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***Abstract*— Since the dawn of time, medicinal plants, usually referred to as medicinal herbs, have been employed in traditional medicine. Numerous substances are produced by plants for purposes including defense against pests, diseases, fungus, and herbivorous animals. Antiquated Ayurvedic original copies, Egyptian papyrus, and Chinese books portray the utilization of spices. Medicinal plants and herbs have been used as medicines for over 4000 years. Plant parts such as flowers, leaves and roots are highly medicinal. However, it is a difficult process for agronomists and pharmaceutical companies to identify suitable medicinal plants, resulting in the loss of ancient knowledge of Ayurveda. This research work proposes an automated system to identify plants by using a CNN model. To identify rare new species, a thorough understanding of plants is required. Changes in leaf properties are useful for conducting comparative studies of plants. Therefore, this automated system will help to identify medicinal plants and helps agronomists identify the correct herbs.**

Keywords—Medicinal Plants, Deep Learning, Computer Vision, Multiclass Classification, Leaf Patterns

I. INTRODUCTION

In our daily lives, we often encounter many kinds of plants and trees. A few plants are easy to identify, but of the plants are difficult to identify, especially when they are of medicinal importance. There are around 8000 [1] species of medicinal plants found in India. Medicinal plants are most commonly found in the tropics, but botanical studies in these areas take a long time. Since the dawn of time, medicinal plants, usually referred to as medicinal herbs, have been employed in traditional medicine [2]. Plants produce a variety of chemicals to protect themselves from insects, fungi, diseases, and herbivorous mammals. Many highly effective species have not yet been discovered. Proper identification of these medicinal plants solves many diseases. The most difficult task is to identify many such plants. Some plants we see are unrecognizable except for their lifetime. Finding these plant species requires a great deal of knowledge and understanding [3]. Identifying these plants will not only help to cure many diseases, but also will help to restore the traditional knowledge of Ayurveda and ancient medicine. It will help the agronomists, ayurvedic medicine practices to identify the medicinal plants easily.

Previously, there have been multiple attempts to address the problem of identifying the medicinal plants. Identifying the plants becomes more challenging because of the change in the seasons, which affects the shape, color and surface of the leaf. By tabulating the extracted texture and shape features attempts have been made to classify the medicinal leaves using K Nearest Neighbours algorithm for identifying the species [3] Also there have been attempts to classify the medicinal plants based on the texture and shape features using Naïve Bayes Classifier [4] after extracting the features. Important features of the leaf such as aspect ratio, area, rectangularity, number of venations, color-based features have been mentioned in [5] which is then used to classify the leaves using Support Vector Machine. Using images also attempts have been made to classify the medicinal plants using CNN [6-7]. Transfer learning (TL) is a machine learning (ML) research subject that is concerned with the storage of information got while resolving one problem and its subsequent application to another similar but unrelated problem. [8] An Artificial Neural Networks based classification system has also been experimented to classify the medicinal plants after converting the images into an array of pixels [9]. Data visualization, dimension reduction, and classification are all done using linear discriminant analysis [10]. All these systems though have provided a solution for classifying the medicinal plants, yet they have not been effective in implementing the solutions on edge devices which can be used by a common man or an agronomist for identifying the medicinal plants accurately.

Here in this section, we have mentioned about medicinal plants, its advantages and different methods of identifying the medicinal plants. In the upcoming section, we put forth some of the literary works about Deep learning approaches in identifying the medicinal plants. In the subsequent section, we present our deep learning CNN approach, its model, methodology, and results. Finally, we discuss the need for our approach and future enhancements in the last section of our paper.

II. RELATED WORKS

A Linear Discriminant Analysis and Random Forest based approach is discussed in the paper [10] for classifying the medicinal plants. Pre-Processing, Feature

Extraction, and Classification Phases make up most of the methodology examined in this work. In the preprocessing stage, the background is removed. Each image is changed from RGB to HSV once the backdrop has been eliminated. To get the vein characteristics, GLCM is applied. The classification of the therapeutic plants has been done using 14 form characteristics and several colour moments. A normalizing step is then performed on every segment of the vector prior to moving to the classification stage. In the classification phase, both LDA and Random Forests have been tried to classify the medicinal plants. Linear discriminant analysis is a method that is often employed classification of data and dimensionality reduction (LDA). The dilemma is effortlessly resolved using linear discriminant analysis when the inside class frequencies are inconsistent and their performances have been assessed using test data created at random. One of the most well-known classification and regression approaches, Random Forests (RF), can accurately categories enormous datasets. The Random Forests technique is used to build a group of decision trees. The main concept behind ensemble techniques is the creation of strong learners by combining weak learners. The results showed LDA had the highest accuracy and that the best accuracy was attained when all parameters were considered.

In the study conducted [11], the authors suggest the important parameters that are used to identify a leaf. The parameters include shape of the leaf, venations present in the leaf, surface of the leaf and color. Shape features include aspect ratio, compactness, dispersion, centroid, eccentricity, polar fourier transforms, HU invariant moments. They also proposed an algorithm to group the leaves of medicinal plants. Once the leaf image is captured, it is preprocessed to take out all the noise and the background. The preprocessed picture is compared to the database-stored image after preprocessing. A similarity percentage is calculated. The one with the least dissimilarity value is considered as the closed match. MATLAB is used for this purpose. They used 10 different plants and achieved an efficiency of 92%. Digital image processing techniques have been used to perform the preprocessing of the images which comprises algorithms for processing digital images. To summarise the work steps, comprise leaf images, pattern recognition, feature extraction, and classification have been performed. To maintain the aspect ratio, the image was kept at a dimension of 200 pixels high and 15 pixels wide. Boundary-based features, moment features, and leaf colors are some parameters used to compare the leaf images.

In the work [12], a combination of color, texture and edge features has been used to identify and classify the Indian medical leaves into a tree, herb and shrub. A dataset of various medicinal plants is collected of various categories. Support Vector Machine and Neural Network classifier are used to categorise the medicinal herbs. After the photos have been first filtered, other characteristics are retrieved, including color, edge, and edge direction histograms. HSV and YcbCr color spaces are used to get the color histogram. The edges are extracted using an edge direction histogram. After that, the SVM classifier is trained using these features. A comparative study is done between the Neural Network and SVM Classifier. A maximum of 94% was observed with SVM classifier and maximum of 90% accuracy was observed using ANN classifier. It was found that the accuracy was highest for trees and lowest for shrubs. According to the experimental findings, the combined color and edge histogram surface elements expanded the grouping exactness from 74% to 90%. This work can be used for classification of the medicinal plants as a feature, i.e., once the tree is classified as a shrub or tree , it can be used to classify the medicinal plants.

The work [13] suggests classifying medicinal plant leaves using machine learning. Six different types of medicinal plant leaves were gathered. The Sobel filter was then used to detect edges and lines. A total of 65 fused features, comprising run-length matrix, and multi-spectral features, were extracted. The extracted features were then fused to get a master dataset. Then a chi-square feature selection strategy has been employed and 14 optimized features have been selected for the feature optimization process. Ultimately, five machine learning classifiers are applied on an optimized dataset of medicinal plant leaves, including the multi-layer perceptron, logit-boost, random forest, and simple logistic and it is found that the multi-layer perceptron classifier outperforms the others with an accuracy of 99.01%. when the region of interest was changed to 280*280 where both multispectral and texture features where used.

III. DATASET PREPRATION

A. Dataset Collection

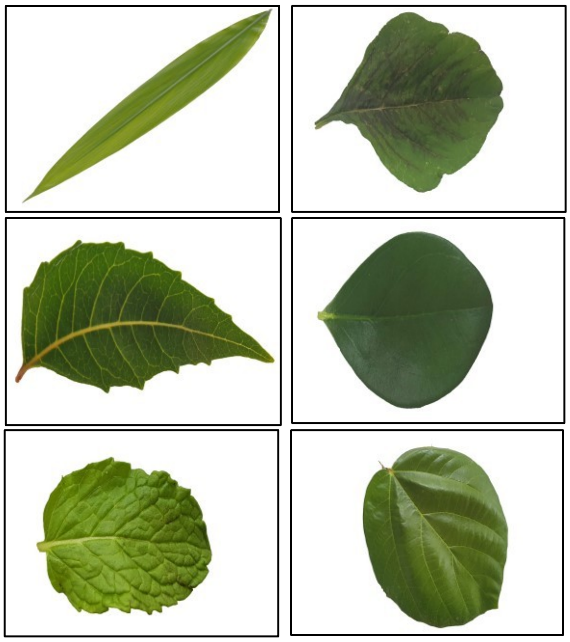

Fig. 1. Sample of the dataset.

In order to begin, the first step must be to collect the datasets. A qualitive study was conducted regarding the dataset sources and the format of the dataset and at the end, we gathered around 1204 images belonging to 30 different classes from Kaggle [17]. The images collected were of size 1200*1600 with RGB channels. The dataset initially had 30 classes but we have considered only 10 classes, namely - Alpinia Galanga, Amaranthus Viridis, Azadirachta Indica, Carissa Carandas, Ficus Auriculata, Mentha, Nyctanthes

Arbor-tristis, Ocimum Tenuiflorum, Taberna Montana Divaricata, Trigonella Foenum-Graecum.Since the dataset was not balanced, we manually balanced the dataset for all the 10 classes. Fig.1 represents a sample of our dataset.

B.Data Augmentation

The concept of data augmentation refers to the technique of extending the size of the dataset used for training a model. A lot of training data is needed for deep learning models to make reliable predictions, but it is not easily available. For this reason, the current data is augmented so that the model can be more generalized. Data augmentation artificially increases the size of the training set by producing new variations of each training instance. It is a very well-known and widely used technique that permits the creation of fresh training examples that belong to the same class as the basis instance for all computer vision problems. The model is forced to be more understanding, and data augmentation boosts the model's ability to generalize. It uses a variety of techniques to randomly and subtly change the original data.

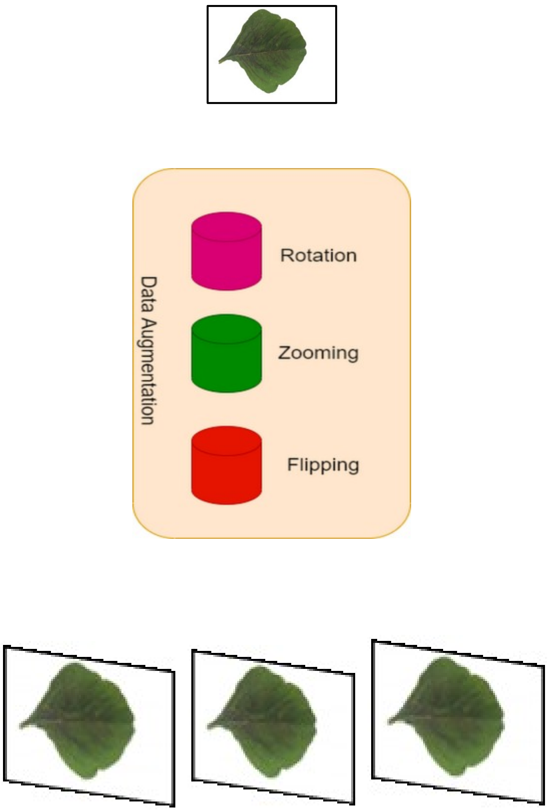

Fig. 2. Image fed to Data Augmentation method to generate augmented images.

Here we have used the built in Keras class ImageDataGenerator and Augmentor library, which provides an easy way to augment those images. Some data augmentation techniques of the ImageDataGenerator and Augmentor library we have used are – rotation, flipping and zooming. In random rotation the rotation of the picture is random. In flipping the picture is either flipped horizontally or vertically and in zooming the change is done to picture smoothly from a long shot to a close-up or vice versa. Data augmentation is visualized in Fig.2

Ultimately, we have got over 2000 images (200 images for each class) after augmentation and balancing the dataset, which were sufficient for training the CNN. Around 400 images were used to test the model, i.e., 40 images for each class. Thus, making it a balanced dataset for the model to be trained.

II. METHODOLOGY

In recent years, artificial intelligence has made tremendous strides in bridging the human-machine gap. To make amazing things possible, both researchers and enthusiasts work on various aspects of the subject. And one such aspect is the domain of computer vision. Th is field aims to enable machines to recognize images and videos, classify images, and recommend media using the knowledge they gain from viewing the world like humans. Convolutional neural networks have been the subject of substantial research, leading to improvements in CV with deep learning.

Convolutional Neural Networks (CNN) are Deep Learning algorithms which can handle input imagery, assigning weights to various aspects/objects, and detecting differences among them. An object, a face, or a scene can be recognized using a CNN to find patterns in images. In comparison with other classification algorithms, CNN requires less preprocessing, and they can learn features/characteristics.

Machine learning algorithms only use structured data. If the data is unstructured, the feature engineering stage must be done by humans. Deep learning, however, can also be used to handle unstructured data. Since images are an unstructured data type, deep learning was used to find a solution.

We have built a simple CNN model [20] which comprised of 7 convolution blocks as seen in the Fig.3. Convolution blocks consists of a convolution layer, a max pooling layer. Image size of 224*224*3 is passed as a parameter to the convolution layer with 64 filters and a size of kernel 3*3 along with an activation function as ReLu. Pool size of 2,2 is passed as parameter to the max pooling layer.

A second convolution layer with 128 filters is immediately followed by the first convolution block with a ReLu activation function. A max pooling layer of 2,2 is also present in the 2nd Convolutional block. The second convolutional block is followed by a third and fourth convolutional layer with 256 filters and a size of kernel 3*3 with a ReLu activation function. The fifth, sixth and the seventh layer consists has a filter size of 512 and a size of kernel 3*3 along with a ReLu Activation function. A max pooling layer of 2*2 is present in the third, fourth, fifth, sixth and the seventh convolution block. Through flattening, the two-dimensional arrays are converted into a single linear vector. Layers with dense connections are tightly linked to the layers that precede them, i.e., every neuron in a layer is connected to every neuron in its former layer. Activation functions for the Dense layer with 512 units are applied. Another dense layer of 10 units is added in order to represent the dimensionality of the output vector. We apply SoftMax activation function to get multiclass output, which gives the probability of each class. Comparatively, CNN has the advantage that it can detect important features automatically without any human intervention. With its performance and efficiency benefits, CNN is one of the most popular deep learning approaches.

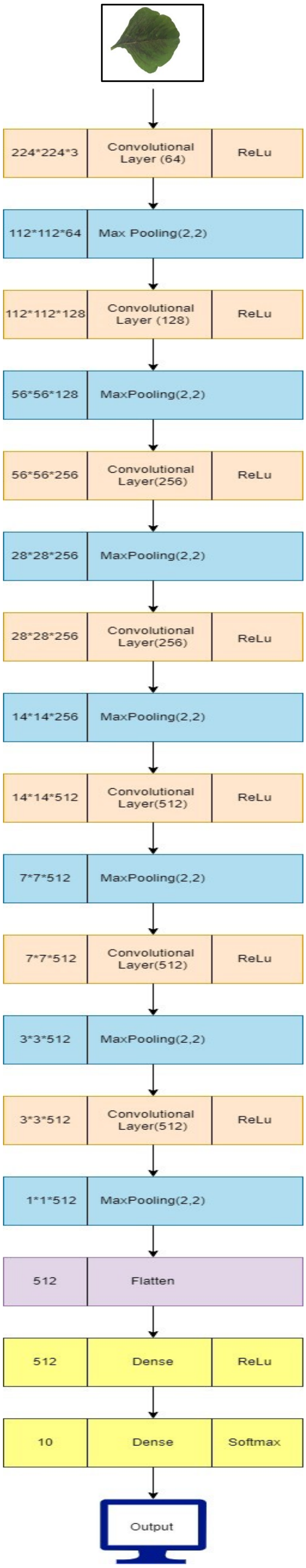

Fig 3. Architecture of Convolution Neural Network

IV. RESULTS

The model includes 7,128,458 trainable parameters fitted via the Adam optimizer with a learning rate = 1.0e-4. Adam optimizer is preferred here as they have less computation time and require very few parameters for tuning. Hence, Adam optimizer is used in our applications.

We use categorical cross entropy loss function along with the metrics as accuracy. To avoid overfitting of the model on the training data, image augmentation was done prior feeding to the model. As soon as performance ceases to improve, one can stop training early with an early stopping method. The model was trained for 100 epochs. The model takes around two to three hours to get trained. The accuracy and loss of the model plotted against the validation dataset can be visualised from the Fig.4. The training accuracy was around 100% after training the model.

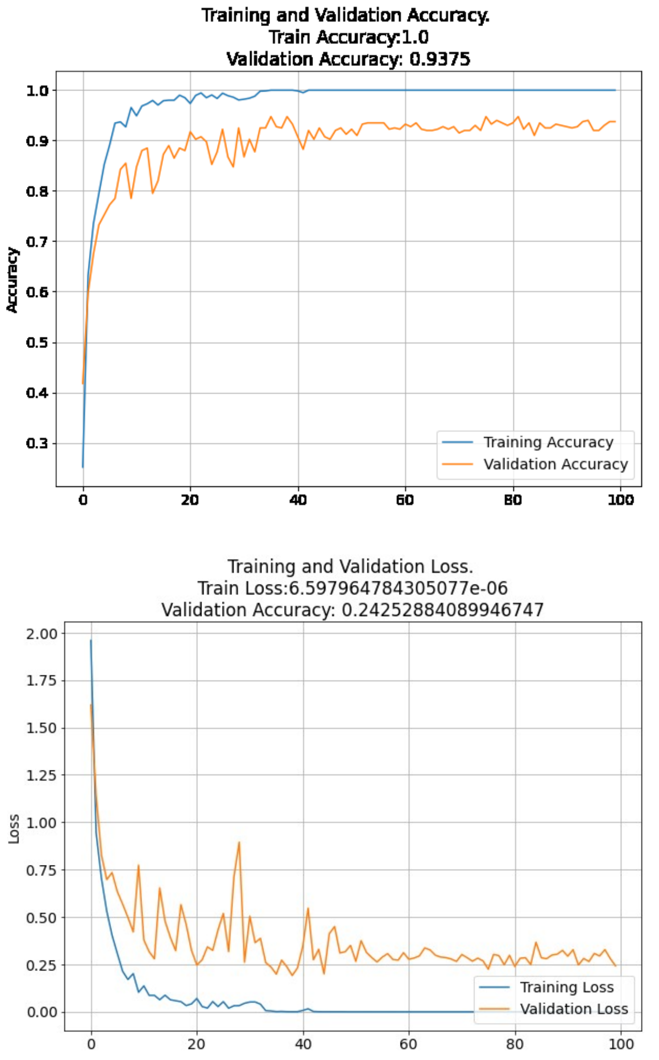

Fig. 4. Training and validation set accuracy and loss during training

The trained model was made to predict on the test dataset and an accuracy of 93.75% was achieved. The training loss was 6.5980e-06 whereas the validation loss was around 0.2425.

V. IMPLEMENTATION

The main motive of our work is not just building a model, but to provide a real-time implementation of the model. We have built a mobile application using Java and Android. The model was converted to a tensorflow lite model using tensorflow lite converter [19]. It identifies the image and displays the label.

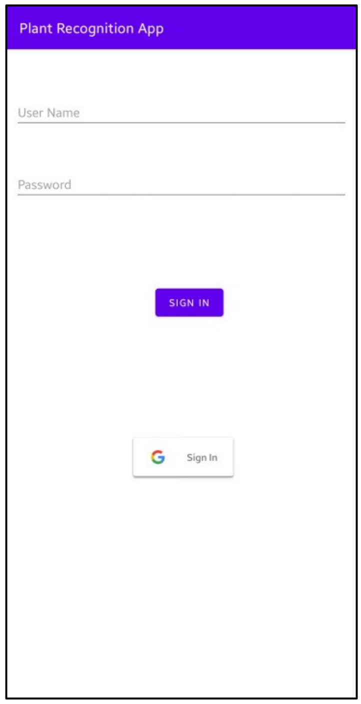

Fig.5 Sign In Page

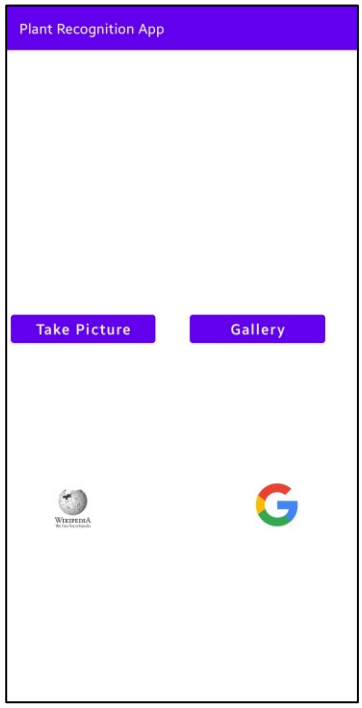

Fig.6 Homepage of the UI to recognize the plant

Fig.7 Prediction of the plant on uploading the image with the details of the plant on the android device

The application which includes an authentication system as seen in the Fig.5 takes an input of the leaf image using the upload option or using the camera as seen in the Fig.6. Once the image is captured or uploaded on to the pre trained model, it would return the predicted name of the plant as seen in the Fig.7. The predicted results are displayed on the page with the details of the plant.

VII. CONCLUSION

The approach discussed in this paper is one among many approaches in identifying the medicinal plants, but every brick of upgradation in this field was the drive for us to deploy a dense model and presenting it with a well-organized user interface. Contributing to this field of study, we wish our paper to be used as a helping hand for further research or development in another way of approach.

Having known the gap of research which we have confined only with leaf images, we would surpass this wall and explore towards training with natural hand images and implement a much more user-friendly solution to identify the medicinal plants.

REFERENCES

[1] India is home to over 8,000 species of medicinal plants – and they're increasingly under threat - https://scroll.in/article/954167/india-is-home-to-over-8000-species-of-medicinal-plant s-and-theyre-increasingly-under-threat

[2] Medicinal Plants. [cited 2022]; Available from: https://en.wikipedia.org/wiki/Medicinal_plants

[3] Amala Sabu, K Sreekumar and Rahul R Nair "Recognition of ayurvedic medicinal plants from leaves: a computer vision approach" Proceedings of Fourth International Conference on Image Information Processing, Jaypee University of Information Technology, Shimla, 21-23 December, 2017, pp: 1-5

[4] Ding Min Yue and Feng Qin "Plant leaf recognition based on naive Bayesian classification and linear discriminant analysis model" Proceedings of Fourth International Conference on Communication and Information Systems, Wuhan, China ,19-21 December,2019, pp. 191-196

[5] D Venkatraman and N Mangayarkarasi, "Computer Vision Based Feature Extraction of Leaves for Identification of Medicinal Values of Plants", Proceedings of IEEE International Conference on Computational Intelligence and Computing Research, Agni College of Technology, Chennai, Tamil Nadu, India, 15-16 December,2016, pp. 1-5

[6] B. Raja, M. Anand, V. Malathy and K. Sudhaman "Identification of Plants with their Medicinal Uses by Convolutional Neural Network" Proceedings of International Journal of Advanced Science and Technology, Vol.29, Issue No 6s,2020 pp.1401-1408

[7] Sue Han Lee, Chee Seng Chan, Wilkiny Paul and Remagninoz Paolo, "Deep-plant: plant identification with convolutional neural networks", proceedings of IEEE International Conference on Computational Intelligence and Computing Research, Quebec City, QC, Canada ,27-30 September,2015, pp: 452-456.

[8] Nghia Duong Trung, Luyl Da Quach, Hoang Minh Ngyuen and Chi-Ngon Nguyen "A Combination of Transfer Learning and Deep Learning for Medicinal Plant Classification" Proceedings of International Conference on Intelligent Information Technology, A Nang, Vietnam, Feburary,2019, pp:93-90

[9] Boran Şekeroğlu and İnan Yücel, "Leaves recognition system using a neural network", Proceedings of 12th International Conference on Application of Fuzzy Systems and Soft Computing, ICAFS, Vienna, Austria, 29-30 August,2016, pp:578-582

[10] Elhariri Esraa, Nashwa El-Bendary and Aboul Ella Hassanien, "Plant Classification System based on Leaf Features", Proceedings of IEEE International Conference on Computational Intelligence and Computing Research, Cairo, Egypt,22-23 December,2014, pp: 71-76

[11] A Gopal, S Prudhveeswar Reddy and V Gayatri, "Classification of Selected Medicinal Plants Leaf Using Image Processing" proceedings of IEEE International Conference on Machine Vision and Image Processing (MVIP),Coimbatore,India,14-15 December,2012, pp: 5-8

[12] Basavraj S Anami, Suvarna S Nandyal and A Govardhan "A Combined Color, Texture and Edge Features Based Approach for Identification and Classification of Indian Medicinal Plants", proceedings of International Journal of Computer Applications, Volume 6, Issue No.12, September 2010, pp:45-51

[13] Samreen Naeem, Aqib Ali, Christophe Chesneau, Muhammad H Tahir, Farrukh Jamal, Rehan Ahmad Khan Sherwani and Mahmood Ul Hassan "The Classification of Medicinal Plant Leaves Based on Multispectral and Texture Feature Using Machine Learning Approach" proceedings of Agronomy, 11.263.10.3390, 2021.

[14] Shashank M Kadiwal, Venkatesh Hegde, Shrivathsa NV, Gowrishankar S, Srinivasa A. H, Veena A, "A Survey of Different Identification and Classification Methods for Medicinal Plants" in the proceedings of 4th International Conference on Inventive Computation and Information Technologies, Coimbatore, India, 25-26 August,2022, in press.

[15] Manoharan, Samuel "Image Detection, Classification and Recognition of Leak Detection in Automobiles" Proceeding of Journal of Innovative Image Processing, Vol 01, Issue No 2, 2019, pp:61-70

[16] Dhaya, R. "Flawless Identification of Fusarium Oxysporum in Tomato Plant Leaves by Machine Learning Algorithm" Proceedings of Journal of Innovative Image Processing, Vol 02, Issue No 4, 2020, pp:194-201

[17] Segmented Medicinal Plants Dataset can be accessed from - htt ps://www.kaggle.com/dat aset s/rit eshranjansaroj/segment ed-medicinal-leaf-images

[18] To create diagrammatic models to represent certain workflows refer this link https://app.diagrams.net/

[19] To convert a tensorflow lite model to tensorflow lite model - https://www.tensorflow.org/api_docs/python/tf/lite/TFLiteConverter

[20] To build a convolutional neural network architecture from scratch – https://www.tensorflow.org/tutorials/images/cnn