**CHAPTER 1**

**INTRODUCTION**

**1.1 Introduction to the Project**

Accurate identification of skin problems and knowing which natural remedies to use can be difficult, especially in rural areas or when using traditional medicine. Usually, people rely on visiting a doctor or matching symptoms themselves, which can sometimes lead to wrong guesses and treatments that don’t work. Even though many plants are known to help with skin issues, most people don’t have an easy way to find the right plant or learn how to use it properly for their skin.

This project introduces HerbalLink, an intelligent, machine learning–powered mobile application that assists users in detecting common skin diseases and recommends suitable medicinal leaves as treatment options. Unlike existing solutions that rely on user descriptions or predefined medical databases, HerbalLink uses real-time image classification and user input to deliver personalized, nature-based healthcare guidance. Through a simple interface built with React Native and deployed via the Firebase, users can register, upload images of affected skin areas, or scan leaves to receive tailored disease identification, natural remedy suggestions, and detailed usage instructions.

The backend, developed using Flask and Python, leverages machine learning models trained on skin disease and leaf datasets. Image processing is handled using OpenCV, while classification tasks utilize CNN (Convolutional Neural Network) models built with TensorFlow. For the skin module, the system predicts conditions like acne, eczema, or fungal infections based on image features and symptom inputs. For the leaf module, the system identifies the scanned leaf and retrieves a list of skin diseases it can treat, along with preparation and application guidance sourced from a curated database.

HerbalLink offers a new and complete way to care for your skin by combining traditional herbal treatments with modern AI technology. It helps people rely less on chemical medicines and gives them easy, natural options for treating skin problems. With just a few steps, users can get useful advice, making skin care more accessible and convenient. By using real-time image analysis and machine learning, HerbalLink not only improves the accuracy of skin condition detection but also ensures that users receive personalized herbal remedies based on their specific needs.

**1.2 Introduction to Technology used**

HerbalLink is a smart healthcare application that blends traditional medicine with modern technology to help users identify skin diseases and discover relevant medicinal herbs for treatment. This system leverages several technologies such as Python, Flask, MongoDB, Firebase, Convolutional Neural Networks (CNN), TensorFlow, OpenCV, and Flutter to deliver a seamless, intelligent, and accessible experience across platforms.

**1.2.1 Python with Flask**

Python with Flask serves as the core backend framework in the HerbalLink application. Python’s simplicity and rich ecosystem make it ideal for machine learning and web development tasks. Flask, a lightweight and modular web framework in Python, enables the creation of RESTful APIs that connect the mobile app to the backend logic and machine learning models. The backend receives images and user inputs from the frontend, processes them using Python scripts and CNN models, and sends back the predictions and medicinal leaf recommendations. This architecture ensures a fast and responsive interaction between the user and the system while maintaining flexibility and scalability for future enhancements.

**1.2.2 MongoDB**

MongoDB is a NoSQL database used in HerbalLink to store user information, scan history, and mapping data between diseases and medicinal leaves. The document-based architecture allows the system to store flexible data structures, including JSON-like documents, which is particularly useful for applications that need to evolve and scale quickly.

**1.2.3 Firebase**

Firebase by Google is an all-in-one platform that makes it easy to deploy the entire project, including the frontend, backend, database, authentication, and file storage. Firebase Hosting is used to deploy the Flutter app, providing fast and secure delivery of static files. For backend logic, Firebase Cloud Functions typically run JavaScript, also interacts with external Python services to handle tasks such as image processing. Additionally, Firebase Storage allows secure storage of uploaded skin, leaf images and even trained machine learning model files. This unified setup simplifies deployment and management, making Firebase a recommended choice for HerbalLink.

**1.2.4 Convolutional Neural Networks (CNN)**

CNNs are the core technology behind the image classification feature of HerbalLink. They enable the automatic detection of skin diseases and identification of medicinal leaves from scanned images. CNNs are composed of three main layers:

**Convolution Layers**: These layers consist of several filters that scan across the input image to detect features such as edges, textures, and patterns. Each filter performs a 2D convolution operation on the image and produces a feature map. These filters act like neurons and learn to identify different features through training.

**ReLU Layers**: ReLU (Rectified Linear Unit) layers apply an activation function to introduce non-linearity into the model. The function is defined as f(x) = x when x >= 0, and f(x) = 0 when x < 0. It helps the model to learn complex patterns by allowing only positive values to pass through.

**Pooling Layers**: Pooling layers are used to reduce the dimensions of the feature maps. Max pooling is the most common type, where the highest value in a group of pixels is retained, and the rest are discarded. This reduces computational load and helps extract the most important features.

**1.2.5 TensorFlow**

TensorFlow is an open-source deep learning framework developed by Google. It is used to build, train, and deploy the CNN models used in HerbalLink. TensorFlow supports both CPU and GPU computation, making it suitable for running complex models efficiently. It is also integrated with tools like Keras to simplify the design of neural networks.

**1.2.6 OpenCV**

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision. It is used in HerbalLink for preprocessing images, such as resizing, background removal, and noise reduction. This improves the quality of the input data for better prediction by the CNN model.

**1.2.7 Flutter**

Flutter is an open-source UI toolkit developed by Google for building beautiful, natively compiled applications from a single codebase. HerbalLink uses Flutter to develop the cross-platform mobile application, allowing deployment on both Android and iOS with the same code. Flutter provides smooth performance and flexible UI design, ensuring a user-friendly experience.

**CHAPTER 2**

**LITERATURE SURVEY**

**2.1 Introduction**

The literature survey for the HerbalLink project highlights advancements in skin disease detection using machine learning, particularly CNNs for image-based classification, and the digital integration of traditional medicinal knowledge. Existing solutions have successfully implemented both scanning of skin conditions to recommend suitable medicinal leaves, and scanning of leaves to display their uses in treating various skin diseases. HerbalLink builds on these innovations by combining AI-powered diagnosis with leaf recognition to recommend natural remedies and identify which conditions each medicinal plant can effectively treat.

**2.2 Literature Survey**

Tabassum and Hamdani (2025), [1] explored the traditional use of medicinal plants in Norway for treating skin diseases and cosmetic applications. The study documents a variety of native plants known for their dermatological benefits, such as anti-inflammatory, antimicrobial, and wound-healing properties. It highlights key species like Aloe vera, Calendula officinalis, and Hypericum perforatum, emphasizing their active phytochemicals and therapeutic effects. The paper discusses preparation methods and cultural significance, linking ethnobotanical knowledge with modern pharmacological findings. This research underscores the value of integrating traditional plant-based remedies with contemporary skin disease treatment strategies and promotes further investigation into their efficiency and safety.

Hicham Bouakkaz et al. (2025), [2] presented a study on enhanced classification of medicinal plants using deep learning and optimized Convolutional Neural Network (CNN) architectures. The authors addresses key challenges in plant classification such as inter-class similarity and intra-class variation by proposing a refined CNN-based approach tailored for plant leaf imagery. The research emphasizes the optimization of CNN architectures through hyperparameter tuning and regularization techniques to boost classification performance. They also evaluated their model using publicly available datasets, achieving superior accuracy compared to conventional methods. The study highlights the effectiveness of deep learning in automated botanical classification and its potential application in pharmacognosy, biodiversity preservation, and herbal medicine research. This work contributes to the growing field of AI-assisted plant identification, setting a benchmark for future exploration in medicinal plant informatics.

A. Rajasekar et al. (2024), [3] developed an AI-based Skin Disease Detector integrating convolutional neural networks (CNN) and YOLOv8 for automated skin condition classification. The system processes both images and video frames through a series of preprocessing techniques such as contrast enhancement, segmentation, and hair removal to enhance lesion visibility and accuracy. Trained on a large dataset including the ISIC archive, the model achieved high performance metrics, including 90% accuracy and 0.85 AUC-ROC, demonstrating its diagnostic reliability. YOLOv8 enabled real-time lesion localization with 53 convolutional layers. Additionally, the system incorporates stress and fatigue analysis using physiological data. A robust user interface was also implemented to ensure accessibility and usability in varied lighting and clinical conditions. This approach supports efficient and accurate skin disease detection in both clinical and remote healthcare settings.

Rajasekar A., Shouvik C., and Mariya H. (2024), [4] proposed a multiattribute deep convolutional neural network (CNN) approach for accurately detecting medicinal plants and identifying their applications in treating skin diseases. The study integrates multiple attributes such as texture, color, and shape in the CNN architecture to enhance classification accuracy. Additionally, the paper explores the therapeutic relevance of detected plants by linking them to specific skin disease treatments, contributing to both automated plant recognition and practical medicinal use. The proposed method demonstrates improved performance compared to traditional techniques and highlights the potential of deep learning in botanical and medical informatics. This work sets a foundation for further research on AI-driven plant-based healthcare solutions.

Kale et al. (2024), [5] investigated the identification of Ayurvedic medicinal leaves and the recommendation of home remedies using state-of-the-art deep learning algorithms and a comprehensive dataset. The study introduces an Android-based application designed to classify 115 distinct species of medicinal leaves from a dataset of 6,541 images. The system employs well-known pre-trained neural networks including CNN, VGG16, MobileNet, and Inception to accurately identify leaves. In addition to leaf classification, the research addresses disease identification through a symptom-disease dataset encompassing 35 symptoms and 20 diseases. The conventional train-test split method ensures reliable model evaluation, preventing overfitting. The study emphasizes the integration of leaf image recognition with symptom-based Ayurvedic medicine and home remedy recommendations. Comprehensive performance metrics including accuracy, precision, recall, F1-score, and confusion matrices are utilized to assess the model's effectiveness. This work contributes significantly to bridging traditional Ayurvedic knowledge with modern AI techniques, enabling automated medicinal leaf identification and personalized treatment suggestions.

Andrew Al C. Aquiro, Shannen L. Arreola, and Ramon G. Garcia (2024), [6] developed a device that can recognize and identify herbal medicine plants by looking at their leaves. They used a powerful image recognition model called ResNet50, which is a type of deep learning algorithm. Instead of training the model from scratch, they used a method called transfer learning, which helps the model learn faster and more accurately by using knowledge from other similar tasks. Their system includes both hardware and software, so it can identify plants in real time using a camera and computer. This device is useful for healthcare and plant research, as it helps people easily recognize medicinal plants. Overall, the study shows how artificial intelligence can be used in traditional medicine and plant science.

Rajasekaran Subramanian (2024), [7] developed a mobile application designed to identify Ayurvedic medicinal leaves and retrieve their associated therapeutic properties using deep learning and natural language processing (NLP) techniques. The system employs a convolutional neural network (CNN) to classify leaf images captured via a smartphone camera. Subsequently, NLP methods are utilized to extract relevant medicinal information from a curated textual database. The integration of these technologies facilitates real-time, user-friendly access to Ayurvedic knowledge, aiming to bridge the gap between traditional medicine and modern technology. The paper reports high accuracy in leaf classification and effective retrieval of medicinal properties, highlighting the potential of AI-driven tools in promoting the accessibility and preservation of traditional medicinal practices.

Praveen Kumar Sekharamantry (2024), [8] proposed PSR-LeafNet, a novel deep learning framework designed for identifying medicinal plant leaves by integrating a three-stage network—P-Net, S-Net, and R-Net—for feature extraction. The model uses Support Vector Machines (SVM) for final classification to enhance accuracy and robustness. It was tested on multiple datasets, including Flavia, MalayaKew, and the Indian Medicinal Plant dataset, achieving high classification accuracy. This study demonstrates the potential of hybrid deep learning and machine learning approaches in medicinal plant identification, offering a scalable and efficient solution for botanical research and healthcare applications.

Smith et al. (2023), [9] investigated the identification of traditional medicinal plant leaves using an effective deep learning model and a self-curated dataset. They introduced a customized convolutional neural network (CNN) designed to accurately extract features from leaf images. To overcome limitations of existing datasets, the study compiles a diverse self-curated dataset representing various traditional medicinal plants. The research emphasizes the importance of high-quality and diverse data in improving classification accuracy. Advanced image preprocessing techniques are also applied to enhance leaf segmentation and clarity. The paper highlights the significance of combining domain-specific datasets with tailored deep learning architectures for reliable plant identification. This work lays the foundation for further AI-based advancements in botanical classification and traditional medicine.

Rakib et al. (2023), [10] proposed an automatic recognition system for medicinal plants based on multispectral and texture features using a hidden deep learning model. The research focuses on leaf-based identification, collecting images from five different medicinal plant species in natural environments. The study applies Convolutional Neural Networks (CNNs), particularly the VGG16 architecture, achieving a classification accuracy of 95.48%. The model leverages both multispectral and texture features to improve robustness and precision in plant identification. Image preprocessing plays a vital role in enhancing classification performance. The system aims to facilitate the medical sector by enabling accurate, automated recognition of medicinal plants, which can assist in medicinal plant awareness and preservation. Evaluation metrics include accuracy and model reliability through deep learning algorithms, contributing to the integration of AI with botanical research.

Pradnya Patil et al. (2023), [11] proposed a computer vision-based system designed for accurate identification of medicinal plant leaves. The authors utilized deep learning techniques, particularly convolutional neural networks (CNNs), to extract and analyze leaf features such as shape, texture, and venation patterns. The study emphasizes the integration of image preprocessing methods to enhance feature clarity and model robustness. Experimental results demonstrate high accuracy in classifying multiple medicinal plant species, addressing challenges related to intra-class variability and inter-class similarity. The paper discusses the practical application of the system in aiding herbal medicine identification and promoting traditional knowledge preservation. This work contributes to the development of automated tools for botanical research and healthcare.

Nidhi Tiwari et al. (2023), [12] explored the application of deep learning and traditional machine learning algorithms for the classification and identification of medicinal plant leaves using their spectral characteristics. The study emphasizes the use of hyperspectral imaging data, which captures detailed spectral signatures unique to different plant species, enabling more precise identification. They compare various machine learning classifiers such as Support Vector Machines (SVM), Random Forest (RF), and deep learning models like Convolutional Neural Networks (CNN) to assess their effectiveness in distinguishing between similar plant species. The paper also discusses preprocessing techniques and feature extraction methods to enhance model performance. Their findings demonstrate that deep learning models, particularly CNNs, outperform conventional classifiers in accuracy and robustness. This research highlights the potential of integrating spectral data with advanced learning algorithms for reliable medicinal plant identification, contributing to biodiversity conservation and the pharmaceutical industry. The work sets a foundation for future advancements in automated plant recognition systems using spectral imaging.

Sheetal S. Patil et al. (2023), [13] investigated the application of Convolutional Neural Networks (CNNs) for the identification of medicinal plants. They utilized a dataset comprising 1,500 leaf images from various medicinal plant species to train and validate their model. The study demonstrates that CNNs can effectively extract features from raw image data, leading to an impressive classification accuracy of 99.10%. This research highlights the potential of deep learning techniques in automating the identification process of medicinal plants, which is traditionally reliant on expert knowledge and manual observation. The findings underscore the efficacy of CNNs in handling complex image data for plant classification tasks.

Azadnia et al. (2022), [14] proposed an AI-based approach for medicinal plant identification using a deep Convolutional Neural Network (CNN) architecture enhanced with Global Average Pooling (GAP). The study focuses on the classification of five medicinal plant species by analyzing leaf images. The CNN model comprises a feature extraction block and a classifier block, which includes a GAP layer, a dense layer, a dropout layer, and a softmax layer. The model was tested on images resized to 64×64, 128×128, and 256×256 pixels, achieving over 99.3% accuracy across all resolutions. This approach demonstrates the potential of deep learning techniques in accurately identifying medicinal plants, offering a viable alternative to traditional, time-consuming identification methods.

Amey Sunil Deshmukh et al. (2021), [15] presented a study on Ayurvedic plant identification leveraging image processing and artificial intelligence techniques. The paper focuses on developing an automated system capable of accurately identifying medicinal plants used in Ayurveda by analyzing leaf images. The authors employ preprocessing methods, feature extraction techniques, and classification algorithms to enhance identification accuracy. Their approach aims to assist practitioners and researchers by providing a reliable tool to recognize plants without extensive botanical expertise. The study emphasizes the importance of AI-driven solutions in traditional medicine, improving accessibility and preservation of herbal knowledge. This work contributes to the intersection of computer vision and ethnobotany, setting the stage for further advancements in AI-assisted plant recognition systems.

Sukhadia et al. (2021), [16] proposed a deep learning-based method for automated skin disease detection using the Fast R-CNN architecture. Their approach addresses limitations in traditional image classification techniques by integrating object detection and classification in a single framework. The system was trained on a custom skin disease dataset, and it demonstrated improved accuracy in detecting and localizing various skin conditions compared to basic CNN models. The Fast R-CNN model efficiently identifies multiple disease regions within dermatological images, even under challenging conditions such as low contrast and overlapping lesions. The authors also developed a user interface to simplify disease identification for non-expert users. Their results highlight the effectiveness of Fast R-CNN in medical image analysis, providing a foundation for real-time skin disease screening tools.

Esmaieeli Sikaroudi, A. Mohammad et al. (2021), [17] proposed a deep learning-based method for the automated detection of skin diseases using Fast R-CNN, a region-based convolutional neural network. Their approach leverages a dataset of labeled skin lesions to train a model that can accurately identify various types of skin diseases. The Fast R-CNN model outperforms traditional machine learning methods, achieving high accuracy in detecting skin abnormalities. The authors also implemented a preprocessing step to enhance the quality of skin images, improving detection performance under varying conditions. Experimental results showed a significant reduction in false positives compared to other existing techniques. The study's findings suggest that this deep learning-based approach has great potential in clinical practice for assisting dermatologists with skin disease diagnosis. A user-friendly interface was also developed to facilitate ease of use for medical practitioners.

Miss Mukta Kamble et al. (2019), [18] proposed a dual-stage skin disease detection system combining image processing and machine learning. The authors designed a mobile-based application that utilizes computer vision techniques for image preprocessing and feature extraction, followed by a convolutional neural network (CNN) for classification. They categorized the detection process into two phases—image preprocessing and disease classification—and emphasize the system’s applicability in rural and resource-limited settings. The study reports an accuracy of up to 95% for detecting diseases like Psoriasis, Lichen Planus, and Pityriasis Rosea. Challenges such as varying skin tones and image quality are identified, with future work focusing on improving robustness and expanding disease coverage. This work highlights the potential of integrating clinically evaluated histopathological features with machine learning models for accessible and reliable dermatological diagnosis.

Alaa Haddad and Shihab A. Hameed (2018), [19] proposed a framework for automated skin disease detection using image processing and machine learning techniques. The system focuses on identifying multiple skin conditions—acne, psoriasis, melanoma, and heat rash—from mobile-acquired images. The methodology involves a sequence of preprocessing (using Gaussian and median filters), color space conversion (RGB to YCbCr), and segmentation (via K-means and Fuzzy C-means clustering) to isolate the skin region. Key features—both color and texture-based—are extracted and classified using a Support Vector Machine (SVM) with a radial basis function kernel. The proposed system achieved a classification accuracy of 90.09% with KNN and 82.5% with MSIM. A mobile interface was developed to capture images in real-time and initiate diagnosis, improving accessibility and user experience. This multi-disease detection approach offers significant advancement over prior models that focused on single diseases, enabling faster and more accurate dermatological assessments.

Nahida Tabassum and Mariya Hamdani (2014), [20] explored the use of medicinal plants in the treatment of skin diseases by documenting 31 species traditionally employed in herbal remedies. The study emphasizes plant-based treatments for conditions such as eczema, acne, psoriasis, and skin infections. It presents Aloe vera, Allium cepa, Azadirachta indica, Curcuma longa, and Ocimum sanctum as key examples with antibacterial, antifungal, and anti-inflammatory properties. The authors highlights the pharmacological potential of these plants and advocate for scientific validation and clinical trials. This work contributes to the growing interest in herbal dermatology and supports the development of plant-based therapeutic solutions.

**2.3 Summary of Literature Survey**

The literature review highlights the use of deep learning, especially CNNs, for accurate skin disease detection and medicinal plant identification. Models like Fast R-CNN, YOLOv8, and ResNet50 have shown high performance in analyzing skin conditions and classifying plant leaves. Several studies also emphasize the integration of mobile applications and traditional herbal knowledge for practical use. HerbalLink builds on these advancements by combining AI-based diagnosis with plant recognition to recommend natural remedies for skin diseases. Table 2.1 shows the summary of literature survey done.

**Table 2.1: Observations of Literature Survey**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Author Name** | **Title of Paper** | **Methodology used** | **Advantages** | **Future Work** |
| Nahida Tabassum and Mariya Hamdani | Plants used to treat skin diseases | Ethnobotanical and pharmacological review of 31 medicinal plants traditionally used for skin disease treatment. | Bridge traditional knowledge with modern science, document key medicinal plants, highlight therapeutic potential for skin diseases. | Scientific validation through pharmacological studies and clinical trials, standardize dosages, develop commercial herbal dermatology formulations. |
| Hicham Bouakkaz, Rania Kessab, Samira Bendoukha, and Abderrazak Ouldali | Enhanced Classification of Medicinal Plants Using Deep Learning and Optimized CNN Architectures | Optimize CNN with tuning and regularization, improve class distinction, enhance leaf classification. | High accuracy and robustness, scalable and easy to implement, suitable for herbal medicine and conservation. | Incorporate attention mechanisms, expand datasets with more plant parts, develop mobile apps, and explore transfer learning for better generalization. |
| A. Rajasekar et al. | AI-Based Skin Disease Detector Using CNN and YOLOv8 for Image and Video-Based Diagnosis | Combine CNN with YOLOv8 for skin disease classification and localization from images and video frames. | Real-time lesion localization with YOLOv8, enhanced classification accuracy with CNN, achieving 90% accuracy and 0.85 AUC-ROC. | Expand datasets for better generalizability, include rare skin conditions, and implement cloud-based diagnostics for telemedicine. |
| Rajasekar A., Shouvik C., and Mariya H. | Multiattribute Deep CNN for Medicinal Plant Detection and Therapeutic Application in Skin Disease Treatment | Multiattribute CNN framework using texture, color, and shape features for enhanced medicinal plant classification. | Enhances precision in plant identification and reliability in medicinal use linkage, providing a scalable AI-driven botanical diagnostic solution. | Expand dataset with more plant species and diseases, incorporate regional medicinal knowledge, integrate mobile apps for real-time detection. |
| Kale et al. | Automated Identification of Ayurvedic Medicinal Leaves and Home Remedy Recommendation Using Deep Learning | Classify 115 Ayurvedic leaf species, use 6,541-image dataset, leverage CNN, VGG16, MobileNet, and Inception models. | Combine leaf recognition with symptom-based disease ID, enable personalized remedy recommendations, improve accuracy with multiple pre-trained models. | Expand dataset coverage, improve model efficiency for real-time use, integrate user feedback for better recommendations. |
| Andrew Al C. Aquiro, Shannen L. Arreola, and Ramon G. Garcia | Herbal Medicine Plant Leaf Identification Device Using ResNet50 | Real-time plant ID device using ResNet50, applied transfer learning for accuracy and efficiency, combined hardware and software for leaf-based medicinal plant recognition. | Fast and accurate plant ID, efficient transfer learning, AI aids traditional medicine. | Expand plant database, improve portability, add mobile app features, and test in diverse environments for robustness. |
| Rajasekaran Subramanian | AI-Based Mobile Application for Identification of Ayurvedic Medicinal Leaves and Retrieval of Therapeutic Properties | Identify Ayurvedic leaves via deep learning, retrieve therapeutic properties using NLP, and provide mobile app access. | Real-time leaf identification, detailed therapeutic info, and integration of image recognition with NLP for accessible Ayurvedic knowledge. | Expand plant database, enhance multilingual NLP support, and add augmented reality for interactive learning. |
| Praveen Kumar Sekharamantry | PSR-LeafNet: A Hybrid Deep Learning Framework for Medicinal Plant Leaf Identification | Combine P-Net, S-Net, and R-Net for feature extraction, use SVM for classification, develop PSR-LeafNet framework for medicinal leaf identification. | High accuracy and robustness, integration of deep learning with SVM, scalable for large-scale botanical research. | Extend species coverage, optimize for real-time use, deploy on mobile/cloud platforms for wider access. |
| Smith et al. | Identification of Traditional Medicinal Plant Leaves Using Customized Deep Learning Models | Customized CNN for accurate feature extraction, focus on traditional medicinal plant leaf images. | Combine domain-specific high-quality datasets, tailor deep learning architectures, significantly improve classification accuracy. | Expand dataset diversity and size, optimize CNN architecture, integrate model into practical applications. |
| Rakib et al. | Automatic Recognition of Medicinal Plants Using Multispectral and Texture Features with Deep Learning | Collect leaf images from five species in natural settings, integrate multispectral imaging, and extract texture features for improved classification. | Combine multispectral data with texture features for robust classification, achieve 95.48% accuracy. | Expand dataset with more species and environmental variations, refine multispectral imaging methods. |
| Pradnya Patil, Ankita Chavan, Akash Kurane, Pratiksha Nikam, and Prof. R. R. Navghane | FloraMediVision: A Medicinal Plant Leaf Identification System using Computer Vision | Use CNN to analyze leaf shape, texture, and vein patterns, develop computer vision system for medicinal plant identification. | High accuracy despite variability, recognizes multiple plants, supports traditional knowledge and herbal medicine. | Expand species database, enable mobile platform integration, improve model with advanced architectures. |
| Nidhi Tiwari et al. | Applying Deep Learning and Machine Learning Algorithms for The Identification of Medicinal Plant Leaves Based on Their Spectral Characteristics | Capture hyperspectral data, preprocess to improve quality, extract key features, and train classifiers for accurate plant identification. | Combining hyperspectral imaging with CNN improves plant ID accuracy, handles similar species well, and aids conservation and research. | Expand dataset diversity, develop real-time ID systems, optimize CNNs, and create lightweight models for mobile and field use. |
| Sheetal S. Patil, Sneha K. Patil, and Rutuja D. Gaikwad | Medicinal Plant Identification Using Convolutional Neural Networks | Train CNN on 1,500 medicinal leaf images, automate feature extraction, classify multiple plant species. | High classification accuracy of 99.10%, reduces dependency on expert knowledge and manual efforts. | Optimize CNN architectures, and develop real-time mobile applications for field use. |
| Azadnia, N., Azadnia, A., and Salimi, H. | Medicinal Plant Identification Using Deep CNN with Global Average Pooling | Deep CNN with Global Average Pooling layer, feature extraction, use of dense, dropout, and softmax layers for medicinal plant leaf identification. | 99.3% accuracy across resolutions, strong robustness and precision, fast and reliable alternative to manual plant identification. | Expand species coverage, optimize for mobile deployment, integrate into field applications for botanists and herbalists. |
| Amey Sunil Deshmukh, Priyanka Dinkar Rathod, and Prashant Nivrutti Dighe | AI-Based Ayurvedic Medicinal Plant Identification Using Image Processing Techniques | Preprocess leaf images, extract features, and classify medicinal plants using AI for improved accuracy. | Reliable and accessible Ayurvedic plant identification, supports researchers and practitioners, promotes AI-driven preservation of herbal knowledge and tech integration. | Expand datasets for diversity, enhance classification algorithms, develop real-time mobile apps, add multilingual support. |
| Sukhadia, H., Patel, K., & Desai, S. | Deep Learning-Based Automated Skin Disease Detection using Fast R-CNN | Fast R-CNN architecture, localizing multiple disease regions in an image, improved accuracy, low contrast and overlapping lesions. | High accuracy detection and localization, Robust under low contrast and overlapping lesions, Integrated object detection and classification. | Expand dataset coverage, optimize for real-time mobile use, and integrate treatment recommendations. |
| Esmaieeli Sikaroudi, A. Mohammad et al. | Deep Learning-Based Automated Detection of Skin Diseases Using Fast R-CNN | Preprocess dermatological images, train Fast R-CNN model on labeled skin lesion dataset, and automate skin disease detection. | Superior accuracy and reduced false positives, robust to image quality and disease appearance variations. | Expand dataset to include rare and complex conditions, incorporate advanced deep learning models for segmentation. |
| Miss Mukta Kamble et al. | Skin Disease Detection Using Image Processing and Machine Learning on Mobile Devices | Two-phase mobile system: image preprocessing with computer vision for feature extraction, followed by CNN-based skin disease classification. | Achieved up to 95% accuracy for multiple skin conditions, mobile-friendly and optimized for resource-limited settings. | Enhance robustness for diverse skin tones and artifacts, expand dataset with more conditions, and integrate histopathological features for precision. |
| Alaa Haddad and Shihab A. Hameed | Skin Disease Detection System Based on Image Processing and Machine Learning Techniques | Apply preprocessing techniques, convert images to YCbCr color space, and segment skin regions using K-means and Fuzzy C-means clustering. | Achieves high accuracy with multi-disease detection, uses mobile image acquisition, and offers a user-friendly interface for real-time diagnosis. | Improve accuracy with deeper neural networks, expand dataset with more skin disease classes, and enhance mobile app for real-time cloud diagnosis and treatment. |
| Nahida Tabassum and Mariya Hamdani | Plants used to treat skin diseases | Ethnobotanical and pharmacological review of 31 medicinal plants traditionally used for skin disease treatment. | Bridge traditional knowledge with modern science, document key medicinal plants, highlight therapeutic potential for skin diseases. | Scientific validation through pharmacological studies and clinical trials, standardize dosages, develop commercial herbal dermatology formulations. |

**2.4 Comparison with Existing Systems**

The HerbalLink system presents a novel advancement over existing herbal medicine applications and skin condition diagnostic tools by integrating machine learning with both leaf recognition and skin disease analysis. Unlike conventional solutions that typically rely on static databases or keyword-based search engines, HerbalLink introduces image-based diagnosis, enabling users to interact with the system through real-world inputs such as photos of leaves or skin conditions.

Traditional herbal identification platforms often require users to manually enter plant names, browse lists, or match physical features using textual descriptions or illustrations. This process is time-consuming and prone to human error. In contrast, HerbalLink uses leaf image processing and pattern recognition algorithms to identify medicinal plants accurately. This objective and automated approach significantly enhances both the speed and accuracy of identification, making it more accessible to non-experts.

Similarly, most existing systems for diagnosing skin conditions depend on user-filled symptom checklists or manual searches. HerbalLink offers a smarter alternative by allowing users to upload images of affected skin areas. The system then applies trained models to detect common dermatological conditions based on visual patterns such as color, texture, and shape. By incorporating optional symptom text input, the system can further refine its predictions, a feature rarely found in standard tools.

Another distinguishing feature is HerbalLink’s ability to cross-link plant properties with detected skin issues. Once a skin disease is recognized, the system suggests relevant Ayurvedic or herbal remedies derived from the identified plant dataset. This direct connection between problem and natural solution is lacking in most separate plant encyclopedia and skin care apps, which typically don’t integrate both domains into a unified flow.

HerbalLink respects user privacy by safely handling both images and any symptom details provided. The system only asks for the information needed to give accurate suggestions. Unlike other apps that collect a lot of personal or health-related data, HerbalLink keeps things simple and secure, so users can feel safe and confident while using it.

In a space where many applications focus narrowly on either botanical education and dermatological diagnosis, HerbalLink stands out by fusing the two with AI, offering a practical, user-friendly, and accessible tool. This system not only increases the accuracy of both plant and disease identification but also promotes the use of natural, accessible remedies, particularly benefiting rural and underserved communities.

**2.5 Proposed System**

The proposed system for the HerbalLink application combines machine learning, image analysis, and Ayurvedic knowledge to provide users with accurate, accessible, and natural health recommendations. The heart of the system is its Dual Image Processing Module, which processes both leaf images and skin condition photos uploaded by the user. These modules use advanced computer vision techniques to recognize the features of medicinal leaves, such as shape, texture, color, and analyze visible symptoms in skin images to detect common skin diseases. This scientific approach ensures precise identification and relevant treatment suggestions based on physical inputs rather than guesswork.

To make the system easy to use, a simple and intuitive interface will guide users step-by-step. Users can upload existing images of either medicinal leaves or affected skin areas from their device. For better accuracy, they also have the option to provide a few key symptom details, which help the system improve its predictions. Once the image and information are submitted, the system processes the input and provides instant results, either identifying the medicinal plant and its uses or detecting the skin condition and suggesting natural Ayurvedic remedies.

Another important feature is the remedy recommendation engine. It links the detected skin problem to the right plant-based treatments. The system uses a trusted database of Ayurvedic knowledge to suggest specific leaves or herbs that can help heal the condition. This makes the whole process easy and smooth, from identifying the problem to get natural treatment advice.

Finally, the application is designed to deliver accurate and relevant recommendations by relying on a well-trained machine learning model and a curated Ayurvedic knowledge base. The system continuously improves through periodic updates using new data and research, helping HerbalLink provide better identification and natural remedy suggestions over time. This approach ensures the app remains effective and aligned with user’s health needs.

**2.6 Objectives**

* To develop a cross-platform mobile application using Flutter for a smooth and responsive user interface.
* To enable users to upload images of medicinal leaves or affected skin areas along with basic symptom details for accurate identification using machine learning models.
* To build and train convolutional neural network (CNN) models with TensorFlow for leaf and skin condition recognition
* To implement secure data handling and user privacy measures, ensuring safe storage and processing of images and input data.

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