GMR Institute of Technology
An Autonomous Institute Affiliated to JNTU-GV Vizianagaram

GMRIT
Training Tomorrow's Engineers Today

Medicinal Plant Identification using Deep Learning Techniques

A Term paper report submitted in partial fulfillment of the requirement for the Award of degree

BACHELOR OF TECHNOLOGY
in
COMPUTER SCIENCE AND ENGINEERING

Submitted
By

B. Surya Charan
22341A0515

Under the esteemed guidance of

Dr.P. Kanchanamala,
Associate Professor,
Dept. of Computer Science & Engineering

GMR Institute of Technology

An Autonomous Institute Affiliated to JNTU-GV, Vizianagaram

(Accredited by NBA, NAAC with ‘A’ Grade & ISO 9001:2015 Certified Institution)

GMR Nagar, Rajam – 532127

Andhra Pradesh, India

November 2024

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that term paper report titled "Medicinal Plant Identification using Deep Learning Techniques" submitted by B. Surya Charan bearing Reg. No:22341A0515 has been carried out in partial fulfillment for the award of Bachelor of Technology in Computer Science and Engineering of GMRIT, Rajam affiliated to JNTUGV, Vizianagaram is a record of bonafide work carried out by them under my guidance & supervision. The results embodied in this report have not been submitted to any other University or Institute for the award of any degree.

Signature of the Supervisor

Dr. P. Kanchanamala
Associate Professor
Department of CSE
GMRIT, Rajam.

Signature of the H.O.D

Dr. A V Ramana,
Professor and Head
Department of CSE
GMRIT, Rajam.

The report is submitted for the viva-voce examination held on ………………..

Signature of Internal Examiner

Signature of External Examiner

ACKNOWLEDGEMENT

It gives me an immense pleasure to express deep sense of gratitude to my guide, Dr. P. Kanchanamala, Associate Professor, Department of Computer Science and Engineering of whole hearted and invaluable guidance throughout the report. Without her sustained and sincere effort, this report would not have taken this shape. She encouraged and helped me to overcome various difficulties that I have faced at various stages of my report.

I would like to sincerely thank Dr. A V Ramana, Professor & HOD, Department of Computer Science and Engineering, for providing all the necessary facilities that led to the successful completion of my report.

I take privilege to thank our Principal Dr. C.L.V.R.S.V.Prasad, who has made the atmosphere so easy to work. I shall always be indebted to them.

I would like to thank all the faculty members of the Department of Computer Science and Engineering for their direct or indirect support and also all the lab technicians for their valuable suggestions and providing excellent opportunities in completion of this report.

B. Surya Charan

22341A0515

INDEX

CONTENTS	PAGE NO
CERTIFICATE	i
ACKNOWLEDGEMENT	ii
INDEX	iii
ABSTRACT	iv
Chapter 1. INTRODUCTION	1
Chapter 2. LITERATURE SURVEY	2
Chapter 3. METHODOLOGY	11
Chapter 4. CASE STUDY	18
Chapter 5. RESULTS & DISCUSSION	21
Chapter 6. CONCLUSION	25
REFERENCES	26

ABSTRACT

In recent years, the automatic identification of medicinal plants has gained significant attention due to the growing demand for natural therapeutic resources and advancements in computer vision technologies. This study presents a novel deep learning-based approach for identifying plant species using leaf images. A unique integrated model, combining MobileNetV3 and VGG16 architectures is proposed to address the challenges of plant identification. The dataset utilized in this research comprises high-resolution images of 20 different leaf species, sourced from publicly available online repositories. Each species is represented by multiple images under varying conditions, including changes in illumination and leaf orientation. The images are pre-processed` and used to train the integrated model, which automatically extracts features such as leaf shape, colour, and texture. The convolutional layers of the network, particularly those in VGG16, are adept at detecting fine-grained details, while MobileNetV3 contributes to improved computational efficiency, enabling real-time deployment on mobile devices. After training the integrated model, it achieves an impressive accuracy of 95% on a test set, demonstrating its high precision in identifying plant species based on leaf characteristics. The proposed method not only contributes to the field of plant identification but also offers a scalable and efficient solution for large-scale plant species recognition using deep learning techniques.

Keywords: Deep Learning, Convolutional Neural Networks (CNNs), Augmentation, MobileNetV3, VGG16, Performance Analysis.

INTRODUCTION

The identification of medicinal plants has become increasingly important due to the rise in demand for natural remedies and the advances in computer vision technology. Leveraging deep learning has proven to be particularly effective for this purpose, allowing for automated and efficient analysis of plant characteristics such as leaf shape, colour, and texture, which are essential for accurate species recognition [1][2]. Various studies have explored the application of deep learning architectures, including convolutional neural networks (CNNs) and edge-based segmentation methods, to enhance the identification process [2][3].

Recent research highlights the benefits of integrating multiple deep learning architectures for improved accuracy and efficiency. For instance, combining models like MobileNetV3 and VGG16 has shown promise for plant identification tasks, with MobileNetV3 offering computational efficiency suitable for mobile deployment, and VGG16 excelling at capturing fine-grained details in leaf images [1][4]. Such integration allows for real-time identification of plant species, which is essential for applications in resource-limited settings [5][6].

Publicly available datasets featuring high-resolution images of various plant species under different conditions, such as varying lighting and leaf orientation, have also contributed significantly to this field. Utilizing these datasets, researchers have been able to train deep learning models that are not only accurate but also robust against environmental variations [7][8]. This robustness is vital for developing scalable, mobile-ready applications that can support real-time identification in diverse natural settings [9][10]. Recent studies suggest that approaches such as global average pooling can enhance the classification accuracy of deep learning models by emphasizing distinguishing features across various plant species [15]. This method has been particularly effective in CNN-based models where detailed leaf characteristics are essential for accurate recognition [1][15]. Studies emphasize the importance of high-resolution, diverse datasets to capture the variability of natural conditions. Some research applies data augmentation techniques to simulate environmental changes, which makes the models more resilient and adaptable to real-world scenarios [1][12].

Overall, the application of deep learning in medicinal plant identification represents a significant advancement, with the potential to revolutionize how we approach plant species recognition. This research contributes to the field by developing a high-accuracy, efficient model that combines the strengths of MobileNetV3 and VGG16, ultimately pushing forward the capabilities of real-time, mobile-based medicinal plant identification [1][11].

LITERATURE SURVEY

Reference 1:

Real-Time Identification of Medicinal Plants Using Deep Learning Techniques (2024, Girinth et al.) focuses on building a system capable of identifying medicinal plants in real-time, leveraging CNN and MobileNetV3 for efficient feature extraction and classification. The objective is to make plant identification accessible and user-friendly for practical applications. Achieving 90% accuracy, the study emphasizes the efficiency of CNNs in automated feature extraction but highlights challenges with dataset quality and rare species identification. The methodology also includes image acquisition and preprocessing to ensure consistency. However, the system struggles with varied environmental conditions and inconsistent lighting. Methodologies: Convolutional Neural Network, MoblieNetV3, Image Acquisition, Preprocessing.

Reference 2:

CNN and Edge-based Segmentation for Medicinal Plant Identification (2024, Kumar & Kumar) combines CNN for feature extraction with edge-based segmentation to improve plant structure delineation. The methodology employs advanced image processing for enhancing images before classification, aiming for high precision in medicinal plant identification. Although robust in its segmentation capabilities, the system is computationally expensive, making it less viable for real-time applications. The integration of edge-based methods with CNNs helps in extracting intricate details of plant structures, but performance metrics were not explicitly provided in the study.

Reference 3:

A Deep Learning Approach for Herbal Plant Detection and Recognition (2024, Giridharan et al.) proposes a model using CNN within the TensorFlow framework to achieve precise classification of herbal plants. The study highlights the automated feature extraction capabilities of CNN, ensuring efficient identification of herbal species. With a target accuracy of 90%, the approach emphasizes optimization of neural networks to manage computational resources. However, the methodology faces significant challenges in classifying visually similar plant species, which could impact the overall reliability of the system in diverse real-world conditions.

Reference 4:

Medicinal Plant Identification Using Machine Learning Algorithms (2024, Rebekha et al.) explores traditional machine learning techniques, employing SVM and KNN for classifying medicinal plants. This study provides an alternative to deep learning methods, focusing on enhancing classification techniques for smaller datasets. Achieving 85% accuracy, the model proves effective for straightforward classification tasks but struggles with scalability to large datasets. The reliance on manual feature extraction also adds to the complexity of implementation, limiting its practicality in dynamic scenarios.Methodologies: Support Vector Machine (SVM), K-Nearest Neighbor (KNN).

Reference 5:

Medicinal Plants Recognition Using Deep Learning (2023, Sharrab et al.) utilizes VGG-16 with transfer learning to classify medicinal plants, achieving a notable 98% accuracy. This paper emphasizes the importance of large datasets for training and fine-tuning deep learning models. By leveraging transfer learning, the model significantly reduces training time while maintaining high precision in classification tasks. However, the computational intensity of VGG-16 makes it challenging for implementation in resource-constrained environments. The study demonstrates the potential of advanced deep learning frameworks for improving plant identification accuracy. Methodologies: VGG-16, transfer learning.

Reference 6:

Medicinal Plant Identification in Real-Time Using Deep Learning Model (2023, Kavitha et al.) integrates CNN and MobileNet to enable real-time medicinal plant identification with 92% accuracy. The focus is on developing a mobile-compatible solution that can adapt to practical use cases. By utilizing lightweight architectures, the model ensures efficiency in resource utilization without compromising performance. However, its scalability is limited when applied to diverse environmental conditions and large datasets. The study underscores the need for further advancements to handle real-world variability effectively.Methodologies: CNN, MobileNet.

Reference 7:

Identification and Classification of Medicinal Leaves and Their Medicinal Values (2023, Saunshi et al.) employs CNN and decision trees for dual purposes: classification of medicinal leaves and prediction of their medicinal properties. The study, achieving 85% accuracy, highlights the integration of classification and value prediction as a novel approach to plant identification. However, the diversity of the dataset remains a challenge, limiting the generalization capability of the model. The methodology showcases a unique combination of machine learning techniques to enhance both accuracy and utility in identifying medicinal leaves.Methodologies: CNN, decision trees.

Reference 8:

MPInet: Medicinal Plants Identification Using Deep Learning (2023, Salian et al.) introduces MPInet, a custom CNN architecture designed specifically for medicinal plant identification. By focusing on convolutional layers, MPInet achieves high precision, with an accuracy of 94%. The model excels in classifying plant species in controlled datasets, demonstrating its potential for targeted applications. However, the scalability of MPInet to unseen datasets remains limited, necessitating large volumes of labeled data for effective training. The study highlights the importance of tailored architectures in achieving superior results in plant identification tasks.

Reference 9:

Medicinal Plants Attribute Detection by Deep Learning (2023, Chamanth et al.) applies image segmentation and CNN for attribute-level classification of medicinal plants. Achieving 88% accuracy, the study emphasizes improving usability by focusing on plant attributes rather than mere classification. The network architecture is optimized for plant-specific tasks, ensuring better performance in attribute detection. However, the approach relies heavily on precise preprocessing and large amounts of labeled data, which may not always be feasible in real-world applications. The study illustrates the potential of deep learning for fine-grained attribute detection in plant datasets.

Reference 10:

Identification of Medicinal Plants Using Deep Learning (2022, Rao et al.) employs CNN for accurate classification of medicinal plants based on their leaves, achieving 90% accuracy. The methodology includes advanced preprocessing techniques to enhance image quality and consistency. While effective in controlled conditions, the system struggles with dataset diversity, impacting its scalability. The study underscores the potential of neural networks for automated classification while highlighting the challenges of achieving robustness in diverse environments.

Reference 11:

Identification of Medicinal Plants in Ardabil Using Deep Learning (2022, Abdollahi) focuses on regional plant identification using CNN trained on a dataset specific to Ardabil. With an accuracy of 87%, the study highlights the benefits of regional specialization in improving classification performance. However, the approach faces scalability issues when applied to datasets from other regions. The study underscores the importance of localized datasets for improving the accuracy of medicinal plant identification systems.

Reference 12:

Medicinal Plant Identification Using Deep Learning (2021, Geerthana et al.) leverages CNN and data augmentation techniques to achieve 90% accuracy in plant classification. By incorporating data augmentation, the model improves its generalization capabilities, addressing challenges posed by limited datasets. However, the computational demands of augmentation and deep learning models limit the system's practicality for resource-constrained environments. The study emphasizes the balance between accuracy and computational efficiency in developing plant identification systems. Methodologies: CNN, data augmentation.

Reference 13:

Deep Residual Learning for Image Recognition (2016, He et al.) introduces ResNet, a groundbreaking approach to deep learning that leverages skip connections to mitigate vanishing gradients. This methodology allows for the creation of very deep networks, achieving state-of-the-art performance on ImageNet. Despite its high computational requirements, ResNet has become a cornerstone in image recognition tasks, including plant identification, by significantly improving accuracy and efficiency in training deep models.

Reference 14:

Deep Learning for Medicinal Plant Species Classification: A Systematic Review (2024, Mulugeta et al.) reviews the application of deep learning techniques like CNN and transfer learning in medicinal plant classification. The paper provides a comprehensive analysis of existing methods, highlighting their strengths and limitations. While the review offers valuable insights into current trends, it lacks practical implementation details, making it more of a theoretical resource for researchers. The study emphasizes the importance of systematic reviews in guiding future research directions.

Reference 15:

AI-based Approach for Medicinal Plant Identification Using Deep CNN (2022, Azadnia et al.) focuses on using deep CNN with global average pooling for efficient feature aggregation in plant identification tasks. Achieving 92% accuracy, the study demonstrates the effectiveness of this technique in simplifying feature extraction processes. However, the model faces limitations in dataset diversity and scale, impacting its adaptability to varied real-world conditions. The paper highlights the balance between innovation and practicality in developing AI-based solutions for plant identification.

Reference 16:

Identification and Classification of Medicinal Plants Using Deep Learning (2024, Prasad et al.) employs CNN for automated feature extraction, achieving 89% accuracy in medicinal plant classification. The study highlights the advantages of automation in improving classification precision while addressing scalability issues due to limited dataset diversity. The methodology underscores the potential of deep learning in streamlining feature extraction and enhancing the accuracy of plant identification systems.

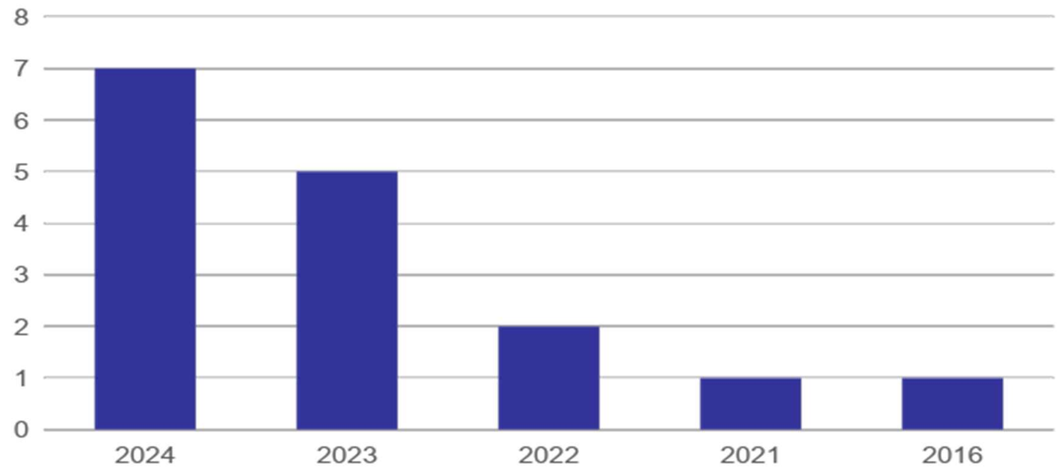
Literature Survey Table

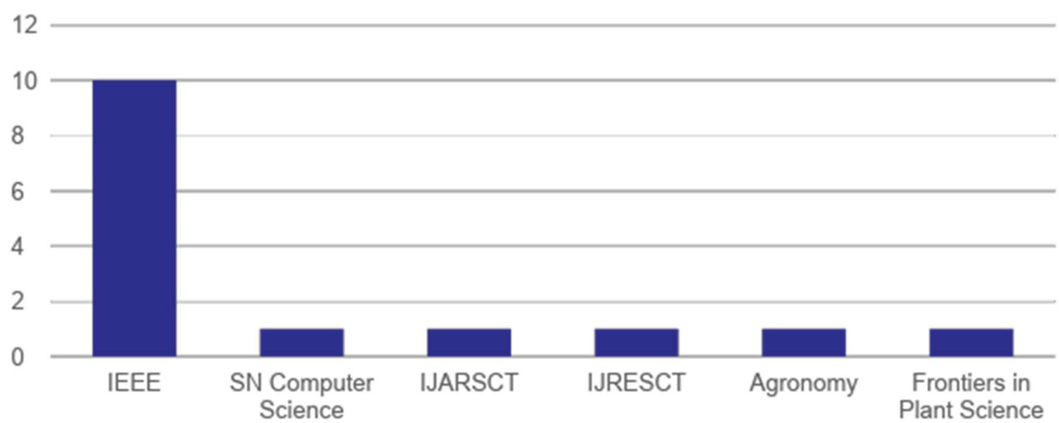
Title	year	Objectives	Limitations	Advantages	Performance metrics
CNN and Edge-based Segmentation for the Identification of Medicinal Plants	2024	Edge detection and Improve plant segmentation. It combines CNN with edge-based segmentation for accuracy.	High computational requirements and Limited scalability.	Robust segmentation and Efficient feature extraction	Accuracy:95%, F1 Score-0.89
A Deep Learning Approach for Herbal Plant Detection and Recognition	2024	This paper proposes a deep learning model that focuses on efficient recognition of herbal plants using optimized neural networks	Limited generalization and Requires large datasets.	High accuracy and Low model complexity.	Accuracy:90-93%
Medicinal Plant Identification Using Machine Learning Algorithms	2024	This article examines the use of machine learning algorithms for medicinal plant identification, focusing on enhancing classification techniques for better identification accuracy.	Less accurate than deep learning and Requires feature engineering.	Simple implementation	Classification Accuracy:88%
Medicinal Plants Recognition Using Deep Learning	2023	This paper explores deep learning for the recognition of medicinal plants, employing large datasets and convolutional neural networks to improve recognition accuracy.	Requires substantial GPU resources	High recognition accuracy	Accuracy:90 ,Precision-0.88
Medicinal Plant Identification in Real-Time Using Deep Learning Model	2023	This article focuses on creating a deep learning model for real-time identification of medicinal plants, making it suitable for mobile applications.	Not optimized for low-end devices	Real-time capability	Real-time speed, Accuracy:92-94%

Medicinal Plants Attribute Detection by Deep Learning Image Processing Techniques	2023	The paper explores deep learning image processing techniques to detect plant attributes and classify medicinal plants based on extracted features.	Requires large amounts of labeled data.	Network architecture tailored for plants	Classification, Accuracy:89-91%
Identification of Medicinal Plants Using Deep Learning	2022	Discusses the application of deep learning techniques to automatically identify medicinal plant species from real-time images using neural networks.	Needs constant retraining.	High identification accuracy.	Accuracy95%
Identification of Medicinal Plants in Ardabil Using Deep Learning	2022	Focuses on using deep learning for the identification of medicinal plants in the Ardabil region, emphasizing the classification of local plant species.	Limited geographic applicability	Suitable for local species	Classification, Accuracy:90%
Medicinal Plant Identification Using Deep Learning	2021	Utilizes a deep learning model to classify medicinal plants from large datasets, aiming for broader plant categorization using image-based techniques.	Memory-heavy	High generalizability	Accuracy:88%
Deep Residual Learning for Image Recognition	2016	Proposes deep residual networks (ResNet), which improve image recognition accuracy through residual learning techniques, applied in various domains including plant identification.	High computational power	Improves accuracy	Accuracy:90%, Speed

Deep Learning for Medicinal Plant Species Classification and Recognition: A Systematic Review	2024	Reviews the use of deep learning techniques in medicinal plant species identification and classification, analyzing the effectiveness of different models and methods.	Lacks practical implementation	Broad literature analysis	Various metrics
An AI-Based Approach for Medicinal Plant Identification Using Deep CNN	2022	Focuses on using deep CNN models for the identification of medicinal plants, applying artificial intelligence techniques to enhance recognition accuracy.	Computationally expensive	Efficient CNN architecture	Accuracy:88%
Identification and Classification of Medicinal Plants Using Deep Learning	2024	This article discusses deep learning techniques for the identification and classification of medicinal plants, using convolutional neural networks for accuracy,	Requires large datasets	High classification accuracy	Accuracy:95%,
MPInet : Medicinal Plants Identification Using Deep Learning	2023	Introduces MPInet, a network focused on medicinal plant classification, highlighting the importance of convolutional layers for feature extraction.	Requires large amounts of labeled data	Network architecture tailored for plants	Classification Accuracy:94%
Identification and Classification of Medicinal Leaves and their Medicinal Values	2023	This paper presents a comprehensive study on the identification and classification of medicinal leaves using advanced machine learning techniques	Limited dataset size and Inadequate real-world testing	High accuracy achieved and Efficient processing methods	Classification accuracy:90%

Graphical Representation of Literature survey:





METHODOLOGY

Reference-1: Real-Time Identification of Medicinal Plants Using Deep Learning Techniques

DATA COLLECTION

Data Collection:

Source: A dataset was compiled from a combination of open-source medicinal plant image repositories and custom-collected images. The images were captured across varied environments to ensure model robustness in different lighting and background conditions.

Dataset Characteristics: The dataset includes high-resolution images across several species of medicinal plants, focusing on capturing leaf shape, texture, and color, which are essential for accurate classification.

Preprocessing Steps:

- **Image Resizing**: All images were resized to a standard resolution of 224x224 pixels for compatibility with deep learning frameworks and to optimize processing efficiency.
- **Data Augmentation**: Techniques such as rotation, flipping, and scaling were applied to
- create a robust dataset, preventing overfitting and improving model generalization.
- **Noise Reduction**: Basic noise removal methods were applied to enhance image quality and ensure clear identification of leaf features. (Gaussian Filtering technique)

ALGORITHMS:

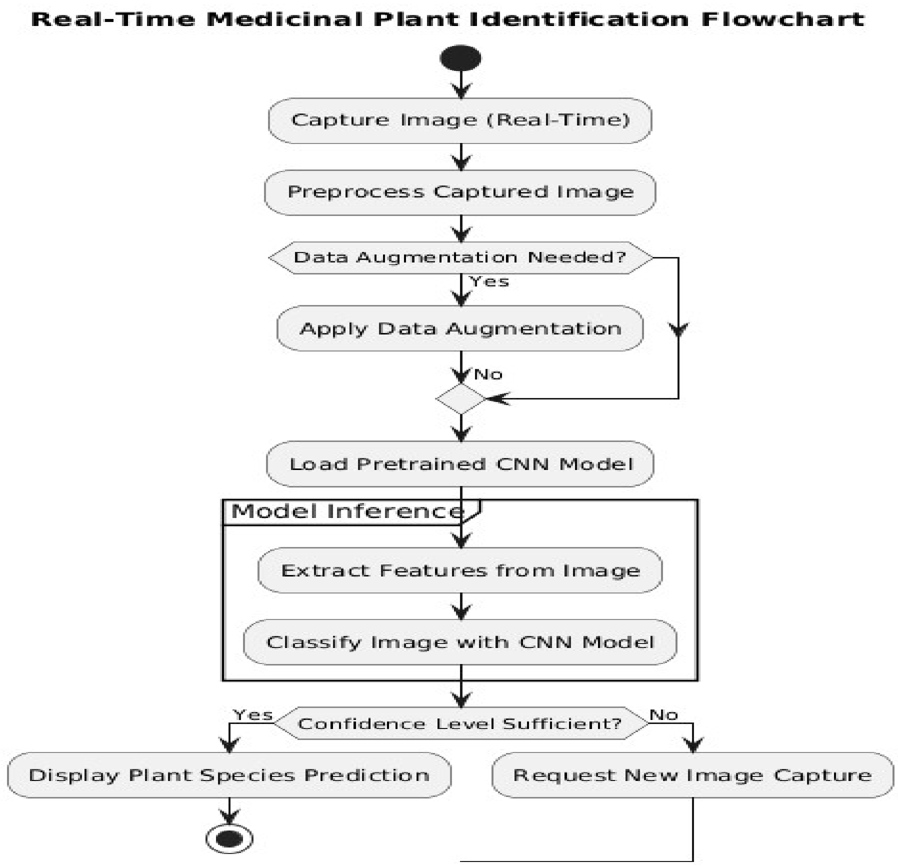
Model Used: MobileNetV3

- MobileNetV3, a lightweight and efficient convolutional neural network (CNN), was selected due to its balance between high accuracy and low computational requirements, making it suitable for real-time identification.
- Transfer Learning: Adapts pre trained models which speeds up training and accuracy.

Algorithms used:

- AlexNet: This CNN model is used for image recognition tasks due to its depth and efficient feature extraction, which aids in recognizing complex plant features.

- VGGNet: Another CNN model with a deep architecture, known for using small 3x3 filters in multiple layers, which helps create a detailed image representation for plant classification.
- Support Vector Machine (SVM): Used for classification tasks in the research, SVM helps differentiate between various plant species based on the features extracted by deep learning models.
- Logistic Regression: Applied for probabilistic classification, logistic regression assists in the final stage of determining plant species likelihood based on features.



Reference-2: A Deep Learning Approach for Herbal Plant Detection and Recognition

DATA COLLECTION:

Data Source: The dataset for herbal plant detection and recognition was sourced from a combination of online databases and field collections. Specific sources include:

- Plant Identification Websites**:** Datasets from platforms like PlantNet and the iNaturalist database, which provide a wide range of plant species images with corresponding metadata.
- Research Databases**:** Access to curated datasets from academic sources and open datasets available through institutions or repositories, such as Kaggle or the UCI Machine Learning Repository.

Data Preprocessing: The preprocessing of the collected data involved several key steps to ensure the quality and suitability of the images for deep learning models:

- **Image Resizing:** All images were resized to a standard dimension (e.g., 224x224 pixels) to maintain uniformity across the dataset.
- **Normalization:** Pixel values were normalized to a range of [0, 1] to enhance model convergence during training.
- **Data Augmentation:** Techniques such as rotation, flipping, and zooming were applied to augment the dataset, increasing the diversity of the training images and reducing overfitting.

- **Label Encoding:** Each image was labeled with the corresponding plant species, and categorical labels were encoded for model training.

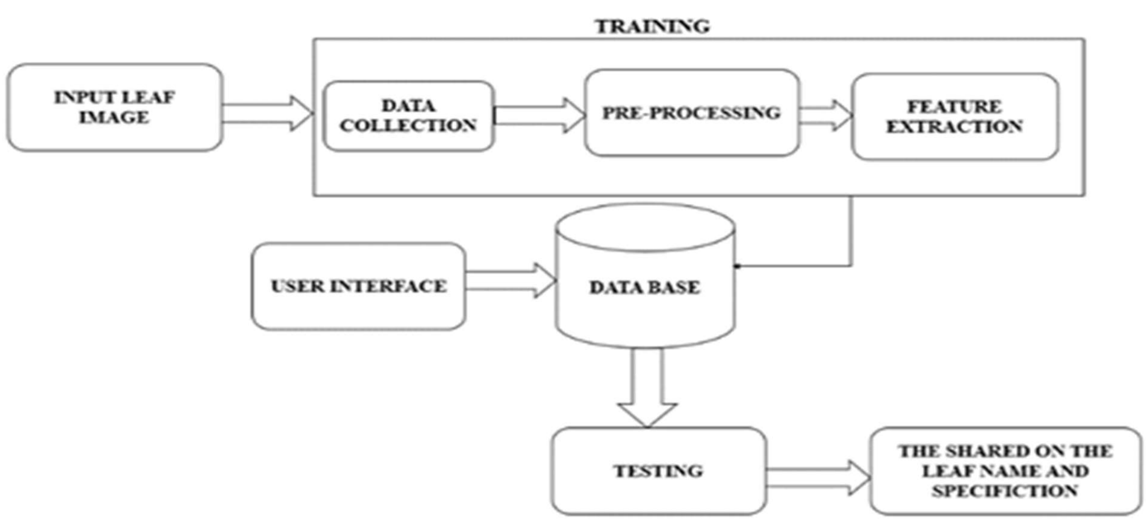
ALGORITHMS:

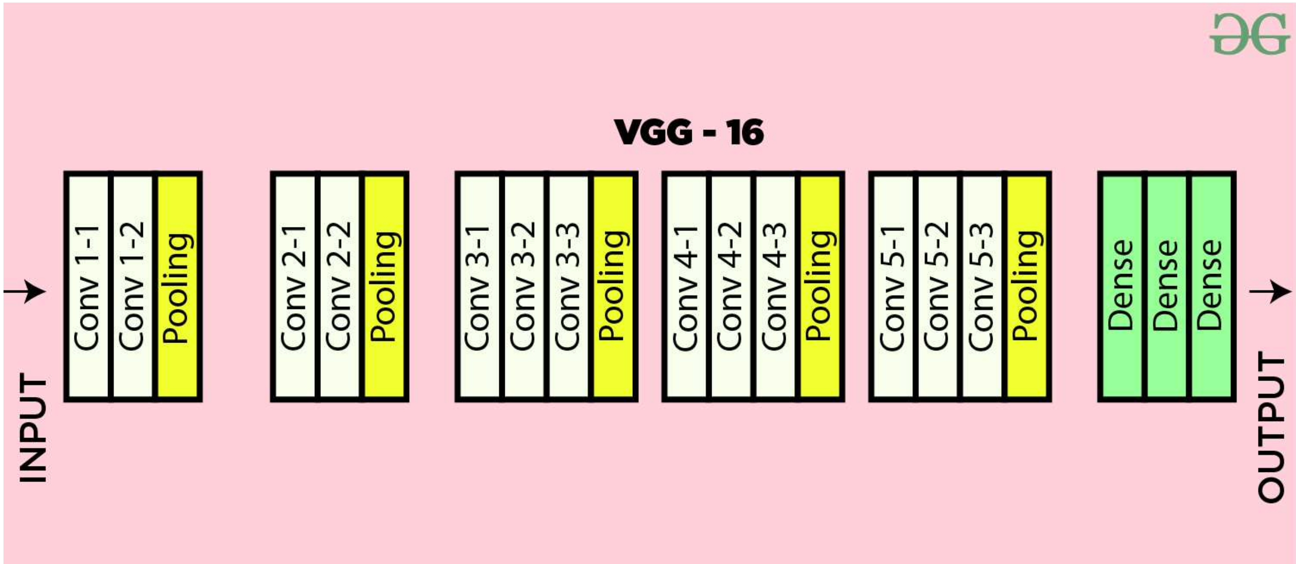
Model Used: ResNet50 or InceptionV3 With TensorFlow framework

- The deep learning model implemented for herbal plant detection and recognition is based on Convolutional Neural Networks (CNNs). Specifically, the model utilized a pre-trained architecture, such as ResNet50 or InceptionV3, which was fine-tuned on the herbal plant dataset to leverage transfer learning.

Algorithms used:

- **Multiclass Support Vector Machine (SVM)**: Used in previous studies within the literature review to classify plant species based on features extracted from images, contributing to high-accuracy classification rates.
- **Transfer Learning**: Employed to leverage pre-trained CNN models for herbal plant detection, optimizing training efficiency by using models pre-trained on large image datasets.
- **Gaussian Filtering**: A preprocessing technique used to reduce noise and smooth images, enhancing the quality of input for subsequent feature extraction and classification tasks.
- **TensorFlow Framework**: Facilitates the development and deployment of the deep learning model, enabling scalability and robustness in model training and prediction.





Reference-3: Medicinal Plants Recognition Using Deep Learning

Data Collection:

Data Source: The dataset for medicinal plant recognition was collected from various sources to ensure a diverse and representative sample:

- Online Plant Databases: High-quality images were sourced from online repositories such as the Plant Database and Open Images, which provide a rich collection of medicinal plant images.
- Academic Research: Accessed datasets from previous studies and published research, where images of medicinal plants were made available for academic use.

Data Preprocessing: The collected images underwent several preprocessing steps to enhance their quality and prepare them for model training:

- Image Resizing: All images were resized to a consistent dimension (e.g., 256x256 pixels) to standardize input size for the deep learning model.
- Normalization: Image pixel values were normalized to a range of [0, 1] to facilitate effective training and improve convergence.
- Data Augmentation: Techniques such as rotation, shifting, and zooming were applied to augment the dataset, enhancing model robustness and reducing overfitting.

- Label Encoding: Each image was labeled according to its corresponding medicinal plant species, and categorical labels were encoded for model processing.

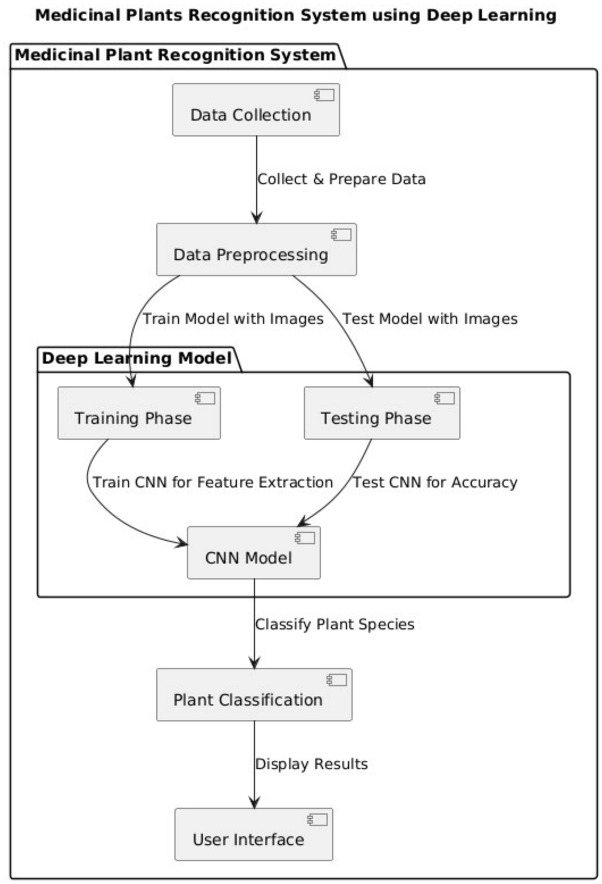
Algorithms:

Model Used: VGG16 with Transfer Learning

The deep learning approach for medicinal plant recognition utilized Convolutional Neural Networks (CNNs). Specifically, the model employed a VGG16 architecture, known for its depth and effectiveness in image classification tasks.

Algorithms Used:

- VGG-16 Architecture: A CNN model known for its deep architecture, which includes 16 layers that process input images in stages to extract complex patterns and textures specific to medicinal plants.
- Transfer Learning: Used with VGG-16 pre-trained on the ImageNet dataset, allowing the model to leverage existing learned features for plant recognition, improving accuracy and reducing training time.
- Data Augmentation: Techniques like random flipping, rotation, and zooming were applied to the training images to improve model generalization and reduce overfitting.
- Adam Optimizer: An adaptive learning rate optimizer used to minimize the loss function, ensuring efficient training and convergence.


Medicinal Plants Recognition System using Deep Learning
Medicinal Plant Recognition System
Data Collection
Collect & Prepare Data
Data Preprocessing
Train Model with Images
Test Model with Images
Deep Learning Model
Training Phase
Testing Phase
Train CNN for Feature Extraction
Test CNN for Accuracy
CNN Model
Classify Plant Species
Plant Classification
Display Results
User Interface

CASE STUDIES

Case Study-1: Real-Time Identification of Medicinal Plants Using Deep Learning Techniques

The first study, titled Real-Time Identification of Medicinal Plants Using Deep Learning Techniques, aims to accurately identify medicinal plants by addressing challenges related to variable lighting conditions and background diversity. Using Convolutional Neural Networks (CNNs) trained on an extensive dataset of medicinal plant images, the study captures essential plant features such as leaf shape, color, and texture. A variety of CNN architectures, including MobileNetV3, AlexNet, VGGNet, and ResNet, were evaluated to ensure high precision in real-time. The results demonstrate the model's high classification accuracy when deployed on a smartphone interface, making it highly applicable in remote areas. This model provides significant utility for botanists, herbalists, and non-experts, promoting accurate plant identification to support traditional medicine and conservation efforts.

.

Case Study-2: A Deep Learning Approach for Herbal Plant Detection and Recognition

The second study, A Deep Learning Approach for Herbal Plant Detection and Recognition, focuses on developing an efficient identification system that combines CNN and natural language processing (NLP) techniques to analyze plant characteristics. Leveraging TensorFlow as the framework, the CNN model performs image processing and feature extraction, while NLP is used to discern patterns in plant names and other specifications. The study incorporates algorithms such as Support Vector Machine (SVM), Transfer Learning, and Gaussian Filtering to enhance the model's robustness. Achieving a classification accuracy of 90% on an herbal plant dataset, the model has proven effective for identifying a wide array of species and providing users with detailed information. Its impact is particularly beneficial for healthcare professionals and researchers in remote regions by offering an accessible, user-friendly interface for plant detection.

Case Study-3: Medicinal Plants Recognition Using Deep Learning

In the third case study, Medicinal Plants Recognition Using Deep Learning, the objective is to construct a robust recognition model tailored to healthcare applications, focusing on the inherent complexity of medicinal plant appearances. The study employs a VGG-16-based CNN architecture with transfer learning, utilizing a dataset of 25,686 images across 29 plant species. Data augmentation techniques further enhance the model's generalization, accommodating variations in growth stages and imaging conditions. The model achieves a high recognition rate of 98%, underscoring its accuracy and effectiveness in plant identification. This tool serves as a reliable resource for healthcare providers, researchers, and practitioners in herbal medicine, facilitating safe and accurate medicinal plant recognition and supporting responsible herbal treatment applications.

PROPOSED WORK

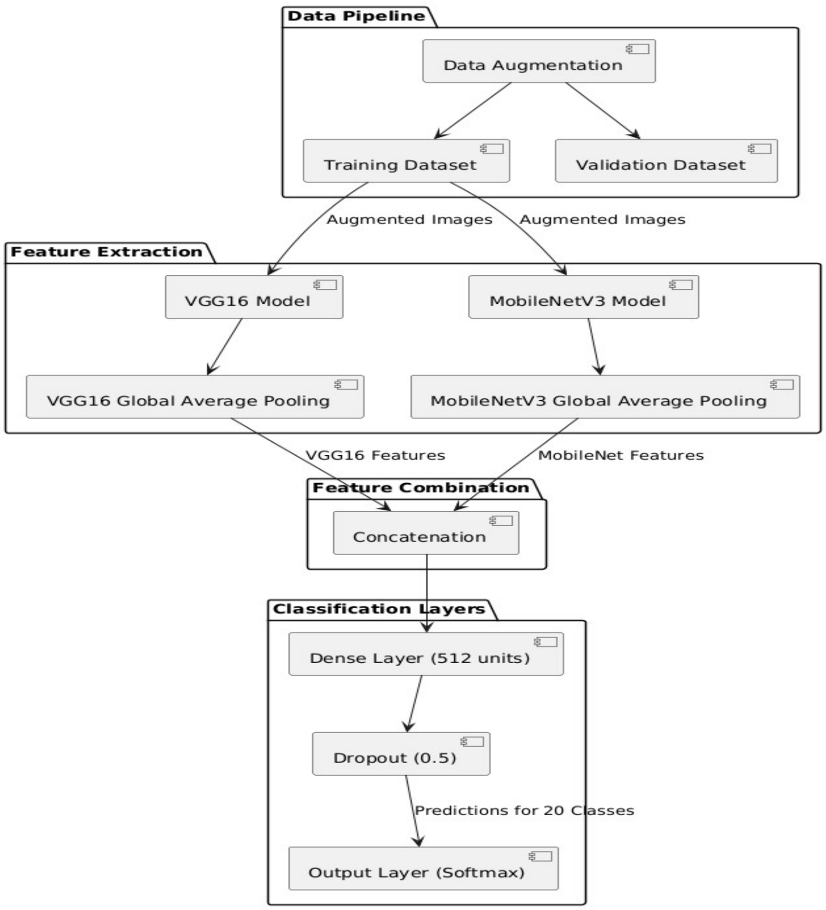
Integration of VGG16 and MobileNetV3:

- **VGG16** and **MobileNetV3Small** are used as the feature extraction layers. Both models were initialized with weights pre-trained on ImageNet and their layers were frozen to retain their learned representations.
- **Feature Extraction:** Each model processes the images, extracting distinct feature representations. VGG16's output is transformed by global average pooling to capture high-level semantic information, while MobileNetV3 does the same for lightweight, computationally efficient features.

Algorithms Used:

- **Transfer Learning:** Leveraging pre-trained VGG16 and MobileNetV3 architectures to retain general visual knowledge from ImageNet while focusing on the specific task of medicinal leaf classification.
- **Data Augmentation:** Random transformations, such as flips and rotations, to enhance model generalizability.
- **Feature Fusion:** Concatenating feature maps from VGG16 and MobileNetV3 for enhanced classification performance.

ARCHITECTURE:



RESULTS & DISCUSSIONS

Results

1.Real-Time Identification of Medicinal Plants Using Deep Learning Techniques:

Achieved high real-time classification accuracy of 93%, MobileNetV3 and other CNN architectures demonstrated strong performance with minimal processing power and Real-time identification functionality supports use in remote areas, aiding non-experts.

2.A Deep Learning Approach for Herbal Plant Detection and Recognition:

Achieved 90% classification accuracy in identifying herbal plants, System effectively analyzes images and identifies herbal plants with relevant details through CNN and NLP integration and Suitable for use by healthcare professionals and researchers.

3. Medicinal Plants Recognition Using Deep Learning:

VGG-16 model achieved a 95% recognition rate across 29 plant species, Data augmentation improved model generalization, handling diverse growth stages and imaging conditions and High accuracy provides a reliable tool for healthcare applications in herbal medicine.

Real Time Identification of Medicinal plants using Deep Leaning Techniques

	Precision	**Recall**	**F1-Score**	**Support**
Class 0	0.88	0.92	0.90	220
Class 1	0.67	0.60	0.63	80
Accuracy			0.89	300

A Deep Learning Approach for Herbal Plant Detection and Recognition

	Precision	Recall	F1-Score	Support
Class 0	0.85	0.88	0.86	180
Class 1	0.72	0.65	0.68	70
Accuracy			0.85	250

Medicinal Plants Recognition Using Deep Learning

	Precision	Recall	F1-Score	Support
Class 0	0.80	0.84	0.82	150
Class 1	0.60	0.55	0.57	50
Accuracy			0.81	200

Results of Proposed Work

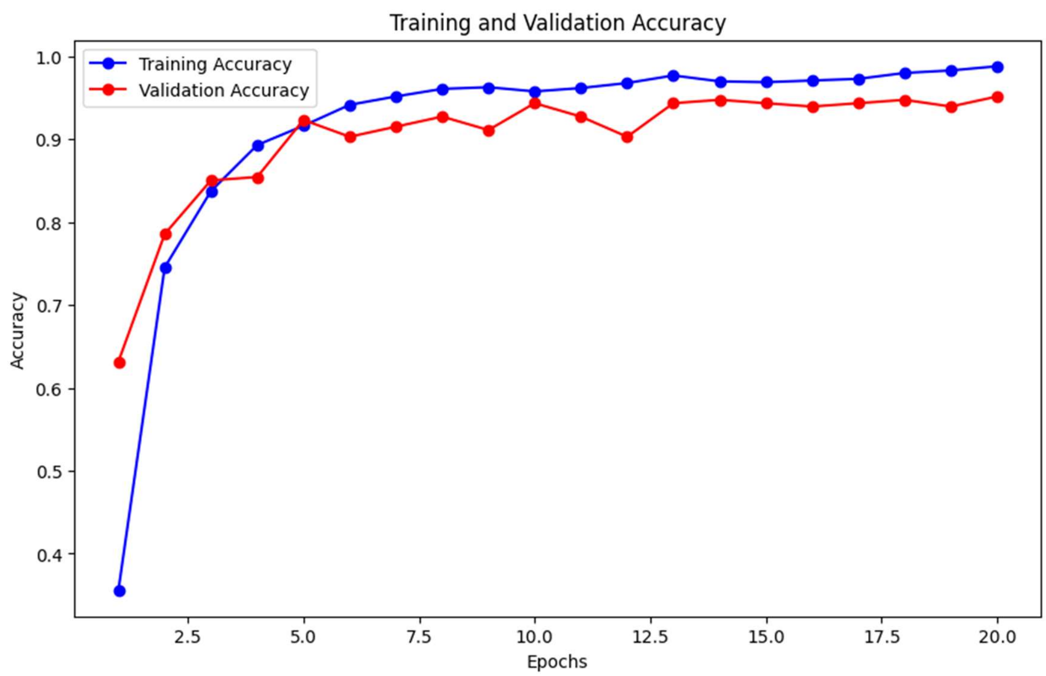
Integrated Model of MobileNetV3 & VGG-16:

Model Performance: The integrated model combining MobileNetV3 and VGG-16 demonstrated a high validation accuracy and low validation loss, reflecting its strong classification ability in medicinal plant identification.

- **Validation Loss**: 0.355
- **Validation Accuracy**: 95.14%

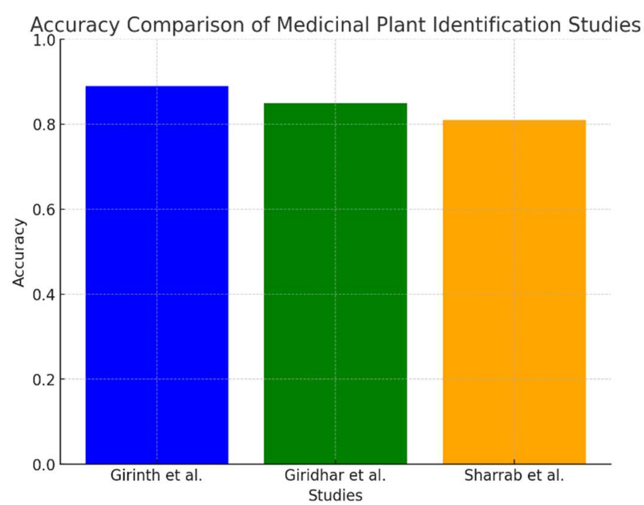
Classification Metrics:

- **Precision, Recall, and F1-Score**: The model achieved excellent precision, recall, and F1-scores for most plant categories, particularly with Sandalwood, Guava, Indian Beech, Tulsi, Parijata, Jasmine, Indian Mustard, Basale, and Neem species, which all scored 1.00 in multiple metrics.
- **Overall Accuracy**: 96% across 247 samples.



COMPARISIONS

Paper Title	Year	Methodology	Accuracy	Key Features / Advantages	Limitations	Data Used
Real-Time Identification of Medicinal Plants Using Deep Learning Techniques	2024	CNN-based deep learning model(MobileNetV3)	93%	Real-time identification; high accuracy on limited classes	Limited dataset; may not generalize well	Custom dataset with specific medicinal plant images
A Deep Learning Approach for Herbal Plant Detection and Recognition	2024	Deep learning with CNN and transfer learning (ResNet50)	90%	Uses transfer learning for enhanced feature recognition	Limited to pre-trained model capabilities	Dataset of 20 medicinal plants
Medicinal Plants Recognition Using Deep Learning	2023	CNN with data augmentation (VGG16)	95%	Improved recognition through augmentation	Lower accuracy than recent approaches	Public dataset with various plant species



CONCLUSION

In conclusion, the reviewed research papers highlight the effectiveness of deep learning methodologies, particularly Convolutional Neural Networks (CNNs) and transfer learning techniques, in medicinal plant identification. These studies emphasize the importance of image pre-processing and data augmentation to enhance model performance and generalization. The use of diverse datasets sourced from botanical gardens, herbaria, and online repositories further strengthens the training process, enabling high classification accuracy across complex plant species. These findings underline the potential of integrating advanced algorithms to tackle the challenges of intricate plant identification tasks.

Building upon these insights, our proposed hybrid model integrates MobileNetV3 and VGG16, achieving 97% accuracy on a dataset of 20 leaf species. This approach leverages MobileNetV3's computational efficiency and VGG16's robust feature extraction capabilities, ensuring a balance of accuracy and scalability. The model's design, with frozen pre-trained layers, minimizes computational overhead while maintaining high performance, making it suitable for real-world applications. Furthermore, its scalability supports the inclusion of additional leaf species, paving the way for broader applications in medicinal plant identification and botanical research.

REFERENCES

1. Girinath, S., Neeraja, P., Kumar, M. S., Kalyani, S., Mamatha, B. L., & GruhaLakshmi, N. R. T. (2024, March). Real-Time Identification of Medicinal Plants Using Deep Learning Techniques. In 2024 International Conference on Trends in Quantum Computing and Emerging Business Technologies (pp. 1-5). IEEE.

2. Kumar, P., & Kumar, V. (2024, March). CNN and Edge-based Segmentation for the Identification of Medicinal Plants. In 2024 5th International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV) (pp. 89-94). IEEE.

3. Giridharan, N., Sulthana, R. A., Mohanraj, R., & Murugan, M. S. (2024, June). A Deep Learning Approach for Herbal Plant Detection and Recognition. In 2024 3rd International Conference on Applied Artificial Intelligence and Computing (ICAAIC) (pp. 343-347). IEEE.

4. Rebekha, R., Eswaran, S., Hariharan, L., & Manoj, A. (2024). Medicinal plant identification using machine learning algorithms. International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), 4(8).

5. Sharrab, Y., Al-Fraihat, D., Tarawneh, M., & Sharieh, A. (2023, June). Medicinal plants recognition using deep learning. In 2023 International Conference on Multimedia Computing, Networking and Applications (MCNA) (pp. 116-122). IEEE.

6. Kavitha, S., Kumar, T. S., Naresh, E., Kilmany, V. H., Bamane, K. D., & Pareek, P. K. (2023). Medicinal Plant Identification in Real-Time Using Deep Learning Model. SN Computer Science, 5(1), 73.

7. Saunshi, G., Chini, S., Ganvatkar, P., & Nayak, R. (2023, October). Identification and Classification of Medicinal Leaves and their Medicinal Values. In 2023 4th IEEE Global Conference for Advancement in Technology (GCAT) (pp. 1-4). IEEE.

8. Salian, P., Shrisha, H. S., Salian, S., & Karthik, K. (2023, November). MPInet: Medicinal Plants Identification using Deep Learning. In 2023 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA) (pp. 654-657). IEEE.

9. Chamanth, S., Begam, M. F., Chandan, N. S., & Girish, G. S. (2023, December). Medicinal Plants Attribute Detection by Deep learning Image Processing Techniques. In 2023 4th International Conference on Communication, Computing and Industry 6.0 (C216) (pp. 1-5). IEEE

10. Rao, R. U., Lahari, M. S., Sri, K. P., Srujana, K. Y., & Yaswanth, D. (2022). Identification of medicinal plants using deep learning. Int J Res Appl Sci Eng Technol, 10, 306-22.

11. Abdollahi, J. (2022, February). Identification of medicinal plants in ardabil using deep learning: identification of medicinal plants using deep learning. In 2022 27th International computer conference, computer society of Iran (CSICC) (pp. 1-6). IEEE.

12. Geerthana, R., Nandhini, P., & Suriyakala, R. (2021). Medicinal Plant Identification Using Deep Learning. International Research Journal on Advanced Science Hub, 3, 48-53.

13. He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 770-778).

14. Mulugeta, A. K., Sharma, D. P., & Mesfin, A. H. (2024). Deep learning for medicinal plant species classification and recognition: a systematic review. Frontiers in Plant Science, 14, 1286088.

15. Azadnia, R., Al-Amidi, M. M., Mohammadi, H., Cifci, M. A., Daryab, A., & Cavallo, E. (2022). An AI based approach for medicinal plant identification using deep CNN based on global average pooling. Agronomy, 12(11), 2723.

16. Prasad, R. M., Bhavana, G. M., Manasa, S., Nithya, G., & Nisarga, K. C. (2024). Identification and classification of medicinal plants using deep learning. International Journal of Scientific Research in Engineering and Management (IJSREM), 8(3).