Rec Shokubutsu: A Plant Identification Application Using Convolutional Neural Network

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Abstract

Plants are the backbone of all life and there are about 40 million plant species on Earth providing us with oxygen, food and many essential products helping for the existence of human life. Species knowledge is important for biodiversity conservation as well. Identification of plants by conventional approach is complex, time consuming, and frustrating tor non experts due to the use of botanical terms. This project uses convolutional neural network models to perform plant species identification using simple leaves images of plants, through deep learning methodologies. Training of the model was performed by using a dataset of 184 distinct classes of plant containing 7744 plant species images. The aim of the project is to develop an application that helps people to identify plant species using simples' leaves images of plants without begin concerned about the knowledge of botany (study of plants). This will help us to identification of new or rare plant species to improve the balance in the ecosystem. We are going to implement these by building our own CNN model on 184 distinct plant species. The deep learning model with conventional neural network is going to be implemented using Tensorflow and will be used in the application using an API.

1. Introduction

The diversity of plant species plays a very important role in various areas such as foodstuff, medical science, industrial growth, and environment protection. Many productive activities of all human beings depend on plants as it provides a lot of food and some necessaries. It also helps to maintain the balance of carbon dioxide and oxygen in the atmosphere. It is estimated that more than half of the world's medicines come from natural plant synthesis, and 1/4 of them are extracted directly from plants or plants are the sole raw materials. To this end, plants are of central importance to natural resources conservation. Plant species identification provides significance information about the categorization of plants and its characteristics. However, manual interpretation is not precise since it involves individual's visual perception. Sampling and capturing digital leaf images are convenient which involves texture features that help in determining a specific pattern. The most important feature to distinguish among plant species are venation and shape of a leaf [6].

The number of species of macro-organisms on the planet is estimated at about 10 million. This staggering diversity and the need to better understand it led inevitably to the development of classification schemes called biological taxonomies. Unfortunately, in addition to this enormous diversity, the traditional identification and classification workflows are both slow and error-prone; classification expertise is in the hands of a small number of expert taxonomists and to make things worse, the number of taxonomists has steadily declined in recent years. However, identification of plants by conventional keys is complex, time consuming, and due to the use of specific botanical terms frustrating for non-experts. This creates a hard to overcome hurdle for novices interested in acquiring species knowledge, therefore become not just a long-time desire but a need to better understand, use, and save biodiversity. Moreover, Plant identification is not exclusively the job of botanists and plant ecologists. It is required or useful for large parts of society, from professionals (such as landscape architects, foresters, farmers, conservationists, and biologists) to the general public (like ecotourists, hikers, and nature lovers). But the identification of plants by conventional means is difficult, time consuming, and (due to the use of specific botanical terms) frustrating for novices. This creates a hard-to-overcome hurdle for novices interested in acquiring species knowledge. identifying the plants [5].

So, identifying the plants correctly is out of reach of an ordinary person as it requires specialized knowledge and only the experts of botanical background are able to pull off this task. In addition to that even botanists do not have knowledge of all the existing plants in this world for there is an unlimited number of plant species. Hence the task of plant identification is limited to a very small number of people. There are enormous plant species in the world, which is nearly 390,000 in numbers, and each year, new species are reported in different parts of the world [4]. Plants are very different from one another hence requiring in depth taxonomic knowledge to identify and assign them to a particular species. Many activities such as studying the flora of a particular area, investigation of the endangered species, discovering new plant species depends profoundly upon precise and accurate dentification skills. With this, the need for automated identification of plant species is increasing but unfortunately, the number of plant systematics experts are limited.

2. Related Work

Sk Mahmudal Hassan et al. [2] in their research paper have proposed a novel depth=separable convolution neural network which in low in computation cost as compared to standard Convolution neural network model which require a large number of parameters and higher computation cost. Author used four different deep learning models (Inception V3, InceptionResnetV2, MobileNetV2 and EfficientNetB0) for the detection of plant diseases. Author achieved best accuracy of 99.56% in EfficientNetB0 model and the MobileNetV2 architecture is an optimized deep convolution neural network that limits the parameter number and operations as much as possible. The author concluded their paper by comparison of other deep learning approaches to their implemented deep learning models which has better predictive ability in terms of both accuracy and loss.

J. Banzi and T. Abayo et al. [1] in their research paper have implemented a CNN with integration of LSTM on top. The proposed CNN technique has been applied to classify 100 plant species with several state-of-the-art model architecture. The author attained 95.06% success rate in identifying the plant species. They also mentioned the resultant of CNN-LSTM model accuracy are far better than normal CNN model. The author has concluded their paper by discussing how it can be expanded to support and integrated plant species identification system to operate in real ecosystem services.

Skanda H N et al. [3] in their research paper they propose 2 methods for plant identification. First one is leaves can be identifies using digital fingerprint, by scanning the leaf by lasers different depth points can be marked and connected to form an image which can be plotted against a graph. The area enclosed by graph from the unique digital fingerprint of the leaf which can be used to recognize the plant. The second one is Leaf recognition can be done by tracing its outline on a digital screen such as a camera. The author has concluded their paper by discussing the challenges and future scope for plant identification.

3. Literature Review

A. Convolutional Neural Network

A convolutional neural network (CNN) is a type of artificial neural network that is commonly used in image and video processing. It is designed to process data with a grid-like topology, such as an image. In a CNN, the input data is passed through multiple "layers" of small neural networks, each of which applies a series of mathematical operations to the data. These operations are designed to identify certain features or patterns in the data. For example, a CNN might be trained to recognize edges, shapes, or objects in an image. Each layer in a CNN typically includes one or more "convolutional" filters, which are used to scan over the input data and apply the mathematical operations.

The output of each layer is then passed to the next layer, until the final output is produced. One of the key advantages of CNNs is that they can learn to recognize patterns in the data automatically, without the need for human-specified rules. This makes them well-suited for a wide range of tasks, including image and video classification, object detection, and language translation.

B. Dropout

In a convolutional neural network (CNN), "dropout" is a regularization technique that helps prevent overfitting. Overfitting occurs when a model becomes too specialized to the training data, and is not able to generalize well to new, unseen data. Dropout works by randomly "dropping out" or ignoring a certain number of neurons during the training process. This forces the model to rely on the remaining neurons, and helps prevent individual neurons from becoming too specialized or over-dependent on certain features in the training data. During training, the dropout rate is typically set to a value between 0.2 and 0.5. This means that, on average, between 20% and 50% of the neurons in the model will be "dropped out" at each training step At test time, the dropout rate is usually set to 0, which means that all of the neurons are used. This is necessary because the goal at test time is to make predictions based on the entire model, rather than just a subset of the neurons.

Overall, dropout can be a useful technique for improving the generalization performance of a CNN, and is often used in conjunction with other regularization methods such as weight decay and early stopping.

4. Methodology

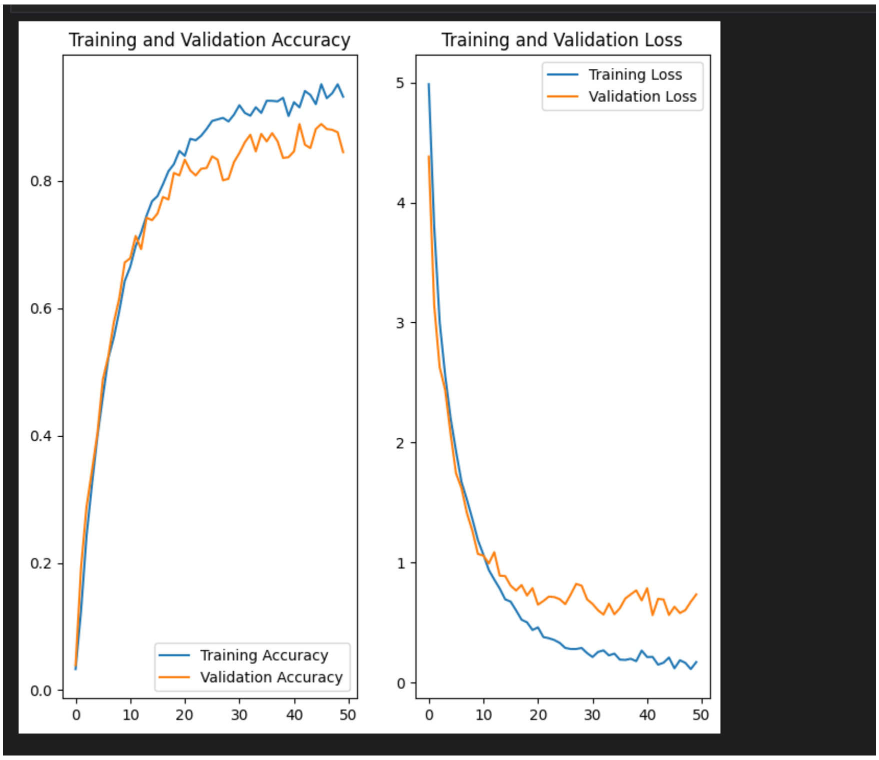
The following methodology will be followed to achieve the objectives defined for proposed research work:

- A detailed study and analysis of the leafsnap datasets will be carried out in order to make conventional neural network model.
- Pre-processing will be done on datasets: such as image resizing, image rescaling and data augmentation.
- A CNN model is implemented with 2 dense layers.
- The model is to be trained for 50 epochs with ‘adam’ optimizer and ‘accuracy’ as a metrics.
- On achieving the desired results, the visualizations and a comparison between training accuracy with validation accuracy and training loss with validation loss is done.
- Used FAST API as a backend for deployment and testing through postman.
- The web application is created to access the model and identify the plant through plant leaves.

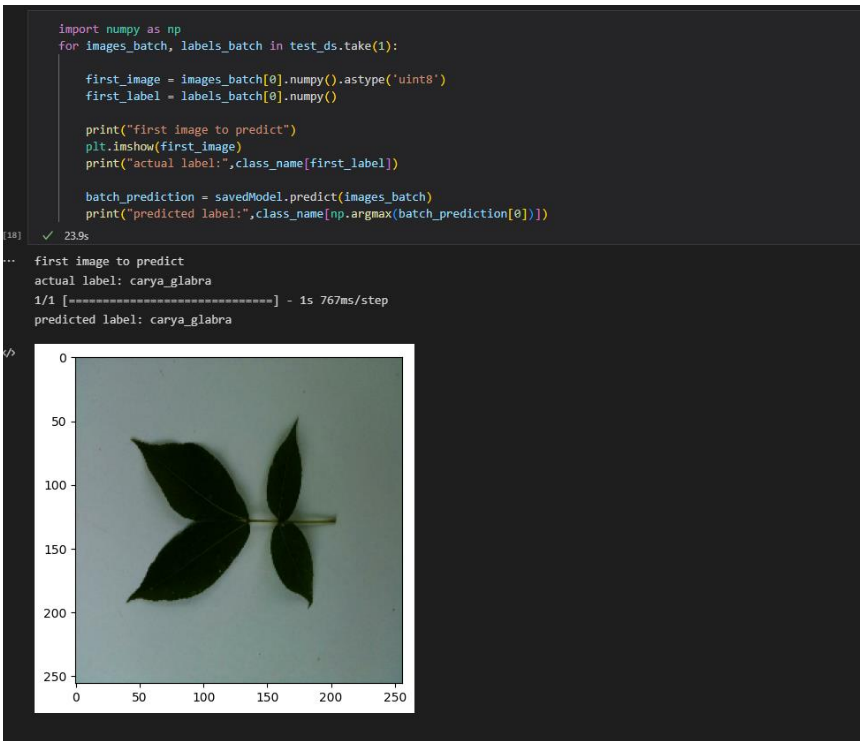
5. Outcomes

```
model.summary()
[15] ✓ 0.8s

Output exceeds the size limit. Open the full output data in a text editor
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 sequential (Sequential)     (32, 256, 256, 3)         0

 conv2d (Conv2D)             (32, 254, 254, 32)        896

 max_pooling2d (MaxPooling2D  (32, 127, 127, 32)       0
 )

 conv2d_1 (Conv2D)           (32, 125, 125, 64)        18496

 max_pooling2d_1 (MaxPooling  (32, 62, 62, 64)         0
 2D)

 conv2d_2 (Conv2D)           (32, 60, 60, 64)          36928

 max_pooling2d_2 (MaxPooling  (32, 30, 30, 64)         0
 2D)

 conv2d_3 (Conv2D)           (32, 28, 28, 64)          36928

 max_pooling2d_3 (MaxPooling  (32, 14, 14, 64)         0
 2D)
...
Total params: 195,512
Trainable params: 195,512
Non-trainable params: 0
_________________________________________________________________
```

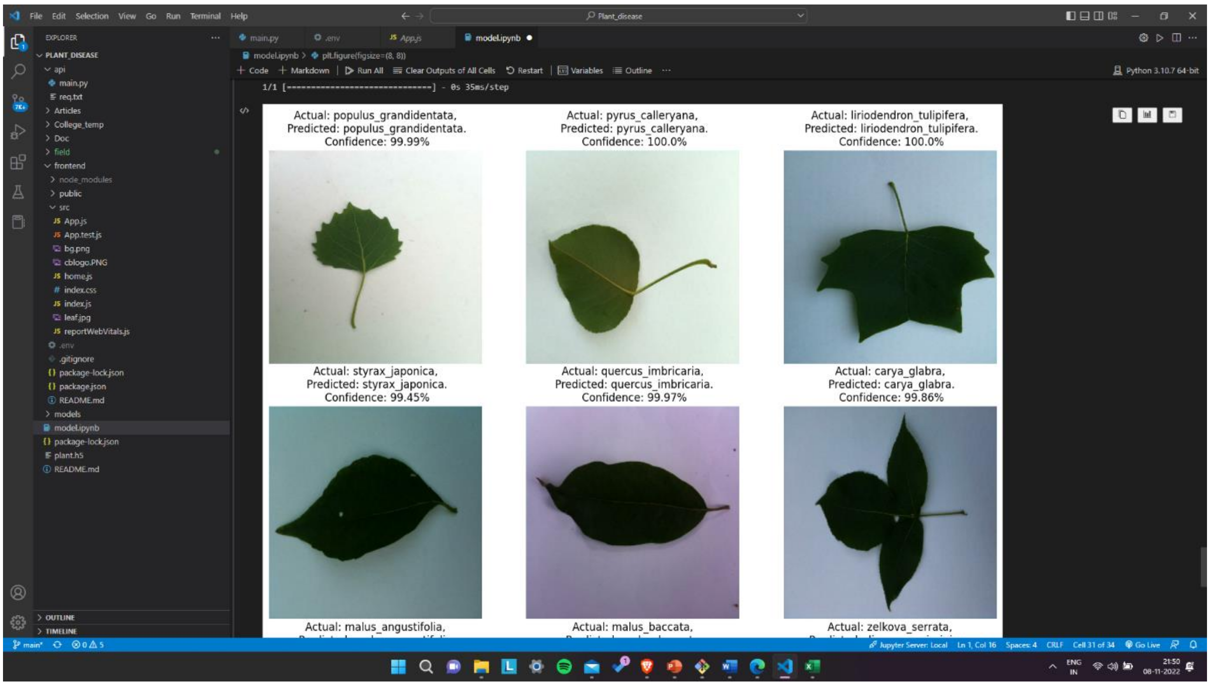
MODEL SUMMARY



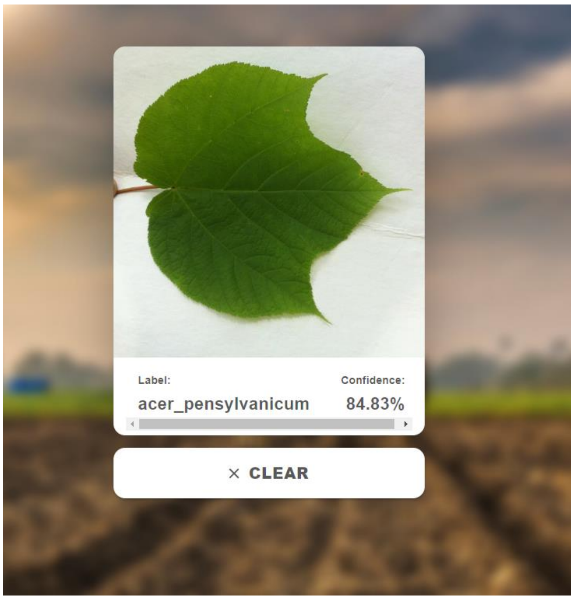
PLOT GRAPH BETWEEN TRAINING ACCURACY – VALIDATION ACCURACY AND TRAINING LOSS – VALIDATION LOSS

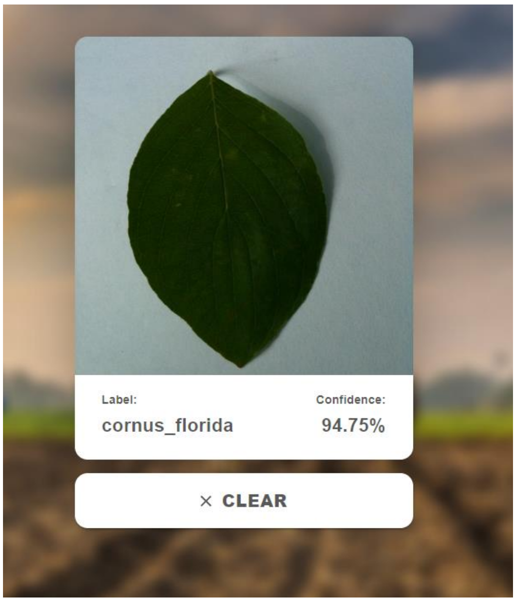


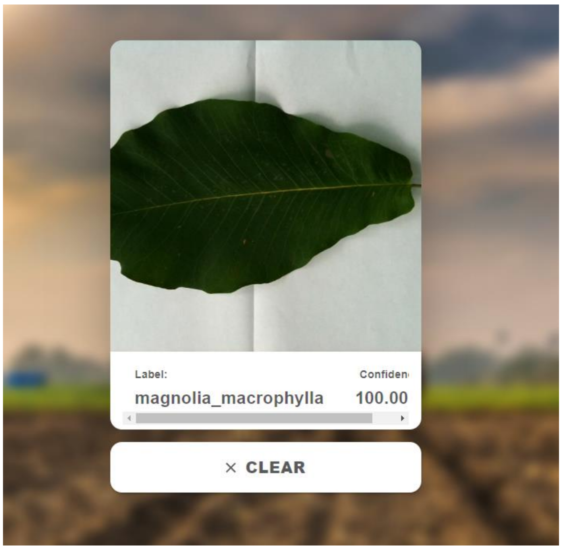
SAMPLE TESTING OF AN IMAGE USING TRAINED MODEL

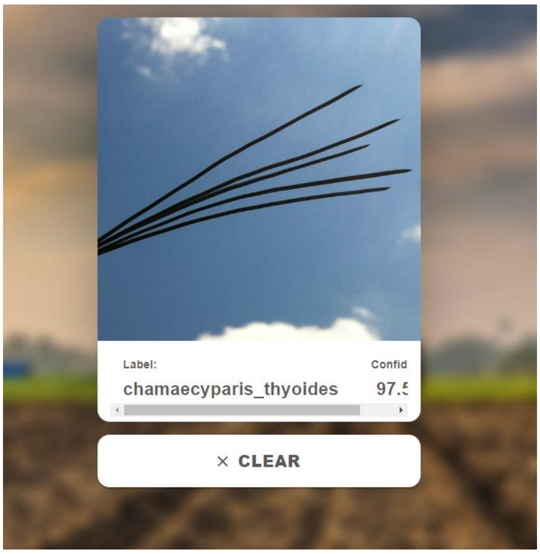


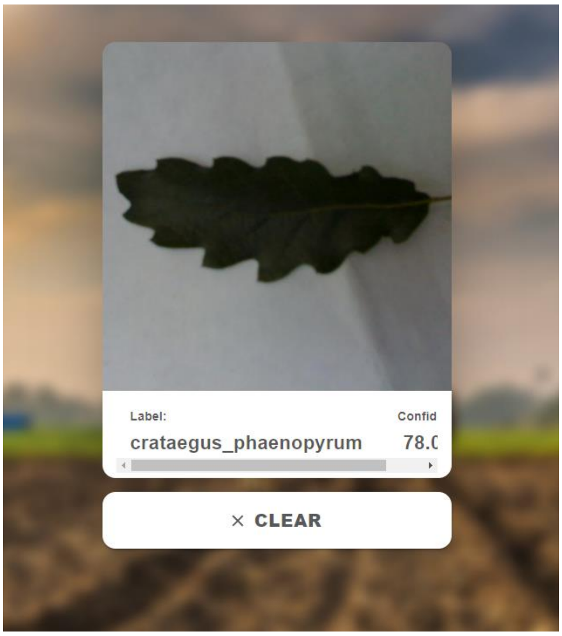
SAMPLE OUTPUT OF SOME LEAFS

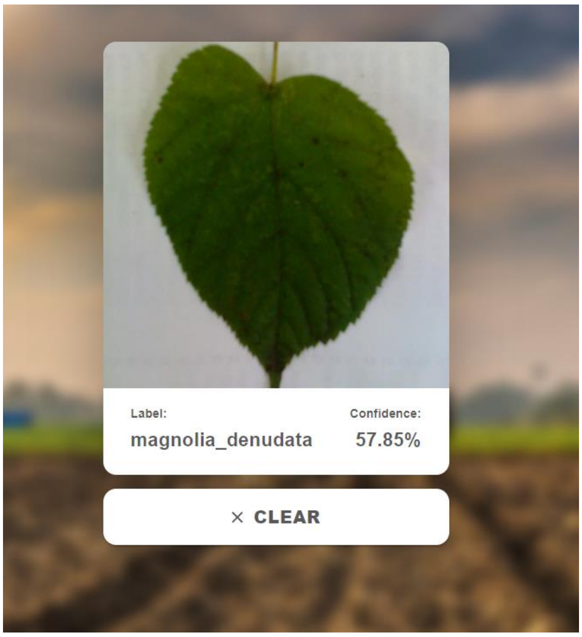

Label:
Confidence:
acer_pensylvanicum
84.83%
CLEAR


Label:
Confidence:
cornus_florida
94.75%
CLEAR


Label:
Confiden
magnolia_macrophylla
100.00
CLEAR


Label:
Confid
chamaecyparis_thyoides
CLEAR


Label:
Confid
crataegus_phaenopyrum
CLEAR


Label:
Confidence:
magnolia_denudata
57.85%
CLEAR

6. Conclusion

- Developed an application that helps people to identify plant species using simple's plant
- leaves image without begins concerned about the knowledge of botany (study of plants).
- The Identification performance of the models will be good enough to be used in web
- application for effective use.
- The end result of this project is a web application.

7. Future Scope

There are enormous plant species in the world, which is nearly 390,000 in numbers, and each year, new species are reported in different parts of the world. Plants are very different from one another hence requiring in depth taxonomic knowledge to identify and assign them to a particular species. Many activities such as studying the flora of a particular area, investigation of the endangered species, discovering new plant species depends profoundly upon precise and accurate dentification skills. With this, the need for automated identification of plant species is increasing. We need more research in this field

8. References

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