Deep Learning for Plant Species Classification

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ABSTRACT
Plants are amid the earth's helpful and attractive products of environment. A plant has been vital to mankind's endurance. The urgent require is the more plant was at the risk of extermination. An Ayurveda medicines can be prepared by using the plant leaves and this plant class belong to the endanger group. So it is crucial to set up the database for plant defense. Plant leaf detection has been challenge for several researchers. In this paper, introduced on the survey of various classification methods is used for the plant leaves classification. In this paper CNN is used to classify plant from its leaves. A combination of texture and color features are extracted and then fed to modified CNN classifier. The system was attained an accuracy more than 94.26% with the help of tensor flow framework. The model automatically classifies 17 different plant species.

Keywords
Tropical tree, profound learning, Convolutional Network, leaf vein morphometric, highlight extraction, characterization

1. INTRODUCTION
For botanists and layman automated plant species identification system could help in identifying plant species quickly. Deep learning is widely used for feature extraction as it is superior in providing deeper information of images[1].

Image based strategies are viewed as a promising methodology for animal types distinguishing proof. A client can snap a photo of a plant in the field with the work in camera of a cell phone and break down it with an introduced acknowledgment application to distinguish the species or possibly to get a rundown of potential animal categories if a solitary match is outlandish. By utilizing a PC helped plant recognizable proof framework additionally non-experts can participate in this procedure. A picture characterization procedure can for the most part be separated into the means in Figure 1.Image acquisition: The reason for this progression is to get the picture of an entire plant or its organs with the goal that investigation towards grouping can be performed.

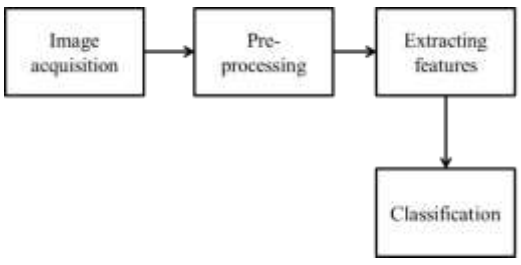


Fig. 1.Generic steps of an image classification process.

The point of picture preprocessing is improving picture information with the goal that undesired contortions are stifled and picture includes that are applicable for additional preparing are underlined. The preprocessing sub-process gets a picture as info and creates a changed picture as yield, appropriate for the subsequent stage, the element extraction. Preprocessing commonly incorporates tasks like picture denoising, picture content upgrade, and division. These can be applied in equal or separately, and they might be played out a few times until the nature of the picture is good. Highlight extraction and portrayal: Feature extraction alludes to taking estimations, geometric or something else, of potentially divided, important districts in the picture. Highlights are portrayed by a lot of numbers that describe some property of the plant or the plant's organs caught in the pictures (otherwise known as descriptors). Arrangement: In the order step, all extricated highlights are connected into a component vector, which is then being characterized.

Globally, it has been found that there are more than 1.7 million species of living organisms (human beings, plants and algae) on Earth, out of which, plants species plays a vital role in human life. Plants are exist everywhere and an essential resource for human well-being. Most of the plants carry significant information for the development of human society and are considered as essential resource for human well-being. Plants are of plenty of use as they form the base for food chain and a lot of medicines are derived from plants. Plants are also vitally important for environmental protection. Even after several innovative advancements made in the field of botany, there are still a huge number of plants that are yet to be discovered, identified and used. It is a well-known fact that unknown plants are wealth waiting to be found. Today's ethno-botanists are combining regions of the world, looking for future agricultural products and medicines. The functional characteristics and the association of plants within ecosystems are explored by them in order to understand the need for diversity to manage the plant resources. Scientists of 21st century are exploring how genetic diversity and ecological sensitivity are necessary in solving problems such as feeding the population and fighting disease. Two main aspects of plant taxonomy that play a vital role in these endeavors are the identification and classification of plants.

- **Plant Identification** is the determination of the identity of an unknown plant in comparison with previously collected specimen. The process of recognition connects the specimen with a botanical name. Once this connection is established, related details like name and other properties of the plant can be easily obtained.
- **Plant Classification** is the placing of known plants into groups or categories to show some relationship. They use features that can be used to group plants into a known hierarchy. This research focuses on the automation of plant identification through leaf recognition. Apart from using the whole plant, the automation of plant identification can be performed using various parts of a plant anatomy like stem, flower, petal, seed and leaf.

This study uses the leaf part of the plant to identify a plant. The continued interest in biodiversity along with the ease of creating digital

images, increased the need for processing power of computers and economical methods. Inorder to gather the information, plant identification using computers has become an interesting subject of research. Global shortage of expert taxonomists has further increased the demand for automated tools that would allow non-botanical persons to carry out valuable field work of identifying and characterizing plants. These tools are of importance in several fields including agriculture, forestry and pharmacological science. The first step during the design and development of such tools starts with leaf recognition. Compared with other methods, such as cell and molecule biology methods, identification of plants based on leaf image is the most successful and proven method . Sampling leaves and obtaining a photograph of them is convenient and viable, due to the availability of low cost digital cameras.

Currently, plant identification through leaf recognition involves finding information about a plant that most matches the species name (key) that has to be known in advance. Though identifying plants using such key is a time consuming task, correct utilization of key plays a direct role in the success of the plant search. The alternative method of allowing users to provide a leaf image is very convenient, user friendly and eliminates the need for key. The task combines the challenges of different fields like image processing, machine learning and pattern recognition. Identifying the most favorable algorithms and techniques from these fields, for plant identification through leaf recognition, is the main focus of this study. With the advancement of science and technology, machine learning has been widely employed for classification and recognition tasks in many domains especially in the biological fields. Machine learning techniques, such as, the Artificial Neural Network, Support Vector Machines, k-Nearest Neighbor, and others are artificial intelligent techniques mainly employed to perform pattern recognition.

Currently, deep learning, a subfield of artificial intelligence (AI), is a popular and widely used technique, that has been applied in various domains including biology, medical, computer vision, speech recognition and others [2-5]. Deep learning is a modern AI approach, which contributes a robust framework towards supervised learning [6]. It is able to map an input vector rapidly and efficiently to an output vector even in a large dataset [6]. Deep learning architecture can be further divided into Convolutional Neural Network (CNN), Deep Belief Network (DBN) and so on. Deep learning is able to extract more detailed information as compared to the conventional machine learning techniques.

1.1 NEED FOR AUTOMATED PLANT IDENTIFICATION

Plant identification is an important task because of concerns about climate change and the resultant changes in geographic distribution along with abundance of species.

Development of new crops often depends on the incorporation of genes from wild relatives of existing crops and hence it is important to keep track of the distribution of all plant taxonomy. Automated identification using leaf images of plant species is a worthwhile goal because of the current combination of rapidly dwindling biodiversity and the shortage of suitably qualified taxonomists. This is particularly important in geographic locations,

- that currently have a huge number of species and
- Those with the huge number of species restricted to that geographic area.

The species to which an organism belongs is often regarded as its most significant taxonomic rank. Identification of a plant to its class allows access to historical or existing knowledge and the mapping of a plant to a class currently depends on a specific name. As a variety of hybrids exists, an automatic method that depends on plant features instead of its name is very much favored.

In addition, with the deterioration of environments, even though many of the rare plant species are already dead, still many more of the rare plant species are at the margin of extinction. So, the investigation of plant recognition can contribute to environmental protection. The plant world is in constant flux, due to human and other factors, the possibility of extinction for many plants can be envisaged. Just as importantly, the need to understand ecological systems which preserve biodiversity is also realized. Today's scientists are exploring how genetic diversity and ecological sensitivity are necessary in solving such problems as feeding the population and fighting human diseases. The recognition of plant leaves is a vital process
in botany and in tea, cotton and other industries and is also used during early diagnosis of plant detects like diseases. Thus, automatic plant classification is vital to these endeavors and is considered by this research work.

1.2 CHALLENGES OF AUTOMATIC PLANT RECOGNITION

The design and development of automatic recognition and identification systems for plants is important and has numerous usage. This field is considered as a challenging field, which motivates more and more researches to be conducted worldwide. A number of systems that aim to recognize plant species from the shapes of their leaves have been developed. The main challenge of automatic leaf recognition using leaf images is to develop computational methods which learn to distinguish among a number of classes from examples. This ability is instrumental in building the next-generation artificial systems, which can cope up with novel situations and aims to achieve general goals as opposed to specific and which integrate capabilities normally associated with people. The following are some of the issues that are faced by the existing plant identification systems.

- **Image quality:** Quality of the leaf image captured plays a very important role in the accuracy of plant identification. In general, the quality of leaf images is affected by three factors, namely, contrast, blur and noise. The presence of these degradation factors has a direct impact on the performance of the automation process.
- **Leaf variation**: In general scenario, a leaf image can take a great number of biological variations. These variations produce more than one representation of the same leaf. An example of variation of leaves for a single specimen of *Quercusnigra*is shown in Figure

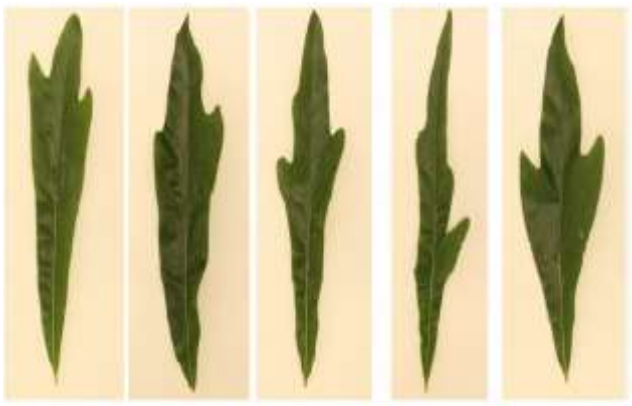


Fig2 : Example of Leaf Variation

The analysis and identification process has to handle this scenario carefully. Accurate and efficient feature extraction techniques that best distinguish these similar leaves are required for successful design of automated system. Further, the availability of huge number of leaf features and selecting a subset that best enhances the process of identification is challenging.

•**Lack of standard leaf datasets**: The design and implementation of a consistent automatic plant species identification system from leaf images requires a representative database that can be used by the machine learning algorithms to identify plants accurately. There is a lack of standard leaf image database that can be used for plant classification and therefore, the database is normally constructed by the researchers. Assembling such a database is time consuming and complex.

The demand for automated systems has led to the development of several techniques which have revolutionized the area of automatic plant classification. This increase in the number of techniques has given rise to the dilemma of deciding which of these methods possesses the best properties and potentials for effective recognition. This problem is mostly occurred in the botany field where the distortion of information may lead to inaccurate diagnosis

2. LITERATURE SURVEY

Jing Wei Tan and Siow-Wee Chang[1] In this research, CNN is applied to extract the features from leaf images of selected tree species. Three different CNN models were used, namely, the pre-trained AlexNet CNN model, fine-tuned pre-trained AlexNet CNN model and the proposed D-Leaf CNN model. The extracted features were then fed into a few classification approaches for learning and training purposes. Five classifiers were employed in this research which are CNN, Support Vector Machine (SVM), Artificial Neural Network (ANN), k-Nearest Neighbour (k-NN) and Naïve Bayes (NB). A conventional method, which segmented the leaf veins by using Sobel edge detection technique and performed vein morphological measurements, was used for benchmarking. Based on the literature review, this is one of the first few studies, which have applied CNN in tropical tree species classification, by using both leaf morphometric and venation pattern approaches.

Pankaja K and Dr. Thippeswamy G[7]There are endless plant species accessible all inclusive. To oversee gigantic substance, improvement of quick and successful classification techniques has transformed into a domain of dynamic exploration. As trees and plants are critical to environment, precise Identification and grouping gets important. Order strategy is helped out through number of sub techniques. A recognizable proof or Classification issue is overseen by planning an info information with one of the one of a kind classes. In this technique, from the start, database of a leaf pictures is made, that involves pictures of test leaf with their equal plant data. Fundamental highlights are removed utilizing picture preparing methods. The highlights must be steady so as to make the recognizable proof framework powerful. Consequently the plant/leaf is perceived utilizing AI procedures. In this paper a review is introduced on the different kinds of leaf distinguishing proof procedure.

Thi Thanh-Nhan Nguyen et al [8] a mix of profound learning and hand-planned element for plant distinguishing proof dependent on leaf and blossom pictures. The commitments of this paper are two-overlay. In the first place, for every organ picture, we have played out a near assessment of profound learning and hand-structured element for plant distinguishing proof. Two methodologies for profound learning and hand-structured component that are convolutional neuron arrange (CNN) and bit descriptor (KDES) are picked in our trials. Second, in view of the consequences of the main commitment, we propose a technique for plant ID by late combining the distinguishing proof aftereffects of leaf and blossom. Trial results on ImageClef 2015 dataset show that hand planned element beats profound learning for all around compelled cases (leaf caught on basic foundation). Notwithstanding, profound learning shows its power in characteristic circumstances. Additionally, the mix of leaf and bloom pictures improves essentially the distinguishing proof when looking at leaf-based plant recognizable proof.

Hulya Yalcin, Salar Razavi [9] Use of the benefits of present day enlisting advancement to improve the capability of plant fields is inevitable with creating stresses over extending world masses and limited food resources. Preparing advancement is imperative not solely to endeavors related to food creation yet moreover to hearty individuals and other related authorities. It isn't unexpected to extend the gainfulness, add to an unrivaled appreciation of the association between common segments and strong harvests, reduce the work costs for farmers and addition the movement speed and accuracy. Realizing AI methodologies, for instance, significant neural frameworks on cultivating data has expanded monster thought starting late. One of the most huge issues is customized course of action of plant species considering their sorts. Customized plant type ID procedure could offer an extraordinary help for utilization of pesticides, arrangement what's more, gathering of different species on-schedule in order to improve the creation strategies of food and medicine organizations. In this paper, we propose a Convolutional Neural Network (CNN) structure to arrange the sort of plants from the image groupings accumulated from splendid agro-stations. First challenges introduced by lighting up changes and deblurring are cleared out with some preprocessing steps. Following the preprocessing step, Convolutional Neural Network building is used to isolate the features of pictures. The improvement of the CNN designing and the significance of CNN are vital core interests that should be underscored since they impact the affirmation capacity of the structure of neural frameworks. In order to survey the introduction of the system proposed in this paper, the results traversed CNN model are differentiated and those got by using SVM classifier with different pieces, similarly as feature descriptors, for instance, LBP and GIST. The introduction of the philosophy is taken a stab at dataset assembled through an organization maintained endeavor, TARBIL, for which more than 1200 agro-stations are gotten all through Turkey. The exploratory results on TARBIL dataset allow that the proposed system is truly suitable.

SURBHI GUPTA and et al [10] Plant species recognizable proof spotlights on the modified ID of plants. But a lot of points like leaf, owers, natural items, seeds could add to the decision, anyway leaf features are the most huge. As a plant leaf is for each situation continuously accessible when stood out from various bits of the plants, it is clear to peruse it for plant recognizable proof. The current paper introduced a novel plant creature bunches classifier considering the extraction of morphological features using a Multilayer Perceptron with Ad boosting. The proposed framework includes pre-getting ready, feature extraction, incorporate decision, and characterization. From the

start, some pre-getting ready methodologies are used to set up a leaf picture for the segment extraction process. Distinctive morphological features, i.e., centroid, noteworthy turn length, minor center length, strength, outskirt, and heading are isolated from the propelled pictures of various orders of leaves. Unmistakable classifiers, i.e., k- NN, Decision Tree and Multilayer perceptron are used to test the precision of the count. Ada Boost approach is examined for improving the precision pace of the proposed structure. Test outcomes are procured on an open dataset (FLAVIA) downloaded from http://avia.sourceforge.net/. A precision pace of 95.42% has been cultivated using the proposed AI classifier, which beat the state-of the craftsmanship counts.

Sigit Adinugroho, Yuita Arum Sari [5] Plant species identification focuses on the programmed identification of plants. Albeit a great deal of angles like leaf, owers, organic products, seeds could add to the choice, however leaf highlights are the most significant. As a plant leaf is in every case progressively available when contrasted with different pieces of the plants, it is clear to read it for plant identification. The current paper presented a novel plant animal groups classifier in light of the extraction of morphological highlights utilizing a Multilayer Perceptron with Adaboosting. The proposed system involves pre-preparing, highlight extraction, include choice, and classification. At first, some pre-preparing strategies are utilized to set up a leaf picture for the component extraction process. Different morphological highlights, i.e., centroid, significant pivot length, minor hub length, robustness, border, and direction are separated from the advanced pictures of different classifications of leaves. Distinctive classiers, i.e., k-NN, Decision Tree and Multilayer perceptron are utilized to test the exactness of the

Sigit Adinugroho, Yuita Arum Sari [11] Plant species identification focuses on the programmed identification of plants. Albeit a great deal of angles like leaf, owers, organic products, seeds could add to the choice, however leaf highlights are the most significant. As a plant leaf is in every case progressively available when contrasted with different pieces of the plants, it is clear to read it for plant identification. The current paper presented a novel plant animal groups classifier in light of the extraction of morphological highlights utilizing a Multilayer Perceptron with Adaboosting. The proposed system involves pre-preparing, highlight extraction, include choice, and classification. At first, some pre-preparing strategies are utilized to set up a leaf picture for the component extraction process. Different morphological highlights, i.e., centroid, significant pivot length, minor hub length, robustness, border, and direction are separated from the advanced pictures of different classifications of leaves. Distinctive classiers, i.e., k-NN, Decision Tree and Multilayer perceptron are utilized to test the exactness of the calculation. AdaBoost approach is investigated for improving the exactness pace of the proposed framework. Test results are acquired on an open dataset (FLAVIA) downloaded from http://avia.sourceforge.net/. An accuracy pace of 95.42% has been accomplished utilizing the proposed AI classifier, which beat the state-of the craftsmanship calculations.

Esraa Elhariri & et al [12] An arrangement approach based on Random Forests (RF) and Linear Discriminant Analysis (LDA) calculations for arranging the various kinds of plants. The proposed approach comprises of three stages that are pre-preparing, include extraction, and order stages. Since most kinds of plants have novel leaves, so the order approach introduced in this examination relies upon plants leave. Leaves are not the same as each other by qualities, for example, the shape, shading, surface and the edge. The utilized dataset for this investigations is a database of various plant species with all out of just 340 leaf pictures, was downloaded from UCI-Machine Learning Repository. It was utilized for both preparing and testing datasets with lO-crease cross-approval. Exploratory outcomes indicated that LDA accomplished order precision of (92.65 %) against the RF that accomplished precision of (88.82 %) with mix of shape, first request surface, Gray Level Co-event Matrix (GLCM), HSV shading minutes, and vein highlights.

Table 1 surveyed papers

year	Author	Paper name	Algorithm	Dataset	Accuracy	Advantages
2018	Jing Wei Tan and Siow-Wee Chang, et al[1]	Deep Learning for Plant Species Classification using Leaf Vein Morphometric	CNN	D-Leaf_Dataset	93.23%	The ANN classifier together with the CNN feature extractor obtained the most optimal result as compared to other classifiers.

2016	Hulya et al [9]	Plant Classification using Convolutional Neural Networks	CNN	TARBIL Agro-informatics Research Center	97.47%	Classification accuracy of CNN based approach outperforms other methods.
2019	Munish Kumar et al [10]	Plant Species Recognition Using Morphological Features and Adaptive Boosting Methodology	Adaboost MLP	(FLAVIA)	95.40%	Maximum precision rate is 95.42% for 32 kinds of plant leaves. the proposed system performed better for plant leaf recognition in agricultural research.
2018	Sigit et al [11]	Leaves Classification Using Neural Network Based on Ensemble Features	GLCM and FFNN	Swedish leaf dataset	95.54%	Feature selection is Reduce by 25.8%. Method has the accuracy of 95.54% by using 14 hidden nodes.
2014	Esraa et al [12]	Plant Classification System based on Leaf Features	Random Forests and Linear Discriminant Analysis	UCI- Machine Learning Repository	92.65% (LDA) & 88.82 % (RF)	LDA achieved accuracy better than RF.
2017	Hedjazi et al [13]	On Identifying Leaves: A Comparison of CNN with Classical ML Methods	CNN	ImageCLEF2013 Plant Identification		CNN model has outperformed traditional machine learning methods on a widely available dataset, i.e., ImageClef2013 Plant Identification.

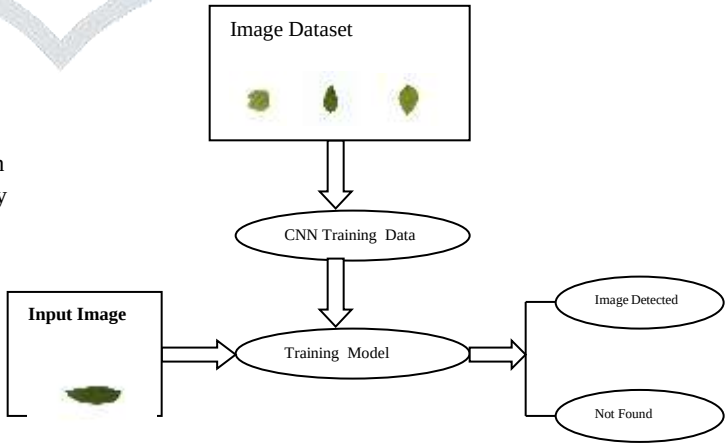
3.Proposed System Architecture

In Praposed system,we are proposing experiment on 17 different plant species. The current work is totally depends on accuracy factor. In a proposed system, we are going to overcome existing drawbacks of low accuracy with the help of tensorflow framework. Our work is based on machine learning techniques for image processing with better accuracy over pre work and image detection with advantages huge accuracy.

A. Architecture

We are going to develop following modules:

- Testing
- Training



Block diagram proposed system

The development of image processing solutions has become one of the most popular use cases for Convolution neural networks. A CNN can recognize shape, size, colour, and texture, detect and classify objects,

and detect and recognize them. In our project, we defined modified CNN architecture with the tensorflow framework and use CNN classifier for detection as classifying image based on a series of regions of interest (ROIs) for an images. However, there are many challenges in using CNNs for recognizing and detecting image. Recently, we worked on a project where the majoreo stream. While working on this project, we are facing a few major challenges:

1. Finding a balance between accuracy and performance
2. Working with real time image sequences.

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B. Algorithms

- **Convolutional Neural Network (CNN):-**

In proposed work we are using CNN which takes image frames as a input. After getting frames from vimage it will processed using image processing techniques for feature evaluation. We extract different features from those images regardless of their events in it consists. By using a series of mathematical functions we are going to identify the object. Every layer in CNN has capability to find out weights of images by using matrix evaluations which converts input to output with valuable functions. Layers of CNN used to identify fire events from extracted frames and give prediction by preserving high accuracy and less time.

- Step 1- input image
- Step 2- Frame extraction from image
- Step 3- Image processing by using open-cv
- Step 4- Feature Extraction from images
- Step 5- Model generation
- Step 6- leaf recognition

Four main layer working approach of CNN explained below:-

a) Convolutional Layer

We are going to extract different features of frames like pixel weight matrix calculations by using feature kernels. Perform mathematical convolutions on frames, where every function uses a unique filter. This outcome will be in different feature maps. At the end, we will collects all of these feature maps and draft them as the destination output matrix of the convolution layer.

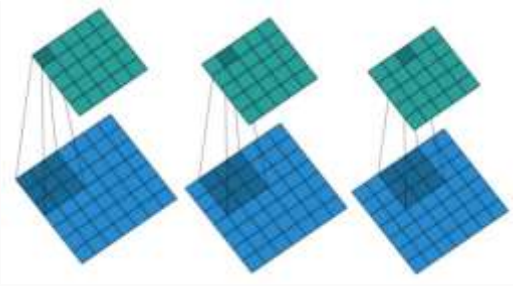

Fig.3 Convolutional Layer

b) Pooling

The expression of pooling is to constantly decrease the dimensionality to limits the number of factors and calculation in the network. This limits the time of training and maintains over fitting problem. The max Pooling extracts out the largest pixel value out of a feature. While pooling average is calculated for the average pixel value that has to be evaluated.

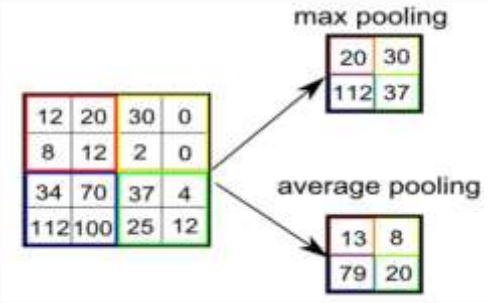

Fig.4 Pooling Layer

c) Flattening

Generally here we put the pooled feature into a single column as a sample input for further layer (transform the 3D matrix data to 1D matrix data)

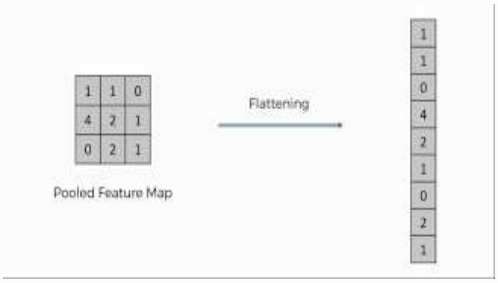

Fig.5 Flattening Matrix

d) Fully Connection

A fully connected layer has full connections of Neurons to all the nodes in the previous layer.
The fusion of more neurons to evaluates accurately.

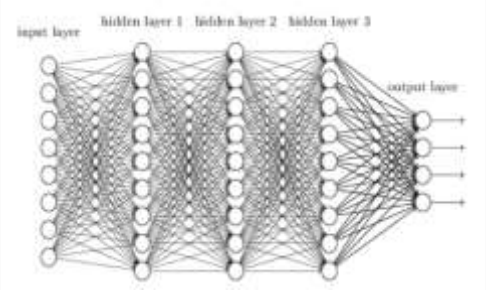

Fig. 6 Fully Connected Layer

4. CONCLUSION

An plant species identification approach which is employed using computer vision and machine learning techniques to classify plant leaf images. The study has been conducted in phases like image pre-processing, image segmentation, feature extraction and finally classification of the image. A combination of texture and color features was extracted and then linear CNN classifier was used for classification. The system was tested on dataset and attained an accuracy more than 94.26% with the help of tensor flow framework. The model could automatically classify 17 different plant species. The proposed method is very easy to implement and efficient. Although the model achieved an accuracy of more than 90%, it still lags in comparison to methods implementing neural networks or deep learning techniques. Finally, the objective is to make the idea of automatic plant species identification more realistic by working on live dataset.

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