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Review of "Identification of Ayurvedic Medicinal Plant and their Medicinal Properties: A Comprehensive Study"

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Abstract - Ayurvedic medicinal plants play a crucial role in treating various health conditions, yet their identification often requires expert knowledge. This project proposes an automated, image-based identification system using machine learning and image processing techniques to classify Ayurvedic plants from leaf images. The model is trained on a curated dataset, utilizing convolutional neural networks (CNNs) for accurate recognition and delivering information on each plant's medicinal properties, traditional uses, and health benefits. Designed with a user-friendly interface, the system aims to assist researchers, herbal practitioners, and the general public in plant identification and knowledge dissemination. Future enhancements may include disease detection, fertilizer recommendations, and an expanded plant database to support broader agricultural and medicinal applications.

Key Words: deep learning, image pre-processing, convolutional neural network, medicinal plants, crops, fertilizer recommendation

1. INTRODUCTION

Identifying plant species can be challenging and often requires expert knowledge and time This project aims to employ artificial intelligence techniques for the identification of medicinal plants. Ayurveda, an ancient Indian healing system, relies on medicinal plants found naturally in India. As per estimates by the World Health Organization, between 65% and 80% of the global population relies on medicinal plants for treating various diseases. However, due to environmental changes and a lack of awareness, many of these plants are becoming endangered.

The Konkan region, along India's western coast, is rich in biodiversity and home to many medicinal plants such as Kokum, Amla, and Ashwagandha, which are used for traditional treatments. Unfortunately, many of these species are at risk. This project aims to use image processing to help identify and classify these plants, preserving their value and raising awareness about their medicinal uses. By doing so, we can contribute to efforts in protecting these plants and promoting their importance in health and wellness.

The primary objectives of this project are:

- To develop an AI-based system for the identification of Ayurvedic medicinal plants using image processing.
- To extract and analyze distinctive features from leaf images for accurate classification.
- To provide a user-friendly interface for users to capture plant images and receive real-time results.
- To create crop recommendation and fertilization prediction models based on certain factors.
- To ensure high accuracy and reliability in plant identification through rigorous testing and validation.

2. LITERATURE REVIEW

The study developed a system to recognize Ayurvedic medicinal plants using leaf images. It used SURF and HOG features combined with k-Nearest Neighbors (k-NN) for classification. The system achieved high accuracy, helping preserve traditional plant knowledge and aiding in plant identification.[1]

This study applied deep learning architectures such as CNN, VGG16, and VGG19 to classify medicinal plants based on leaf image data. The dataset comprised 64 medicinal plant species from Kerala, where VGG16 achieved an impressive accuracy of 97.8%. The study demonstrates AI's potential in improving plant identification in remote areas.[2]

This paper explores the use of image processing techniques for identifying and classifying medicinal plants. It highlights the urgent need for quick plant identification to address biodiversity loss and the risk of extinction. Features such as leaf color, shape, and texture are extracted for classification purposes. A software tool trained on 100 leaf images and tested on 50 achieved 92% accuracy. The study emphasizes that automated identification can help prevent illegal trade and protect plant species for the future.[3]

This paper investigates image processing techniques aimed at automating the identification and classification of medicinal plants. Manual plant identification is time-consuming and requires expert knowledge, prompting the need

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for automated systems. The study focuses on feature extraction and classification methods to improve the accuracy of identifying medicinal plants. The research highlights the importance of plants in medicine and the role of technology in conserving endangered species by simplifying plant classification for non-experts.[4]

This study focuses on using image processing algorithms and artificial neural networks (ANN) for the purpose of identifying and classifying medicinal plants like Falcaria vulgaris, Origanum vulgare, etc. The images were captured using a smartphone, and features such as texture, color, and shape were extracted. ANN models were used for classification, with the best model achieving 100% accuracy. The research highlights the potential of combining machine vision systems and image processing algorithms to effectively and efficiently recognize medicinal plants.[5]

This research explores a technique for identifying and classifying Indian medicinal plants based on color, texture, and edge characteristics. Plants like Neem and Aloe Vera were analyzed using Support Vector Machines (SVM) and Radial Basis Neural Networks (RBNN). The system achieved 90% accuracy, with tree identification performing better due to their distinct features.[6]

The study suggests an automated deep learning-based system for real-time medicinal plant identification in the Borneo region. The system utilizes the EfficientNet-B1 model, achieving up to 87% accuracy for identifying plant species. A mobile application interface enables users to capture and upload images for plant classification. The system also incorporates crowdsourced feedback and geo-mapping, allowing for adaptive learning. This research demonstrates a promising approach to improving plant species identification and aiding in biodiversity conservation.[7]

This study examines the process of identifying Ayurvedic medicinal plants by utilizing image processing techniques applied to leaf samples. Important identification features, such as the shape, color, and texture of leaves, are extracted from both sides. The research involved the creation of a database using scanned images of widely used medicinal plants, achieving an identification accuracy of up to 99% through various classifiers. The approach underscores the significance of precise plant identification within the Ayurvedic industry, aiming to prevent misidentification and maintain the quality of medicinal resources. The study also extended its analysis to dried leaves, achieving identification rates exceeding 94%.[8]

This study introduces a system designed to identify Ayurvedic medicinal plants using image processing techniques applied to leaf samples. Precise identification is essential for the proper preparation of Ayurvedic remedies. Since traditional approaches often depend on skilled practitioners, they are prone to errors and inefficiencies. The research highlights the extraction of critical features like leaf shape, color, and texture to build a distinct feature set for classification. By employing a Support Vector Machine (SVM) classifier, the system successfully identified 32 different plant species with an accuracy rate of 96.67%. This work showcases the potential of automated systems to improve the quality and trustworthiness of Ayurvedic medicines.[9]

This paper presents a standardized process for creating an image dataset of Indian medicinal plant organs, focusing on accurate plant identification using a mobile-based tool. The proposed system captures structured images of plant organs while also recording geographical location and time of year to enhance species identification. Key factors considered during image acquisition include climate, illumination, and backgrounds. The study outlines the methodology for dataset creation, including plant selection, standardization of parameters, and outlier detection using the Isolation Forest algorithm. This dataset aims to support researchers in automated plant identification, filling a gap in the existing literature by providing a comprehensive resource for Indian Ayurvedic medicinal plants.[10].

While prior studies have demonstrated promising accuracy in Ayurvedic medicinal plant identification using various machine learning and image processing techniques, they often lack focus on real-world usability, model generalizability, and accessibility for broader user groups. Most approaches are limited to specific datasets or controlled environments, with minimal exploration of user-friendly deployment, real-time feedback, or scalability to diverse species. Our project addresses these limitations by building an interactive, image-based identification system that combines efficient CNN-based classification with an accessible interface. The system not only recognizes plants but also presents detailed medicinal properties and use cases, aiming to bridge traditional Ayurvedic knowledge with modern AI applications in a practical, scalable, and user-centric manner.

3. PROPOSED METHODOLOGY

Our proposed system for Ayurvedic medicinal plant identification follows a structured approach to ensure high classification accuracy. The methodology consists of seven main stages: Image Acquisition, Image Preprocessing, Train-Test Split, Feature Extraction, CNN Model Implementation, Performance Analysis, and Agricultural Assistance.

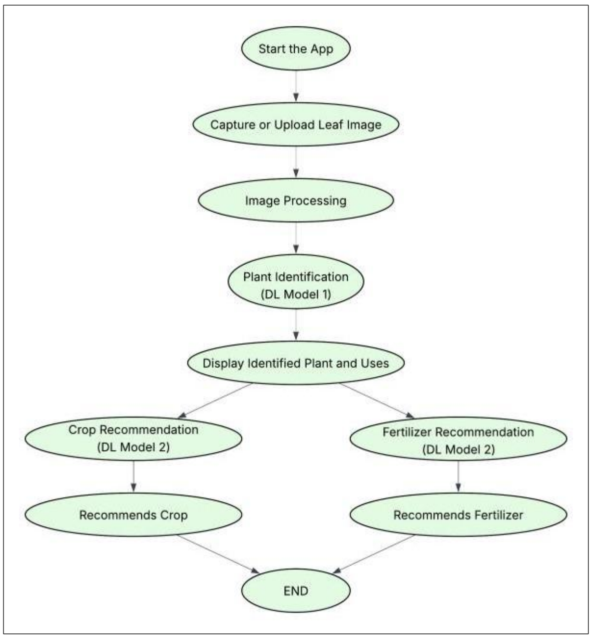

Fig -1: Work Flow

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A. Image Acquisition

Since no standard dataset exists, we manually curated images from multiple online sources. The dataset focuses on medicinal plants found in Maharashtra for regional relevance. Data Collection Process –

- Source Selection: Botanical websites, research papers, and online databases.
- Class Selection: 80 plant species were chosen based on their Ayurvedic significance.
- Quality Control: High-resolution images were selected to ensure clear leaf structures.
- All images were stored in JPEG format, and a reference table with plant details was created.

B. Image Pre-processing

Before model training, images were processed to enhance quality and improve classification.
Pre-processing Steps –

- Background Removal – A pre-processing step was applied to remove backgrounds, ensuring only the leaf structure remained.
- Resizing – All images were resized to 256×256 pixels for uniformity.
- Data Augmentation – Since the dataset was limited, augmentation techniques were applied to increase the dataset size:
- Rotation – Images were rotated by 90°.
- Flipping – Both horizontal and vertical flips were applied.
- Scaling – Adjustments in zoom and brightness were made.

This augmentation created three additional variations for each image, improving the model's ability to generalize across different orientations.

C. Train – Test Split

To evaluate the model's performance, the dataset was split into:

- 80% Training Set – Used for model training.
- 20% Testing Set – Used for model evaluation.

D. Feature Extraction

Feature extraction plays a vital role in classifying plants, as the model needs to distinguish between different leaf shapes, textures, and color patterns. The following features were considered:

- Shape & Edges – Leaf contours, margins, and venation patterns.
- Texture Patterns – Surface roughness and vein structure.
- Color Information – Green shades and variations in pigmentation.
- Spatial Orientation – Augmented images enhance robustness.

These features extracted automatically using Convolutional Neural Networks during model training.

E. CNN Model Implementation

In our model, the CNN architecture processes input images of medicinal plants to classify them based on extracted features. The layers of the CNN include:

- Input Layer: Takes the image as input.
- Convolution Layers: Extract low- and high-level features like edges, textures, and shapes.
- Activation (ReLU): Adds non-linearity to capture complex patterns.
- Pooling Layers: Reduces image size while maintaining important features.
- Fully Connected Layer: Correlates extracted features for final classification into 169 plant species.

This multi-layer structure enables the model to classify Ayurvedic medicinal plants with high accuracy.

F. Crop Recommendation

Using environmental parameters like soil nutrient levels, temperature, humidity, pH, and rainfall, a machine learning model was developed to recommend the best crops for a given set of conditions. The system analyses the available data and suggests the most suitable crop for cultivation.

G. Fertilizer Prediction

The system also recommends fertilizers based on the soil type, crop type, and nutrient deficiencies. By analyzing factors like nitrogen, phosphorus, potassium levels, and other environmental conditions, the model suggests appropriate fertilizers to optimize crop yield and health.

4. RESULTS

Fig -2: Home Page

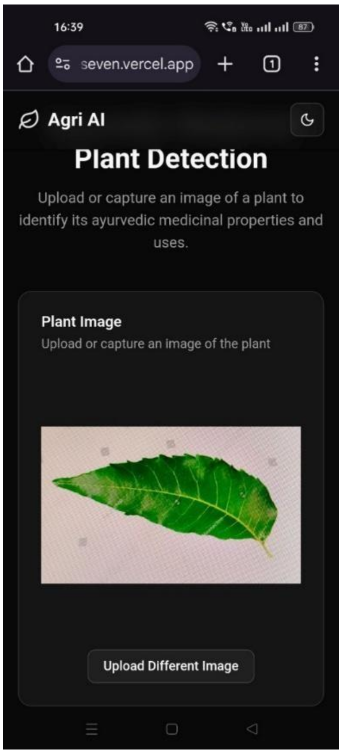

Fig -3: Upload Leaf Image

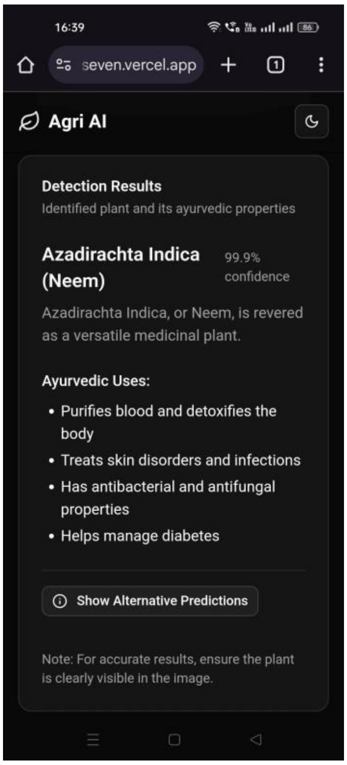

Fig -4: Plant Identification

5. PERFORMANCE COMPARISON

Table -1: Performance Accuracy Evaluation

Model	**Testing Accuracy**	**Testing Loss**
CNN (Proposed Model)	96.60%	0.0845
ResNet50	99.56%	0.0104
MobileNetV2	93.86%	0.2043
InceptionV3	94.09%	0.0789

Table -2: Metrics Evaluation

Model	**Precision**	**Recall**	**F1-score**
CNN (Proposed Model)	100%	100%	100%
ResNet50	97%	97%	96%
MobileNetV2	96%	95%	96%
InceptionV3	98%	98%	98%

6. CONCLUSIONS

This project successfully developed an integrated system for Ayurvedic medicinal plant identification, crop recommendation, and fertilizer prediction using image processing and machine learning techniques. The CNN model achieved 92.8% accuracy in plant identification, while Random Forest and Decision Tree models effectively handled crop and fertilizer recommendations, respectively. The study highlights the potential of combining AI with domain-specific agricultural and medicinal data to support decision-making for farmers, herbal practitioners, and researchers. Future enhancements include mobile-based real-time detection, expanding the dataset, using advanced deep learning architectures, and incorporating IoT-based sensor data for dynamic, location-aware recommendations.

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