Identification of Indian Medicinal Leaves using Convolutional Neural Networks

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Abstract- *India is well known for its traditional medicines and the field of Ayurveda. Indians have used home remedies as first aid to multiple common ailments like cough, cold, stomach ache, etc. These remedies involve using leaves from our day-to-day household ingredients. It was easy for people in the earlier times to identify these leaves and map them to ailments. Using the latest technologies like Machine Learning and Deep Learning, we have explored a technological way of identifying these leaves for all the naive users. In this paper, we have described the implementation of Convolutional Neural Networks (CNN) for the identification of Indian medicinal leaves.*

Key Words: Indian medicinal leaves, Convolutional Neural Networks (CNN), Ayurveda, Machine learning, Deep learning

1. INTRODUCTION

Ayurveda has existed as a viable treatment option for over 3000 years in India. Ayurvedic treatments are gaining more traction because of the minimum to negligible side effects. 60-80% of the world population uses medicinal plants as remedies for various ailments [11], It is very difficult for naive users to identify these medicinal plants.

Identification of leaves can be time consuming and botanical names are hard to remember for the naive users. This creates a hurdle for the users interested in acquiring the knowledge of plant leaves [2]. Plants can be identified by its multiple features likes leaves, flowers, fruits, stems, etc. Flowers and fruits are seasonal in nature and cannot is a viable factor for identification during off seasons. However, leaves are non-seasonal in nature and can be considered as the prime factor for plant identification. [3]. Identification and classification of these leaves is possible using Machine Learning and Deep Learning techniques. Artificial Neural Network (ANN) [7], k-Nearest Neighbour (KNN) [9], CNN [8], and Support Vector Machine (SVM) [10] are commonly used techniques for identification and classification. The paper [5], provides us with the information of the leaves' economic and ecological importance. It provides the medicinal values and ecological values of the 12 plants taken into consideration namely, Mangifera indica (Mango), Terminalia arjuna (Arjun), Alstonia scholaris (Saptaparni), Psidium guajava (Guava), Aegle marmelos (Bael), Syzygium cumini (Jamun), Jatropha curcas L. (Jatropha), Pongamia pinnata L. (Karanj), Ocimum basilicum (Basil), Punica granatum L. (Pomegranate), Citrus limon (Lemon), Platanus orientalis (Chinar). The paper [6] explores and compares multiple algorithms namely, KNN, SVM, CNN for classification of leaves from the Flavia dataset. In this paper [6], CNN is used for identification and classification. Sigmoid layer and softmax were also used along with pre-training and edge detection techniques. This provided better results in leaf species detection.

In this paper, along with the creation of the Indian Medicinal Leaves, a CNN model is trained for classification and identification of leaves and provides the medicinal values of the leaves against various common ailments.

2. METHODOLOGY

2.1 Algorithm used

CNN is used for the identification of Indian Medicinal leaves. CNN is a Deep Learning classification model. CNN uses labelled dataset for classification and thus a supervised learning algorithm. CNN is considered to be a type of multilayer perceptron since it uses more than one layer of perceptron to learn about the features of an image. [1]

1) Begin with a sequential model: model = Sequential()

2) Add a convolutional layer with Rectified Linear Unit (ReLU) [11] activation function.

3) Add a 2D max pooling layer.

4) Repeat steps 2 and 3.

5) Add a flattened layer and a dense layer with softmax activation function.

6) Now, compile the model.

7) Fit the model to the expected output size.

8) Lastly, save the model.

2.2 Proposed System

The "Fig -1" describes the architecture of the proposed system.

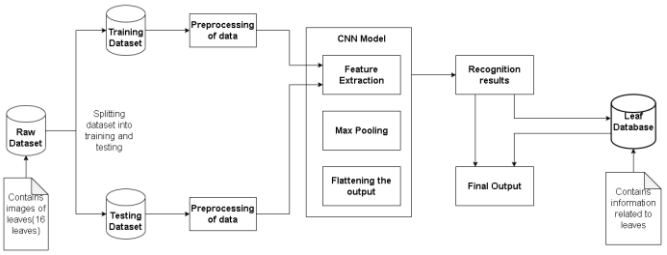

Fig -1: System Architecture

1) Pre-processing of data: The input images are pre-processed before the model training. Images are rescaled, rotated at a certain angle, zoomed and flipped. The images are resized to 150x150 pixels. The testing images are also pre-processed in the same manner.

2) Model: The proposed system consists of a deep learning framework CNN built as shown in "Fig -2". The model has 2 convolutional layers each followed by 2x2 max pooling and ReLU as the activation function. The input to the convolutional layer is an image of 150x150 size with 64 filters and 3x3 kernel size. At the end of the model, there are 2 Fully-Connected layers with softmax as the activation function.

3) Training and Testing: The model is trained under 50 epochs with a batch size of 64. It was observed that there were 12 steps per epoch. Checkpoints are assigned after every 5 epochs, thus saving the model. The image used for validating the model was also pre-processed in the same way as the input image. 80% images are used for training and 20% are used for testing.

The flow of the data is illustrated using "Fig -3"

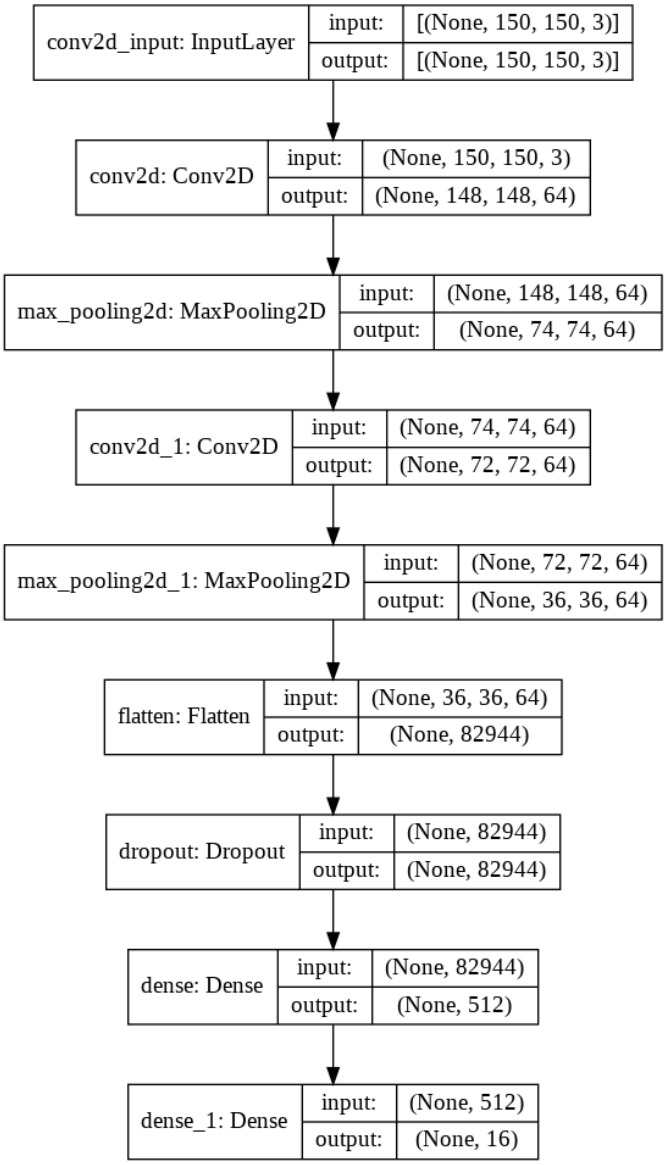

Fig -2: Model

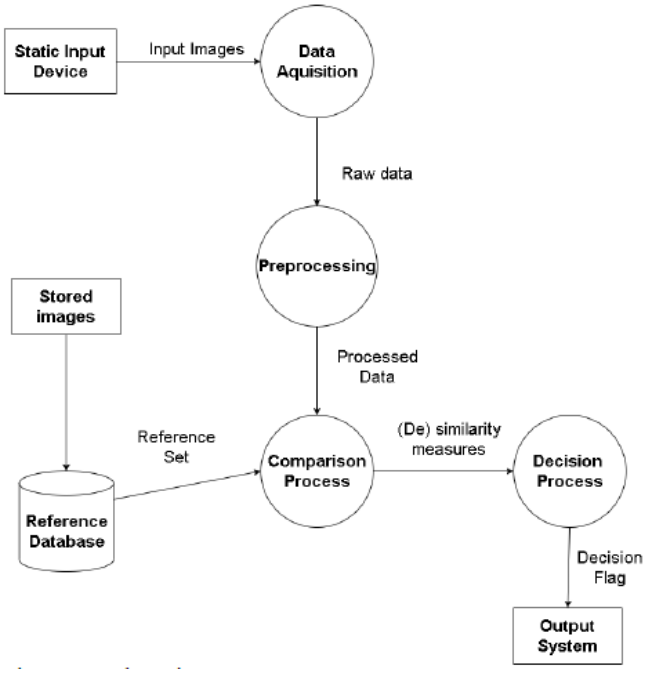

Fig -3: Data Flow Diagram

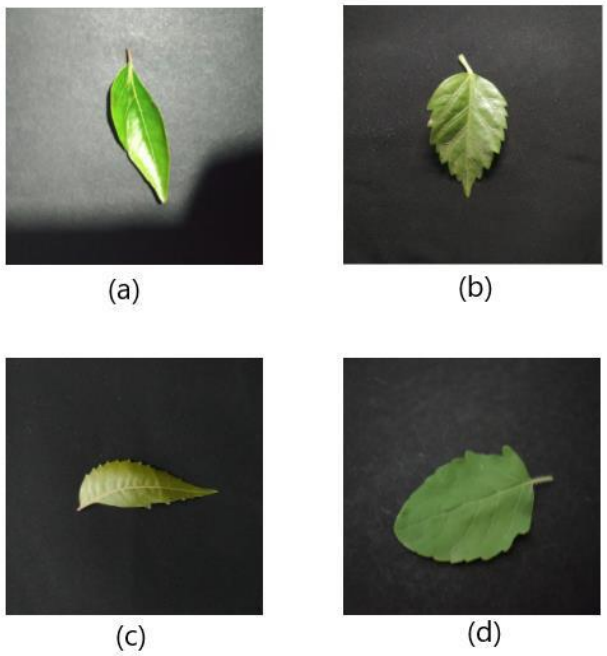

Fig -4: Leaves Sample

3. DATASET

3.1 Image Acquisition

For creating the dataset of the Indian medicinal leaves, the images were captured in a black background. The leaf images were captured using a mobile camera with 12 MP or more. The images were clicked in a well-lit room. A few examples of the images are illustrated in "Fig -4". In "Fig -4", (a) is Curry leaf, (b) is Hibiscus leaf, (c) is Neem leaf and (d) is Tulsi leaf.

3.2 Number of images, classes and size

Dataset name: Indian Medicinal Leaves

Dataset size: 3200 images

Number of classes: 16 classes

For creating the dataset, for each of the 16 classes, 5 different leaves of different sizes of the same plant were used.

Table -1: Names of leaves in dataset

Class no.	Class Name	Class no.	Class Name
1	Arjun	9	Karanj
2	Bael	10	Lemon
3	Betel	11	Mango
4	Curry	12	Mint
5	Guava	13	Neem
6	Hibiscus	14	Pomegranate
7	Jamun	15	Saptaparni
8	Jatropha	16	Tulsi

4. DATABASE

In the leaf database, we have included columns like leaf name, botanical name, other common names, phytochemical constituents [4], and benefits. The database shown in "Fig -5" was prepared from [20], Last accessed on 28/05/2021.

Leaf Name	*Botanical Name*	*Other Names*	*Phytochemical Constituents*	*Benefits*
Arjun	Terminalia arjuna	Arjuna, Koha, Kahu, Arjan, White Marudah	Tannins, triterpenoid saponin, Flavonoids, gallic acid, ellagic acid, OPCs, phytosterols, calcium, magnesium, zinc and copper [4]	Anti-oxidant, strengthens the heart muscles, diarrhea, asthma, cough, Hemorrhages & Bleeding Disorders,Improves High Blood Pressure, Atherosclerosis, Cardiovascular Health, Coronary Artery Disease, Chronic Low-Grade Fever, Dysentery, Bone Fractures
Bael	Aegle marmelos	Bengal quince	Xanthotoxol and the methyl ester of alloimperatorin, flavonoids, rutin and marmesin, essential oils, Aegeline [4]	Weight loss, liver injury, tuberculosis, hepatitis, ulcer, constipation, diarrhoea
Betel	Piper betle	Paan, pinang, or penang	Allylpyrocatechol,hydroxy catechol, β-caryophyllene, methyl eugenol [4]	Anti-diabetic Agent,Anti-cancer Agent,Anti-microbial,Anti-asthmatic Agent, prevention of cardio-vascular disease, high cholesterol and high blood pressure
Curry	Murraya koenigii	Mitha Neem, Karuveppilai, Surabhinimba	Bismahanine, murrayanine, murrayafoline-A, bi-koeniquinone-A, bismurrayaquinone, mukoenine-A, mukoenine-B, mukoenine-C, murrastifoline, Murrayazolinol, murrayacine, murrayazolidine, murrayazoline, mahanimbine, girinimbine, koenioline, xynthyletin, koenigin-Quinone A and koenigine-Quinone B [4]	Anti-Oxidation Activity, Effect On Dental Caries, Wound Healing Effect, Protects The Eyes And Improves Eyesight, Diabetes, Bronchial Disorders, Teeth infection, Ulcer [13]
Guava	Psidium guajava	lychee, lemon guava	Flavonol morin, morin-3-O-lyxoside, morin-3-O-arabinoside, quercetin and quercetin-3-O-arabinoside [4]	Lower Blood Sugar Levels, Weight Loss, Boost Heart Health, diabetes, pain relief, fever, diarrhea, rheumatism, lung diseases, cancer, ulcers [14]
Hibiscus	Hibiscus rosa-sinensis	China Rose, shoe flower, rose of sharon	Tannins, anthraquinones, quinines, phenols, flavonoides, alkaloids, | terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugars, mucilage, essential oils and steroids [15]	Hypertension, lower blood pressure, reduce blood sugar levels, healthy liver, reduces menstrual cramps, help with depression, aid digestion, weight management, constipation, cancer, liver disease, and cold symptoms [15]
Jamun	Syzygium cumini	Malabar plum, Java plum, black plum	Different anthocyanins like delphinidin 3,5-diglucoside,anthocyanins, glucoside, ellagic acid, isoquercetin, kaempferol and myricetin [16]	Improves health of skin and eyes, Strengthens your gums and teeth,Keeps your heart healthy, Improves hemoglobin count,anti-diabetic [16]
Jatropha	Jatropha curcas	Physic nut, Barbados nut, poison nut	Alkaloids, coumarins, flavonoids, lignoids, phenols, saponins, steroids, tannins, phytic acid [17]	Its antimicrobial, anti-cancer and anti-HIV, treating dysentery and diarrhea,against malaria, rheumatic and muscular pains [17]
Karanj	Pongamia pinnata	Pongam, Indian beech, Pongamia tree	Alkaloid, Steroid, Carbohydrate, Tannin, Flavonoids, Terpenoid [18]	Treats Arthritis,wound healing,Ulcer, skin disorders like boils, abscess, eczema,cold, coughs, diarrhoea, dyspepsia, ß flatulence,gonorrhoea and leprosy [18]
Lemon	Citrus Limon	Lemon	Alkaloids, flavonoids, phenols, quinines, terpenoids and carbohydrates,sabinene, carene, limonene, and β-ocimene [19]	Source of vitamin C, promotes weight loss,aids digestion, anemia, kidney stones, digestive issues [19]

Fig -5: Screenshot of Database

5. RESULTS AND DISCUISSONS

The proposed leaf identification system, using CNN and ReLU activation function has achieved 93.17% accuracy for the Indian Medicinal Leaves dataset. The model has got 0.91 precision and 0.95 recall values. "Fig -6" shows the screenshot of the web app of the proposed system. The Indian Medicinal Leaves dataset provides 16 classes for identification and classification which can be used for further research and implementation of various classification and identification algorithms.

The database of the medicinal values of each of the 16 leaves from the database will help naive users understand the use of each leaf as remedies for various ailments. CNN is an effective method for identification and classification. 2 convolutional layers each followed by 2x2 max pooling and ReLU as the activation function has provided the best output without any issues of overfitting or underfitting.

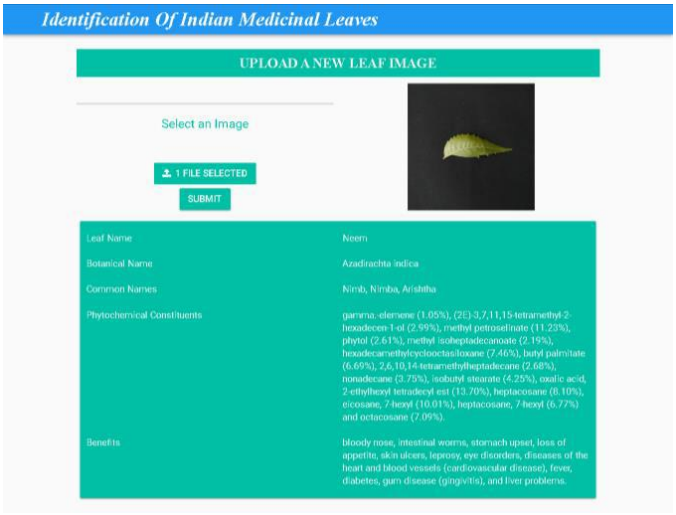

Fig -6: Screenshot of the system

6. CONCLUSIONS

Leaf Identification System can prove to be very useful for naïve users who have a budding interest in Ayurveda. It can help the users identify the medicinal values of different Indian leaves such as neem, Tulsi, etc. This system will help in identifying the medicinal properties of the leaf. It will display the name of the leaf, the biological name, diseases cured by the leaf, etc. Thus, using CNN and ReLU activation function, we have obtained 93.17% accuracy in identifying the leaves from the Indian Medicinal Leaves dataset.

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