ISSN No : 2454-4221 (Print)
ISSN No : 2454-423X (Online)
International Journal of Research in Advanced Computer Science Engineering
A Peer Reviewed Open Access International Journal
www.ijracse.com

Medicinal Plant Detection Using Deep Learning

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Abstract
This paper focuses on leveraging Deep Learning (DL) methodologies, specifically the ResNet50 model, to address the challenge of classifying medicinal plants. Traditional methods for identification and information retrieval fall short of 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 health care.

Keywords: Medicinal plant, detection, deep learning, CNN, resNet50.

Introduction
The plants serve the entire human kind with food, clothing, shelter and medicine from time immemorial. As per statistics from WHO, it is estimated that 80% of people in India depend on herbal medicines obtained from plant extracts. Many health ailments like fever, headache and diarrhea were treated using various herbal machines prepared from the leaf, stem, bark, and root extracts of the plant. The medicinal plants and their uses need to be prevented for future generations in digital form. Ancient India widely practiced Herbal medicine made out of plant extraction the plants and their leaves as it is non-toxic and has no side effects. However many of these medicinal plants are in wild forests. Only an expert can identify such plants with features like leaf shape, color, size, and texture and give us some visual judgment to classify the medicinal plants.

As a result, exploration into new ways to classify herbal specifics has exploded in recent times. It's now extensively accepted that the factory's splint has characteristics that grease harvesting and exploration. Therefore, it's naturally used as the primary system of relating all medicinal shops. Because of recent improvements in image processing, automatic computer image identification is now extensively used in this field. There are millions of factory species on Earth; some are toxic to humans, others are used in drugs, and yet others are on the verge of extermination.

Cite this article as: S.Harini, Pragati Kumar Ray, G.Sowjanya, V.Bharath Kumar Varma, M.Suneetha, "Medicinal Plant Detection Using Deep Learning", International Journal of Research in Advanced Computer Science Engineering, (IJRACSE), Volume 9 Issue 10, March 2024, Page 12-23.

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Shops are vital not just to mortal actuality, but also to the entire stability of the food chain. The main uses for medicinal shops are herbal, Ayurvedic, and traditional drugs. Herbal shops are shops that can be used to treat ailments naturally. Nearly 80 people worldwide still exercise traditional drugs. Herbal shops are those whose roots, stems, or leaves can be used as factors in the product of medicinal. Most of the time, you may detect this kind of medicinal factory in the forestland. By fetching sauces, they can gain a lot about their characteristics, and one strategy is to examine the leaves. To save factory species, accurate factory exploration and bracket are essential.

Ayurvedic croakers used to gather shops and make treatments for their cases. This system is still used by a small number of people moments. Ayurvedic drug manufacture and distribution moment produces further than Rs. 4000 crores in periodic profit. There are around 8500 Ayurvedic medicine manufacturers in India. The quality of the raw constituents used to make Ayurveda treatments has come under free as the Ayurvedic assiduity has become more capitalized. Women and children, who warrant the technical moxie necessary to identify the applicable remedial sauces, now gather the shops from the wild. Incorrect or substitute medicinal shops are constantly delivered to manufacturing installations. Most of these installations warrant proper quality control procedures to check these shops. Also, there's a considerable lot of nebulosity due to indigenous differences in names. Some shops arrive dry, which makes homemade identification mainly more delicate. Ayurveda remedies are useless when medicinal sauces are used inaptly. Unexpected consequences are also a possibility. In this environment, strong quality control procedures must be assessed on Ayurveda medicinal and raw accoutrements employed by the assiduity to guard the assiduity's current growth while maintaining the effectiveness and credibility of specifics. Nevertheless, because expert opinions are available, manually relating medicinal shops is as inversely delicate and time-consuming as relating any other form of the factory. Motivated by these hurdles, experimenters constructed colourful independent shops or splint recognition systems, where most of them applied Deep Learning (DL) methodologies.

Deep Learning (DL), a subset of Artificial Intelligence (AI), offers a cutting-edge solution to the challenge of classifying medicinal plants. In this paper, we leverage the power of DL models, specifically ResNet50, 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.

Problem Statement

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.

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Solution

We propose an innovative approach solely based on Deep Learning, utilizing state-of-the-art models ResNet50. By training these DL models on extensive datasets containing images of various medicinal plants, our goal is to create a powerful system that accurately classifies plants and provides a wealth of information on their medicinal attributes.

Objective

Building a Medicinal Plant Classification System

The primary objective of this paper is to design and implement an accurate and robust medicinal plant classification system using deep learning methodologies. Commencing with the collection of a diverse dataset comprising images of 80 distinct medicinal plant classes from Kaggle, the project progresses to the importation of the dataset for subsequent preprocessing. During preprocessing, techniques such as resizing and augmentation are applied to enhance image quality. The dataset is then strategically split into training (70%), testing (15%), and validation (15%) sets to facilitate effective model training and evaluation.

The core focus lies in the selection and implementation of deep learning models, specifically RESNET50 renowned for their prowess in image classification tasks. Subsequent stages involve training these models on the prepared dataset to enable them to recognize intricate patterns and features associated with medicinal plants. Rigorous validation is conducted to fine-tune model parameters and ensure optimal performance.

The paper concludes with thorough testing of the trained models on a separate test set, evaluating their accuracy and performance metrics. Additionally, an interactive HTML page is developed to provide users with a seamless interface for uploading images for classification. The integration of these components into Flask results in a comprehensive web application, contributing to the field of botany and healthcare by offering a sophisticated tool for medicinal plant identification.

Scope

Advancing Medicinal Plant Recognition Technology

The scope of this paper extends to multiple dimensions within the domain of medicinal plant recognition. Through the careful collection and preprocessing of a diverse dataset, the paper ensures that the classification system is equipped to handle a wide array of medicinal plant classes. The strategic splitting of the dataset into training, testing, and validation sets reflects a commitment to robust model development, allowing for comprehensive training and evaluation phases.

The selection of deep learning models known for their efficacy in image classification broadens the scope of the project, aiming to achieve high accuracy in recognizing intricate features of medicinal plants. By incorporating RESNET50 the project aligns with state-of-the-art technologies in deep learning.

The paper's impact extends further with the creation of an interactive HTML page, providing users with a user-friendly interface

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for medicinal plant image classification. The integration of these components into the Flask framework ensures accessibility and usability, making the system applicable to diverse user groups, including researchers, botanists, and plant enthusiasts. Overall, the scope of this project encompasses advancements in medicinal plant recognition technology, contributing valuable tools for botanical and healthcare applications.

Existing System

Over the past decade, numerous studies have emerged to create tools for the accurate identification of plants. There are many existing systems with their respective features using different Machine learning and Deep learning models likeDecision Tree (DT), K-Nearest Neighbours (KNN), Weighted K-Nearest Neighbours (WKNN), Random Forest (RFC), and Multi-Layer Perceptron trained with Back propagation algorithm (MLP-BP) Logistic Regression, Multi-class classifier with different accuracies.

Here's a glimpse into what existing systems are accomplishing:

CNNs are the rockstars of image recognition, and medicinal plant detection is no exception. Existing systems heavily rely on CNNs to extract features from plant images. These features could be shapes, textures, or color patterns that differentiate one medicinal plant from another.

Pre-trained models get a head start: Many systems leverage pre-trained CNN architectures like VGG-19 or EfficientNet. These models, trained on massive image datasets, can be fine-tuned for medicinal plant classification, reducing training time and effort.

Researchers are actively developing systems for real-time medicinal plant identification, particularly using mobile apps. This can be a game-changer for field studies, citizen science initiatives, and even personal use in identifying plants.

Proposed System

In the realm of medicinal plant detection, the integration of diverse deep learning models such as ResNet50 emerges as a comprehensive and robust strategy. Each of these models brings distinct advantages and characteristics to the table, contributing to the efficacy of the overall detection system. ResNet50, renowned for its deep residual learning architecture, excels in capturing intricate features within medicinal plant images, enhancing the model's ability to discern subtle botanical details. The ResNet50 underscores a holistic approach to medicinal plant detection, harnessing the strengths of each model to create a synergistic system poised to contribute significantly to the fields of ethno botany, pharmacology, and biodiversity conservation.

ResNet50 is a specific type of convolutional neural network (CNN) architecture well-suited for medicinal plant detection tasks. At its core, ResNet50 is a 50-layer deep CNN adept at extracting intricate features from images. These features could be specific textures, shapes, or vein patterns on leaves that differentiate medicinal plants from other flora.

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LITERATURE SURVEY

YEAR	AUTHOR NAME	TITLE NAME	METHODS USED	RESULT
2023	Nidhi Tiwari1 , Bineet Kumar Gupta, Abhijityaditya Prakash3 , Mohammad Husain4 , Devendra Singh5	Applying Deep Learning and Machine Learning Algorithms for The Identification of Medicinal Plant Leaves Based on Their Spectral Characteristics	KNN CNN SVM Naive Bayes	The hierarchical layer structure further enhanced the detection process, resulting in a robust model for identifying and classifying leaf diseases through advanced image processing.
2023	Muhammad Salman Ikrar Musyaffaa , Novanto Yudistiraa , Muhammad Arif Rahmana	Indonesia Medicinal Plants Recognition using Transfer Learning and Deep Learning	ResNet34 DenseNet121 VGG11_bn	Transfer learning, specifically using DenseNet121, achieved the best accuracy of 88.69% for the Vietnam Medicinal Plant Dataset and 87.4% for the Indonesia Medicinal Plant Dataset.
2023	Wirdayant, K A Dwiwijaya, Suriani, D R Rochmawatiand F S Putri1	Identification of Herbal Plants Using Morphology Method and K-Nearest Neighbour Algorithm	KNN K=3 K=5 K=7 K=9	The herbal plant identification system using morphological features achieved an 80% accuracy in classification with the K-NN algorithm (k=3).
2023	Noor Aini MohdRoslana, Norizan Mat Diaha , Zaidah Ibrahima, Yuda Munarko b,Agus Eko Minarnob,	Automatic plant recognition using convolutional neural network on Malaysian medicinal herbs: the value of data augmentation	CNN	. The herbs real dataset achieved an average accuracy of 75%, while the herbs augmented dataset demonstrated a higher average accuracy of 88%.
2022	Kayiram Kavitha, Prashant Sharma, Shubham Gupta, R.V.S. Lalitha	Medicinal Plant Species Detection using Deep Learning	MobileNet, ResNet50, Inception v3, Xception, DenseNet121	The comprehensive evaluation using various metrics demonstrates the efficacy of the advanced computer vision and deep learning architectures.

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2022	Owais A. Malik , Nazrul Ismail , Burhan R. Hussein and Umar Yahya	Automated Real-Time Identification of Medicinal Plants Species in Natural Environment Using Deep Learning Models—A Case Study from Borneo Region	EfficientNet-B1-based deep learning model	The proposed deep-learning-based system for real-time species identification of medicinal plants in the Borneo region achieved a significant improvement of over 10% accuracy
2022	Jafar Abdollahi	Identification of Medicinal Plants in Ardabil Using Deep Learning	CNN-mobile net v2	The successful use of artificial intelligence in identifying medicinal plants based on leaf traits showed an impressive 98.05% accuracy.
2022	Himanshu Chanyal, Rakesh Kumar Yadav, Dilip Kumar J Saini	Classification of Medicinal Plants Leaves Using Deep Learning Technique	SVM KNN ANN	Achieving higher accuracy in plant identification could significantly impact medicinal plant use in the medical field and contribute to environmental conservation.
2021	Nayana G. Gavhale, Dr.A.P.Thakare	Identification of Medicinal Plants by Visual Characteristics of Leaves and Flowers	CNN	The combination of shape, color, and texture features demonstrated the algorithm's aptness for accurate leaf identification.
2020	Krisna Hany Indrani, Duman Care Khrisne , I Made Arsa Suyadnya	Android Based Application for Rhizome Medicinal Plant Recognition Using SqueezeNet	Convolutional Neural Network (CNN) methods with SqueezeNet architecture model.	The study successfully developed an Android application using a Convolutional Neural Network with SqueezeNet architecture to recognize medicinal plant rhizomes.
2020	Raisa Akter, Md Imran Hosen	CNN-based Leaf Image Classification for Bangladeshi Medicinal Plant	CNN	The methodology's promising results, including the analysis of single and compound leaf images,

		Recognition		position it favourably against existing approaches.
2017	Manojkumar P, Surya C. M., Varun P. Gopi	Identification of Ayurvedic Medicinal Plants by Image Processing of Leaf Samples	Multi-Layer Perceptron	A unique feature set combination to identify plants from dry leaves has been proposed with a minimum number of features, getting identification rates up to 94.5%.
2016	Pushpa BR, Anand C and Mithun Nambiar	Ayurvedic Plant Species Recognition using Statistical Parameters on Leaf Images	Feature extraction, Leaf factor, Ayurvedic Leaf Classification	The proposed methodology is tested with 208 different sample leaf images of 26 different species and noticed positive response in most cases.
2014	Mohd Shamrie Sainin , Taqiyah Khadijah Ghazali and Rayner Alfred	Malaysian Medicinal Plant Leaf Shape Identification and Classification	SMO, J48, NB, kNN (k=3) and RF DECIML	The DECIML classifier demonstrated promising results, motivating further research to preserve traditional knowledge through computing
2013	Yeni Herdiyeni , Elvira Nurfadhilah, Ervizal A.M. Zuhud , Ellyn K. Damayanti , Kohei Arai , Hiroshi Okumura	A Computer Aided System For Tropical Leaf Medicinal Plant Identification	PNN method with the PDR classifier	The implemented Computer-Aided System for tropical leaf medicinal plant with an accuracy of 74.67% using the PNN & PDR method

Methodology

1.Dataset Collection:

To conduct a comprehensive analysis, it is imperative to curate a diverse and representative dataset of medicinal plant images. Utilizing reputable sources such as Kaggle, gather images that span a broad spectrum of plant species. Ensure diversity in the dataset by including various families, genera, and species, accounting for geographical and climatic variations. This diversity will enhance the model's ability to generalize and accurately identify medicinal plants across different contexts.

Pay attention to the quality and authenticity of the images, considering factors such as resolution, lighting conditions, and image variations. Properly annotate the dataset with

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accurate plant species labels to facilitate supervised learning during model training. Additionally, it's beneficial to include images capturing different plant parts (leaves, stems, flowers, etc.) and various stages of plant growth. This ensures that the model learns features relevant to medicinal plant identification across different developmental phases.

By adopting this analytical approach to dataset gathering, the resulting data will serve as a robust foundation for training a machine learning model capable of accurately recognizing a diverse array of medicinal plants.

1.Aboutdataset: The "Indian Medicinal Leaves Image Datasets" is a repository that contains a collection of images featuring medicinal plants, specifically focusing on leaves. The dataset is intended for use in the field of medicinal plant research and related applications. The images are captured under diverse conditions, including varying backgrounds, and there are no specific constraints related to the environment in which the images were taken.

2. Data Import and Exploration: Import the dataset and perform exploratory data analysis (EDA) to understand the distribution of classes, image sizes, and potential challenges in the data.

3. Preprocessing: 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 improve model generalization.

4. Dataset Splitting: Split the dataset into training, testing, and validation sets (e.g., 70%, 15%, 15%) to facilitate model training and evaluation.

5. Model Selection: Choose deep learning models suitable for image classification, such as RESNET50. Pre-trained models can be used for transfer learning.

6. Model Training: Initialize the selected model with pre-trained weights (if applicable).
Fine-tune the model on the training dataset, adjusting parameters to adapt to medicinal plant features.

7. Validation: Evaluate the trained model on the validation set to monitor performance and prevent overfitting.
Adjust hyper parameters if necessary.

8. Testing: Assess the model's performance on the separate test set to measure its accuracy, precision, recall, and F1 score.

9. HTML Page Creation: Develop an interactive HTML page allowing users to upload images for classification.
Utilize frameworks like HTML, CSS, and JavaScript to create an intuitive user interface.

10. Flask Integration: Integrate the trained models with Flask, a web framework for Python, to create a web application.

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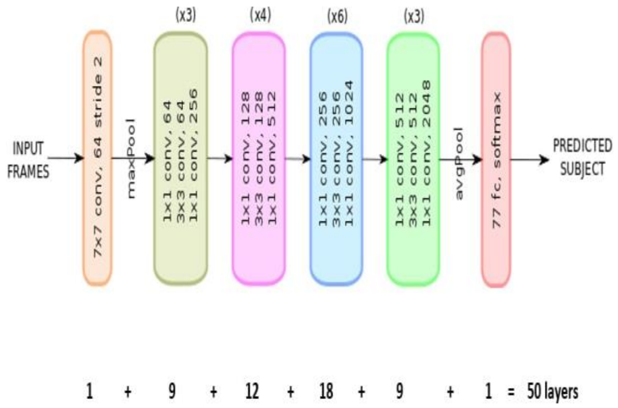
Incorporate the HTML page into the Flask application, enabling users to interact with the medicinal plant classification system.

11. Deployment: Deploy the Flask application on a server to make it accessible over the web.
Algorithms

Let's delve into a more analytical overview of the deep learning model – ResNet50 and discuss its relevance for medicinal plant classification:

ResNet50:



ResNet50 is a deep convolutional neural network architecture commonly used for image classification. Here's a simplified breakdown of its layers:
Input Layer: Takes in the input image.

Convolutional Layers (Conv): These layers perform convolution operations to extract features from the input image. ResNet50 has multiple stacks of convolutional layers.
Max Pooling Layer (MaxPool): Used to down sample the spatial dimensions of the input volume.

Residual Blocks: The unique feature of ResNet. These blocks contain multiple convolutional layers with shortcut connections. They help mitigate the vanishing gradient problem and enable the training of very deep networks.

Average Pooling Layer (AvgPool): Reduces the spatial dimensions of the input by taking the average of each region.

Fully Connected Layer (FC): Typically found towards the end of the network, these layers connect every neuron from one layer to every neuron in the next layer, ultimately leading to the output layer.

Softmax Activation Layer: Often used in the final layer for multi-class classification problems. It converts the raw scores of the network into probabilities

Uses in medicinal plant classification:

- The Vanishing Gradient Problem: In deep neural networks, as the backpropagation algorithm traverses through numerous layers during training, gradients tend to diminish, leading to challenges in updating earlier layers' weights. This phenomenon is known as the vanishing gradient problem.
- Benefit of Skip Connections: ResNet50 introduces skip connections, or residual connections, that enable the network to skip one or more layers during training. This architectural innovation alleviates the vanishing gradient problem analytically by allowing the direct flow of gradients through the skip connections.
- Hierarchical Feature Extraction: In medicinal plant classification, the nuances

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distinguishing various plant species may manifest as subtle and complex features at different hierarchical levels. Analytically, ResNet50's skip connections facilitate the efficient capture of these intricate features, promoting the model's ability to discern subtle differences between different plant species.

- Analytical Significance of Depth: ResNet50's deeper architecture provides the capacity to capture hierarchical features with a greater degree of complexity. This depth is analytically advantageous in tasks where the classification relies on the recognition of detailed patterns and variations among medicinal plant images.

Practical Implications:

- Training Efficiency: The analytical advantage of ResNet50 in mitigating the vanishing gradient problem translates into more efficient training. This is particularly crucial in medicinal plant classification, where the model needs to learn and generalize from a diverse set of plant images, each with unique characteristics.
- Accuracy in Subtle Feature Recognition: Analytically, ResNet50's architecture contributes to the model's ability to recognize and leverage subtle differences, making it well-suited for tasks requiring precision in distinguishing between closely related plant species based on leaf characteristics.
- Generalization to Complex Datasets: In medicinal plant datasets characterized by a rich variety of plant species, ResNet50's analytical prowess in handling complex feature hierarchies enhances its generalization capabilities, leading to improved accuracy in classification tasks.

Conclusion

In conclusion, this paper 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. The limitations of conventional methods for identification and information retrieval have been overcome by our DL-based system, providing real-time, accurate, and comprehensive details about these botanical resources.

The incorporation of age restrictions, gender-specific considerations, and pregnancy restrictions into the model adds a layer of sophistication, offering users invaluable guidelines for the safe and effective utilization of medicinal plants. This not only enhances user safety but also contributes to the responsible promotion of herbal remedies within diverse demographic contexts.

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.

By merging advanced DL techniques with botanical knowledge, this paper has successfully created a powerful tool for precise plant identification and informed

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usage. This not only contributes to the field of natural healthcare but also aligns with the growing global interest in sustainable and holistic approaches to well-being.

In the broader context, the outcomes of this paper hold promise for promoting a more accessible and informed approach to natural healthcare. As we continue to unlock the potential of DL in the realm of medicinal plant classification, we envision a future where the convergence of technology and traditional wisdom leads to a harmonious integration of natural remedies into modern healthcare practices.

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