Amala Sabu (2017) [5]	K-Nearest Neighbor (KNN).	Review	Review
Lee, S.H (2017) [6]	CNN	Using 113,205 images	Accuracy: 96.3%
Ghazi, M.M (2017) [7]	Transfer Learning using AlexNet GoogLeNet and VGGN: VGGN is an object-oriented Model and supports 19 layers and VGGN is still the most popular used architecture for image recognition.	using 91,758 images.	Accuracy: 80.18%
Barbedo, J.G (2018) [8]	Using deep learning concepts	almost 50,000 images use from plantvillage dataset.	Accuracy: 81%
Barbedo, J.G.A (2018) [9]	CNN	Containing 12 different plants and 1383 images were used.	Accuracy: 84%
Zhu, X (2018) [10]	RCNN	For each species, 180 images are taken, of which 150 are taken for	Accuracy:99%
Garcia-Garcia (2018) [11]	semantic segmentation using deep learning techniques.	In this paper they use 2D and 3D datasets.	Review
Kaya, A., Keceli (2019) [12]	Transfer learning method use on deep learning.	Using total number of 54,306 images.	Accuracy: 98.70%
Noon, S.K., Amjad, M., Qureshi, M.A., Mannan, A(2020)[13]	deep learning-based	Review	Review

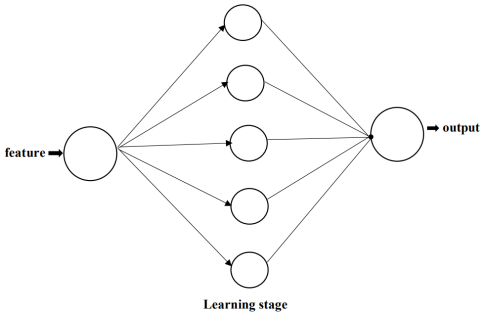

Figure 1: The architecture of our model (CNN)

3. Identification Methodology

For detecting the plans from the images of the leaf, we have discussed various strategies on the CNN model utilizing various leaf dataset to show the characteristics of the visualization approaches for CNNs. CNNs are neural feed forward networks that are fully connected. CNNs are exceptionally effective in decreasing the number of parameters without compromising layout efficiency. Images have a large size (as each pixel is regarded as a feature) that corresponds to the CNNs. it has been developed to take account of images, but milestones were still reached in text processing also. The edges of artifacts in each picture are guided by CNNs.

3.1. Architecture of CNN

Deep Belief Network is used in various methods of Language processing, Computer Vision, Speech Reorganization, and many other applications. Deep Neural Network has a three-layers Input, Hidden, and Output. The Deep Neural Network [6] processes in multiple NN. Fig.1 illustrates how the Neural Network nodes and layers are connected and share information.

3.1.1. CNN

CNN [7] is the part of deep neural network class. This is mostly used in Computer Vision to identify the given structure of the object being subjected. CNN 's primary objective is to identify and forecast the sequence of the given input datasets. It delivers enhanced performance and accuracy.

3.1.2. Layers In CNN

CNN is a controlled methodology in deep learning, and has developed a ground breaking influence on numerous applications focused on machine vision and images. The fields of which CNN is commonly employed include facial recognition, target identification, analysis of videos, etc. CNN platform components involve convection layers, pooling layers, completely linked layers, activation functions, etc.

- `Convolution Layer:` For more processing the layer provides an RGB picture or an output of another layer as data. The obtained information is referred to as image pixels to produce a function map reflecting characteristics of low levels, such as edges and curves. Special characteristics at the higher level can be defined via a sequence of further convolution levels.

- `Activation Layer:` Nonlinearity makes a network of neurons deeper. A Nonlinear activation layer shall be added directly after each layer Convolution stratum. Specific nonlinear mechanisms are used for Add non linearity. They are:

  Tanh: The range between [-1,1] takes the real-valued number of this non-linearity.

  Sigmoid: The range between [0,1] takes the real-valued number of this non-linearity.

Rectified Linear Unit: It improves the model's nonlinear property by altering the convolution layer's receptive field by altering all the lower values to 0.

- `Pooling Layer:` After the activation layer a downsampling layer was added to raising the spatial aspect without any alteration in size. Typically, a size 2x2 input filter is applied to produce an output based on the pooling process. It may be expressed either by peak pooling or by average pooling where the limit or average value is calculated for each sub-region used in the filter. There pooling is no restrictions.

  Then the pooling layer decreases the scale of the characteristic map, i.e., the width and length are limited but the distance is not. It Decreases the number of Weights and Parameters, lowers the preparation period, and thus eliminates the computational expenses. It also requires overfitting controls.

- `Fully Connected Layer:` This layer defines characteristics that are at a very large quality correlates to class or object. Entering a fully connected field layer is a collection of features for picture recognition without requiring to taking into consideration the spatial context of the pictures. Fully connected layer output is often a 1D vector achieved by compressing the final pooling layer output. This is a method of organizing 3D volume in a 1D vector.

4. Process of Leaf Identification

Plants take a significant role in both human and other life on earth. Recognition of the leaf design implements normally the phases

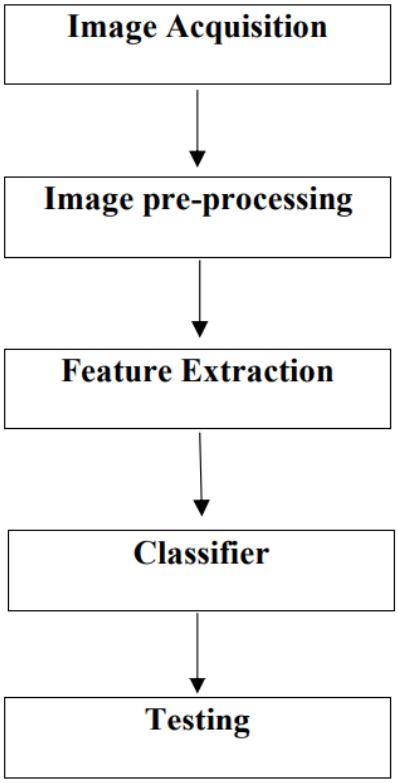

Figure 2: Step of leaf Identification Process

as seen in Figure 2. The demanding one that is part of the research is to determine leaf distinguishing features for the identification of plant organisms. In this situation, a separate classifier with high-performance statistical methods has been used to conduct leaf classification and function extraction of the functionality. The improvement in image analysis and CNN significantly aided researchers in the classification of plants by data analysis.

This is a basic image-based plant recognition process is shown in fig.2 and some define some general stages.

4.1. Image Acquisition

Image acquisition is the process of collecting datasets for identification leaves. Infected leaf photographs of collected in managed settings and are processed in JPEG format. Against a white backdrop, the contaminated leaf is put smooth, the light source was mounted on either side of leaves at a temperature of 45 degrees to remove each reflection and provide even light wherever thereby increasing illumination and clarity. This crop is zoomed such that the photograph captured includes just the crop and white backdrop

4.2. Image Pre-processing

Image pre-processing procedures are essentially used to expose information that is hidden or basically to show any features in such an image. Such methods are largely contextual and are structured to alter a picture and taking advantages of the psycho-cultural dimensions of the human sensory system. Equalization of the histograms and electronic filtration methods were used.

4.2.1. Histogram equalization:

it's some of those strategies for improving images. A certain approach allocates image intensities. Among this process, the contrast between the fields rises through local contrast to greater intensity. The equalization of histograms is used to enhance computational complexity, clarity, and image consistency.

4.2.2. Grayscale conversion:

Gray scale conversion is used for converting images into grayscale. The grayscaled conversion used the method of contrast feature and intensity enhancement techniques for converting the images and then placed them as pieces together for further processing.

4.2.3. Binary conversion:

Create binary images on a gray image scale to use the threshold method. The Binary picture is a visual image that contains just two potential meanings for each pixel. The two shades that a contrasting picture uses are typically white and black.

4.2.4. Noise Removal:

Digital photographs are susceptible to a plethora of Noise levels. Noise emerges from errors in the virtual method of image acquisition which results in pixels values They can be used to eliminate linear filtering those values noise Styles. Few filters are ideal for this purpose, such as Gaussian filters or low pass filters, averaging. An ordinary filter, for example, is useful for having grain noise off the picture. A median filter and averaging filter are used for salt and paper noise removal from an image.

4.3. Feature extraction

mainly the characteristics of leaf color and form. The Specific plant leaf is generally identical in color and form are considered for classification and so a specific function alone cannot achieve anticipated results.

4.3.1. Color features

Dr. H.B. Kekre et al.'s suggested the approach of scanning and retrieving photographs primarily focused on the production of the color function vector by measuring the mean. This three-color Red, Green and Blue are first divided in the suggested algorithm. Then means and column mean of colors are determined for every plane side. For each plane the sum of all means of the row and all means of the columns are determined. The characteristics of all 3 planes converge to create a matrix of features. Until the function vectors for an im-

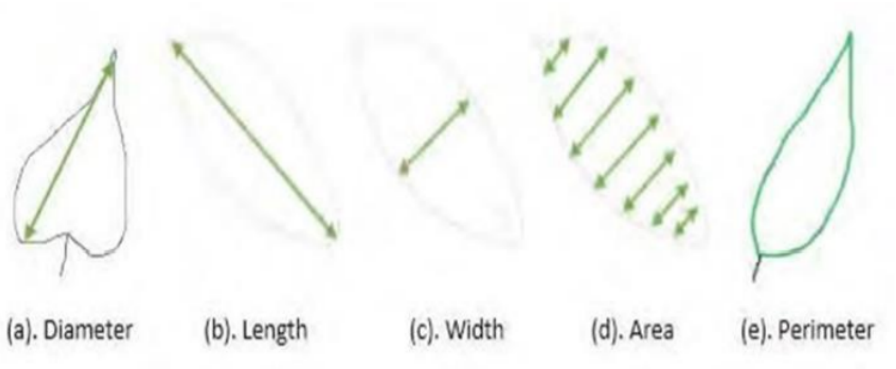

Figure 3: The basic geometric features

age is created, they are contained in a database of features.

4.3.2. Shape features

Based on the of Geometric features, we defined shape features:

a. Geometric features: We used the similar 5 geometric features (DMFs), define in fig. 3, derived from the following 5 basic features:

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1. `Diameter:` between any two points the diameter of the leaf is the longest distance on the closed contour of the leaf.
2. `Physiological Length`: It's the length of the line which connects the two main vein terminals points in the vine.
3. `Physiological Width`: This corresponds to the interval perpendicular to the physiological longitude between the two endpoints of the longest line section.
4. `Leaf Area`: This is the amount of binary representation 1 pixels on the smooth image of the vine.
5. `Leaf Perimeter`: the count of pixels in the leaf's closed contour.

4.4. Classification

Common statistical identification is the method of defining based on the previous information such as a training dataset a group of groups, or classes to which a new phenomenon belongs. More precisely, classification in this work is the method used to attribute a picture to a certain plant genus, based on its collection of features. It is a subclass of more general statistics and deep learning identification problems, including supervised learning.

4.5. Testing

Of this phase, we test the model by giving testing data to the model. Then check how is it identifying the object and also, we get the accuracy.

4.6. Convolution Neural Network Process

CNN is one of the types of neural networks which are widely used in computer vision area. Its name stems from the form of secret layers it consists of. Usually a CNN's concealed layers comprise of convolutionary lay-

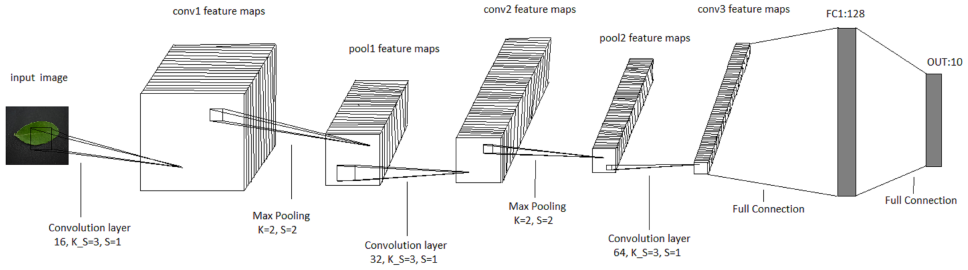

Figure 4: The architecture of our model (CNN)

Table 2
For identification, Some Layer is used for our model

Layer	No of filters	Filter size	Stride Value
1st	16	2*2	1
2nd	16	2*2	1
3rd	32	2*2	1
4th	32	2*2	1
5th	64	2*2	1
7th	64	2*2	1

ers, pooling layers, completely linked layers, and layers of normalization. Here it simply means that convolution and pooling functions are used as activation functions.

4.6.1. Dropout

A Dropout feature is employed in many CNN works. That can result from the problem of overfitting in our model. By randomly removing those connections that exist between the nodes.

Fig 4 this architecture is our work. On the very last layer, the dense function is used.

2

4.6.2. Pooling

Pooling is a discretization method dependent on the samples. The aim is to down-sample an input data (image, hidden-layer output matrix, etc.), decreasing its dimensionality and making conclusions about features found in discarded sub-regions. There are 2 major forms of pooling generally recognized as pooling with max and min. Like the name indicates, max pooling is focused on taking up the highest value from the selected area, and min pooling is based on picking up the selected region's minimal value.

5. Conclusion and Future Work

CNN performs so much more on pictures and videos than traditional neural networks, since the convolutionary layers take advantage of the image's intrinsic properties. Simple neural feedforward networks see little structure in their inputs. When you combined all the im-

ages in the same way, the neural network will have the same success when trained on photos that are not shuffled. But on the other side, it optimizes local spatial picture coherence. This ensures they will significantly decrease the number of operations needed to process an image by utilizing convolution on adjacent pixel patches as adjacent pixels are meaningful together. We name it central connectivity too. The Map is then loaded with the product of a small patch of pixels converting, slid over the entire picture with a window. There are many methods in the detection and classification process of automated or computer vision for plant identification but there is still a lack of research in this field. Moreover, there are currently no consumer options on the market, even those that deal with the identification of plant organisms dependent on photographs of the leaves. It has been concluded that a different approach using deep learning techniques are used to automatically identify and recognize plants from the photographs of the leaf. The model established was able to sense the existence of a leaf and distinguish between healthy leaves.

In the future research would be to raise the size of the dataset by raising the samples and by adding different classes of the plants leaf.

After doing the literature review of various papers, we conclude that CNN is the best approach for detecting the plants and leaves with very good accuracy.

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