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Identification of Medicinal Plants Using Machine Learning

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ABSTRACT: Traditional methods for identification and information retrieval fall short in providing real-time, accurate, and comprehensive details about these botanical resources. Our DL-based system aims to accurately classify medicinal plants based on images, providing detailed information on their medicinal contents. The model incorporates age restrictions, gender-specific considerations, and pregnancy restrictions, offering users guidelines for safe and effective utilization. Additionally, the system provides insights into the mode of use and recommended dosage for each detected medicinal plant. By merging advanced DL techniques with botanical knowledge, this project seeks to create a powerful tool for precise plant identification and informed usage, contributing to a more accessible and informed approach to natural healthcare. This project focuses on leveraging Deep Learning (DL) methodologies, specifically ResNet50 and VGG19 models, to address the challenge of classifying medicinal plants.

KEYWORDS: Botanical resources, medicinal plants, Deep Learning, ResNet50, VGG19

I. INTRODUCTION

In a world where the healing properties of medicinal plants play a vital role in natural healthcare, the accurate identification and understanding of these botanical treasures are essential. Deep Learning (DL), a subset of Artificial Intelligence (AI), offers a cutting-edge solution to the challenge of classifying medicinal plants. In this project, we leverage the power of DL models, specifically ResNet50 and VGG19, to create a sophisticated system that not only identifies medicinal plants with precision but also provides in-depth information on their medicinal contents, age restrictions, gender-specific considerations, pregnancy restrictions, mode of use, and recommended dosage. The vast array of medicinal plants poses a formidable challenge in precise identification and comprehensive information retrieval. Conventional methods often lack the accuracy and efficiency required for real-time and detailed analysis, hindering the widespread and informed use of these invaluable botanical resources for healthcare purposes.

By harnessing the capabilities of machine learning, we are not only streamlining the identification process but also enhancing our ability to discover and utilize the therapeutic potential of these invaluable botanical resources. This synergy between traditional wisdom and cutting-edge technology holds the promise of accelerating medicinal plant research, contributing to the development of new herbal remedies, and ultimately improving global healthcare. This pioneering project aims to revolutionize the identification and utilization of medicinal plants by relying solely on the power of Deep Learning. Through this innovative approach, we seek to empower individuals and healthcare professionals alike, enabling them to harness the healing potential of medicinal plants with precision and confidence, thus contributing to a healthier and more informed society.

II. LITERATURE REVIEW

- **Automatic Classification of Medicinal Plant Species Based on Color and Texture Features [2019]**
  Authors: Luciano D.S. Pacifico; Larissa F.S. Britto; Emilia G. Oliveira; Teresa B. Ludermir.

  In this paper, a new medicinal plant data set based on the extraction of texture and colour features from plant leaf images is developed. A complete automatic plant recognition system is proposed, and five well known machine learning classifiers such as Decision tree, K- Nearest Neighbours (KNN), Weighted K-Nearest Neighbour (WKNN), Random forest and Multi layer preceptor are tested as the recognition module. Experimental results showed that the best classifiers are able to obtain average accuracies over 97% on the proposed data set.

- **Real-Time Identification of Medicinal Plants using Machine Learning Techniques[2019]**
  Authors: Sivaranjani.C; Lekshmi Kalinathan; Amutha.R; Ruba Soundar Kathavarayan; Jegadish Kumar.K.J.

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Here the proposed system is which can identify the plant species based on the input leaf sample. An improved vegetation index, ExG-ExR is used to obtain more vegetative information from the images. the ExG-ExR index identifies a binary plant region of interest. The original color pixel of the binary image serves as the mask which isolates leaves as sub-images. The features of extracted leaf using Logistic Regression classifier with the accuracy of 93.3%.

- **AI Based Indigenous Medicinal Plant Identification[2020]**
  Authors: Anu Paulson; Ravishankar S

- In this system the performance of Convolutional Neural Network (CNN), and pretrained models VGG16, and VGG19 has been compared for leaf identification problem. The dataset proposed in this research work contains indigenous medicinal plants of Kerala. The dataset consists of leaf aVGG19 achieve an accuracy of 97.8% and 97.6% respectively, outperforms basic CNN.

- **Ayurvedic Plants Identification based on Machine Learning and Deep Learning Technologies [2023]**
  Authors: Rajani S; Veena M.N Department of MCA, PES College of Engineering, Mandya, India.

  The present work classifies locally available medicinal plants using leaf images. The experiment considers 100 species from every 15 different species, and a total of 1500 images are used in the experiment. In the current work, the accuracy of the proposed algorithm yields 98.7%.

- **An AI Based Approach for Medicinal Plant Identification Using Deep CNN Based on Global Average Pooling [2022]**
  Authors: Rahim Azadnia, Mohammed Maitham Al-Amid, Hame Mohammadi, Mehmet Akit Cifci, Avat Daryab and Eugenio Cavallo.

The proposed system Deep learning model consists of a CNN block for feature extraction and a classifier block for classifying the extracted features. The solution has been tested for three level of definitions (64x64, 128x128 and 256x256 pixel) images for leaf recognition for five different medicinal plants.

III. PROPOSED SYSTEM

The proposed system for identifying medicinal plants represents a paradigm shift in the field, leveraging the capabilities of machine learning, artificial intelligence, and advanced data analytics. This innovative approach aims to significantly enhance the accuracy and scalability of plant identification, addressing some of the limitations of the existing manual and semi-automated methods.One of the key advantages of the proposed system is the User interface which allows users to upload plant images and receive detailed information, including plant name, its medicinal properties and some related information.
Convolutional Neural Network and Deep Learning for Identification of Medicinal Plants, which is simple Identification system which has the capability to recognize different Plant species in a database. Pre-processing of the proposed frame work includes noise removal and Image Rescaling in colour images. Also, Augmentation techniques is used for more generalization of the model. After pre-processing, Identification is performed by using Resnet-50 architecture. Architecture layers are Convo2D, Maxpooling2D, Flatten, Dense, Dropout. Architecture layers of Resnet-50 are created using Keras Library in Python. After model training Validation and Testing is done for the new set of data and measuring its ability to correctly classify or predict the plant categories associated with that data.

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IV. METHODOLOGY AND DESIGN

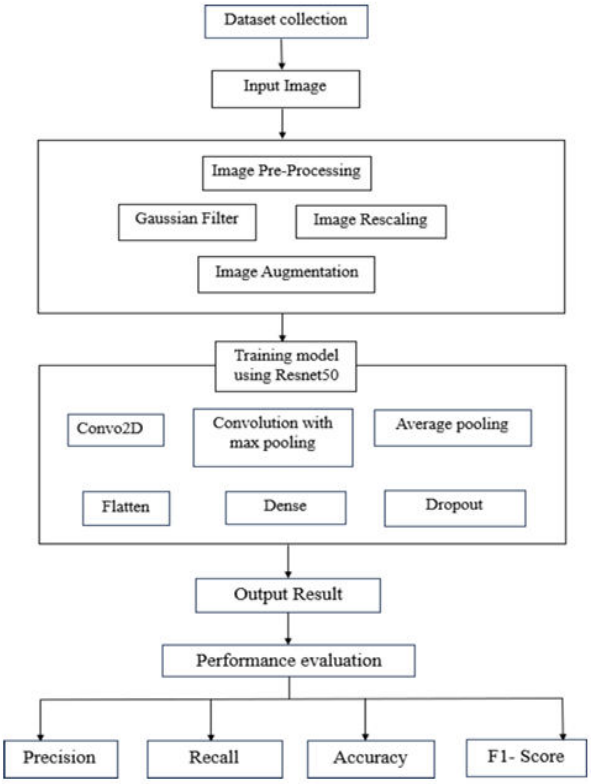

Fig 1: Flow chart of Module design

It starts with the collection of an existing dataset comprising diverse images of medicinal plant species, we are employing meticulous pre-processing techniques like Guassian Blur, Median Filter, Bilateral Filter and Image Rescaling to refine and augment the dataset's quality and diversity.

According to the system's architecture the utilization of ResNet50, a machine learning model like convolutional neural network renowned for its process in image classification tasks. Leveraging transfer learning, we fine-tune ResNet50 on our dataset, capitalizing on pre- trained weights from ImageNet to expedite training while ensuring the model learns pertinent features specific to medicinal plants.

For the core of our system, we select a state-of-the-art machine learning model suitable for image recognition tasks. In this proposal, we opt for ResNet50, a deep convolutional neural network (CNN) architecture known for its exceptional performance in image classification tasks. The model is trained on the pre-processed dataset using transfer learning, leveraging the pre-trained weights from ImageNet or a similar dataset.

This approach enables the model to learn relevant features specific to medicinal plants while significantly reducing the training time and resource requirements. Following training, the performance of the model is evaluated using metrics such as accuracy, precision, recall, and F1-score on a separate validation dataset. This step ensures that the model generalizes well to unseen data and accurately identifies medicinal plants across various species and conditions.

DATASET DETAILS: Indian Medicinal plant datasets is a repository that consists of medicinal plants images. The images are captured with varying background without any environment constraints. Here, we consider both leaf and plant images.

DATA PROCESSING: After the images are extracted from the existing datasets, the dataset is preprocessed using various methods:

Gaussian Blur: Reduces noise and detail in the image and convolves the image with a Gaussian filter.

Image Rescaling: Adjusts the size of the image and also resizes the image to a desired resolution. The image is resized using OpenCV library using the function cv2.imread.Resize images to a standard size (e.g., 224x224 pixels) for consistency. Apply data augmentation techniques (e.g., rotation, flipping) to artificially increase the dataset size and

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improve model generalization.

IMAGE AUGMENTATION:

Increased Dataset Size: By generating variations of existing images through augmentation (e.g., rotations, flips, zooms), effectively expand the dataset, allowing the model to generalize better to unseen data.

Improved Generalization: It introduces variability, making the model more robust to different orientations, scales, and lighting conditions, enhancing its generalization capabilities.

TRAINING MODELS:

ResNet50: ResNet50 skip connections help mitigate the vanishing gradient problem, making it easier to train deep networks. Its depth and capacity make it capable of capturing intricate features from images, leading to high accuracy in identification tasks. ResNet-50 can extract discriminative features from images of medicinal plants. These features can include leaf shape, color, texture, vein patterns, and other botanical characteristics that are crucial for plant identification. This is beneficial when dealing with complex feature hierarchies, which may be essential for distinguishing subtle differences between different plant species.

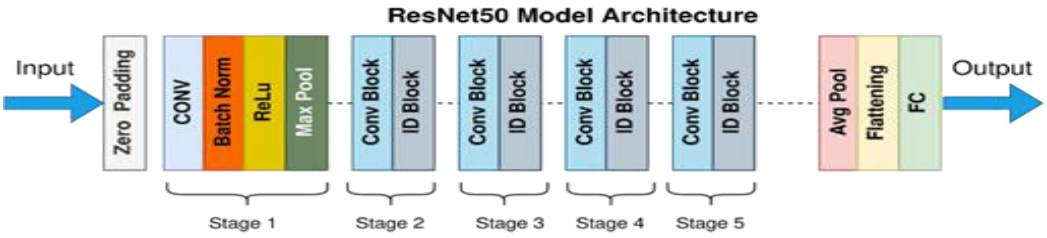

Fig 2: Resnet model architechure

ResNet50 has been trained on the large ImageNet dataset, achieving an error rate on par with human performance, making it a powerful model for various image classification tasks such as object detection, facial recognition and medical image analysis.

Use in Medicinal Plant Classification: ResNet's skip connections help mitigate the vanishing gradient problem, making it easier to train deep networks. This is beneficial when dealing with complex feature hierarchies, which may be essential for distinguishing subtle differences between different plant species.

V. EXPERIMENTAL SETUP AND RESULT ANALYSIS

The utilization of machine learning techniques for medicinal plant identification has shown significant results, particularly through the integration of advanced algorithms like ResNet50. This approach showcased impressive accuracy in distinguishing between different medicinal plant species. By tapping into the capabilities of deep learning, the model effectively scrutinized the nuanced features within plant images, facilitating precise identification even when dealing with visually similar species.

Incorporating Flask into the backend infrastructure played a pivotal role in optimizing communication between the machine learning model and the user interface. This integration not only improved the system's efficiency but also enabled seamless real-time interactions, empowering users to effortlessly engage with and leverage the identification functionalities. Flask's lightweight and adaptable characteristics proved to be highly advantageous, facilitating swift development and deployment of the backend components.

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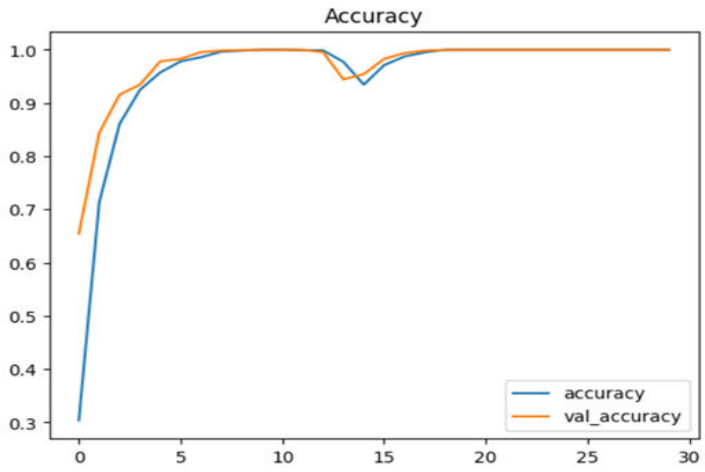

Fig 3: Resnet training model accuracy plot

The given figure shows the accuracy plot for training a ResNet model for identifying medicinal plants shows both training accuracy and validation accuracy over 30 epochs. The model demonstrates rapid convergence, with both training and validation accuracy increasing rapidly within the first few epochs, reaching above 90% accuracy around epoch 5. After approximately 10 epochs, the accuracy curves plateau, with both training and validation accuracies remaining close to 1.0, indicating almost perfect accuracy. There are minor dips in accuracy around epochs 15 and 18, but these recover quickly. The high accuracy of the model suggests it effectively learns the features of medicinal plants.

	Precision	Recall	F1-score
Accuracy			0.82
Macro avg	0.85	0.82	0.82
Weighted avg	0.85	0.82	0.82

Fig 4 : The classification report of the trained model

The table displays the evaluation metrics for a classification model applied to medicinal plants after training. The model's overall accuracy is 0.82, meaning it correctly predicts 82% of the instances. The macro average precision is 0.85, recall is 0.82, and the F1-score is 0.82, indicating that the model performs well across all classes equally, regardless of their frequencies. Similarly, the weighted average precision is 0.85, recall is 0.82, and the F1-score is 0.82, reflecting the model's performance while accounting for class imbalances. These consistent scores suggest that the model maintains a good balance between precision and recall, achieving robust performance in classifying medicinal plants.

Apart from the technical aspects, the user-centered design of the frontend interface played a pivotal role in enhancing the overall efficacy of the system. The interface was carefully crafted to prioritize both usability and accessibility, guaranteeing that users could readily access vital information regarding the identified plant's accuracy.
Overall, this pioneering project aims to revolutionize the identification and utilization of medicinal plants by relying solely on the power of Deep Learning. Through this innovative approach, we seek to empower individuals and healthcare professionals alike, enabling them to harness the healing potential of medicinal plants with precision and confidence, thus contributing to a healthier and more informed society.

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VI. CONCLUSION

As the technology are blooming with emerging trends this project represents a significant stride towards bridging the gap between traditional herbal knowledge and modern technology through the application of Deep Learning (DL) methodologies. The utilization of ResNet50 model has proven instrumental in addressing the inherent challenges of classifying medicinal plants.

Moreover, the system's ability to provide insights into the mode of use and recommended dosage for each detected medicinal plant ensures a holistic understanding of their applications. This feature is particularly crucial in empowering individuals and healthcare professionals to make informed decisions about plant-based treatments.

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