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IDENTIFICATION OF MEDICINAL PLANTS USING DEEP LEARNING TECHNIQUES

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A B S T R A C T :

The classification of medicinal plants is essential for a traditional medicine and botanical study but generally needs a lot of time and expertise. The current work takes advantage of the advanced deep learning methods to expedite and improve the classification of 40 different medicinal plant species. We investigate the performance of convolutional neural networks(CNN),MobileNet,and a hybrid model of MobileNet and Recurrent Neural Network(RNN),VGG16 in doing so. Our strategy is to train these models on a large variety of plants images and measure their performance based on accuracy, precision, and recall. The CNN offers a strong baseline for image classification, while Mobilenet provides and optimized solution for low-resource environments. The hybrid MobileNet+RNN model is explore for potential benefits in sequential or contextual feature extraction. The result seek to promote improved automated plant identification system, making the, more available to researchers, herbalists and practitioners alike, eventually enhancing the efficiency and dependability of medicinal plant classification

Keywords: Medicinal plants, deep learning, Convolutional neural network(CNN), MobileNet, Hybrid Model, Image Classification, Medicinal plant Identification.

Introduction

The recognition of medicinal plants has a significant place in research pharmacology, and traditional medicine, but it is a challenging task since they are variable in image and require expert knowledge. The traditional way of indentifiaction has the disadvantage of being time-consuming and non-scalable, thus not being suitable for mass application. This project seeks to establish an advanced deep learning system that can automatically classify 40 different species of medicinal plants from images, To do this, three models-Convolutional Neural Networks(CNN), MobileNet, and a hybrid Mobilenet+RNN and VGG16 are used and compared on the basis of accuracy, precious, recall, and computational cost. Through comparison of these models, the research aims to determine the best method for accurate and scalable plant classification. The final objective is to provide an effective, easy-to-use device that helps reseachers, herbalists, and practitioners to identify medicinal plants quickly and correctly for research or actual use.

Scope : The project emphasizes the training and validation of a deep learning system for precise identification of 40 medicinal plant species. The scope includes various important steps such as gathering a rich dataset with high-resolution images, then applying preprocessing methods like resizing, normalization, and date augmentation to enhance model generalization. Three deep architectures Convolutional Neural Networks(CNN), MobileNet and a combination of MobileNet+RNN are used and trained with this dataset. Performance metrics like accuracy, precision, recall, and F1-score are used to evaluate the models stringently. Further emphasis is given to optimization of performance is in order to allow for computational efficacy, facilitating the deployment on computationally constrained systems such as embedded or mobile systems. The project also involves comparative analysis, hyperparameter optimization, and model interpretability methods like Grad-CAM to improve model decision understanding. Finally, the system is intended to be a useful and scalable solution for researchers, herbalists, and field practitioners in the quick and accurate identification of medicinal plants.

Literature Survey

There have been some studies that investigation deep learning methods for plant species classification with advances in model architecture and their applications. Sharma et al. [1] studied the use of deep Convolutional Neural Network (CNN) for plant species classification automatically. Their research showed that CNN's, when trained over large image datasets of plants, can be precise and dramatically enhance plant identification efficiency. Kumar et al. [2] emphasized employing MobileNet, a light-weight deep learning model, for plant classification within mobile and limited-resource environments. Their findings established the fact that MobileNet provides competitive accuracy at low computational costs, rendering it appropriate for real-time mobile applications.

Lee et al. [3] introduced a hybrid deep learning approach that integrates CNN's with Recurrent Neural Networks(RNN) to support improved plant species identification. The combination of CNN's for feature extraction and RNN's for sequential data processing resulted in better classification accuracy and sequential data processing resulted in better classification accuracy and stability, particularly on difficult image datasets. Zhang et al. [4] investigated applying transfer learning using deep neural network for the identification of medicinal plants. Through fine-tuning pre-trained models on respective datasets, they registered impressive improvements in accuracy, highlighting the viability of transfer learning for domain-specific classification problems.

In addition, Patel et al. [5] gave an extensive overview of image-based plant classification methods, including classical methods and state-of-the-art deep learning techniques like CNN's, MobileNet and hybrid models. Their paper presented the advantages and disadvantages of each technique and provided valuable unsights into directions for future research to improve plant identification systems. Together, these papers form a strong foundation for the construction of precise and efficient deep learning models for plants species classification.

Existing System

The system existing brings a deep learning-based method to the identification of medicinal plants through leaf images taken from various directions, both front and rear views. Through its emphasis on characteristics morphological characteristics like texture and shape, the system seeks to enhance classification robustness and accuracy. Fundamentally, the model employs the DenseNet architecture, a form of Convolutional Neural Network(CNN) that is recognized for its effective reuse of features and robust feature propagation.

Disadvantage :

- **Higher Computational Requirements :** DenseNet is a more complex architecture and hence demands more memory and processing capacity than models with low computational requirements such as Mobilent..
- **Not Suitable for Mobile or Edge Devices :** Owning to its size and complexity, DenseNet is not as efficient for real-time use in mobile devices or embedded systems.
- **Lacks Sequential Data Handling :** In contrast to hybrid models(e.g., MobileNet+RNN), DenseNet lacks processing of sequential or temporal pattern, which could hamper its performance in dynamic scenarios.
- **Slower Inference Time :** DenseNet tends to have slower prediction times, which makes it less suitable for processes needing fast, real-time output.
- **Higher Energy Consumption :** Dense connections and deeper layers of DenseNet can result in higher power consumption, which is a disadvantage in battery-hungry devices.
- **Reduced Flexibility in Resource Scarce Environment :** The complexity of the model makes it hard to downscale without a considerable loss in performance, as compared to Mobilenet-based models.

Proposed System

The suggested system is set to transform medicinal plant identification by using powerful deep learning methods to automate and optimize the process. In particular, the system will use Convolutional Neural Network(CNN), MobileNet and a combination of MobileNet+RNN model to identify 40 different medicinal plant species from photographs. The CNN will be a strong baseline model, which will be able to extract and process visual features in order to detect plant species with great accuracy. MobileNet, know for its effectiveness in mobile and embedded systems, will be utilized in order to maintain performance while working with limited computational resource, thereby guaranteeing practical, real-world applicability. The MobileNet+RNN hybrid will leverage the strong feature extraction of MobileNet with the sequential data processing competencies of Recurrent Neural Network (RNN) to provide greater performance when temporal or contextual data is advantageous.

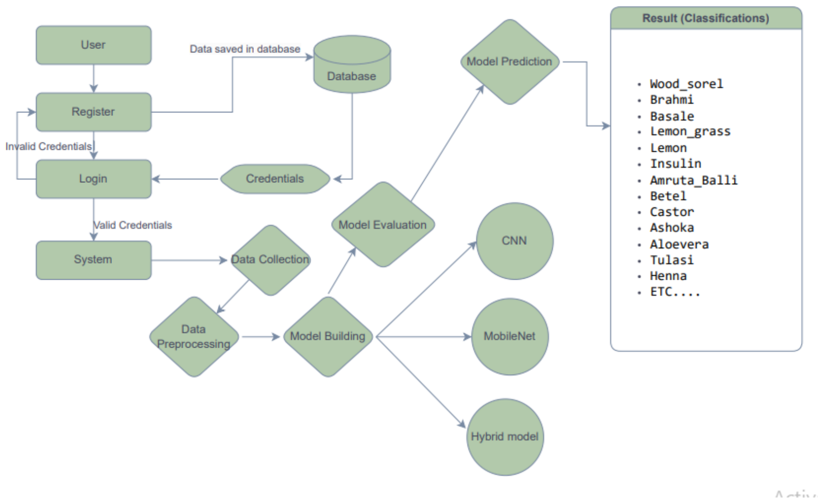

Fig. 1- Architecture

Advantage of Proposed System :

- **Lightweight and Faster Execution (MobileNet):**
  MobileNet is optimized for speed and low computational cost, which ,makes it perfect for mobile deployment and embedded system, as opposed to the heavier DenseNet model.
- **Real-Time Performance:**
  The light-weight architecture of MobileNet and its variants provides quickers inference times, which is very important for real-times medicinal plants detection in field environments.
- **Sequential Pattern Recognition(MobileNet+RNN):**
  The hybrid MobileNet+RNN architecture benefits from combining the feature extraction power of CNN's with RNN's ability to recognize temporal patterns of features, delivering enhanced performance when image data contains time-dependent features (e.g., seasonal changes or growth stages).
- **Improved Scalability:**
  The modularity and efficiency of MobileNet-based models facilitate them being scaled for large dataset or other plant species with minimal growth in computational load.
- **Energy Efficient:**
  The models use less energy, and thus they are more appropriate for bettery-powered systems such as smartphones and handheld field scanners.
- **High Accuracy with Lower Complexity:**
  While having high classification accuracy, the ensemble of such models usually has better performance-to-complexity ratios than DenseNet-based architectures.

System Modules

1.1 Data Collection :

This modules is responsible for acquiring a complete dataset of medicinal plant image. The dataset includes a wide variety of images of 40 different plant specie, taken under different lighting conditions, angles, and backgrounds to make it robust and generalizable. To make model training and testing possible, the dataset is usually divides into three subsets:80% for training, 10% for validation, and 10% for testing.

1.2 Data Preprocessing

In order to make the dataset ready for efficient training, the images gathered are subjected to a series of preprocessing operations:
Image Resizing: All images are resized to a fixed resolution(e.g., 224x224 pixels) to align with the input size expected by MobileNet.
Normalization: Pixel intensity is scaled between 0 and 1 to enhance the speed of convergence during the training process.
Data augmentation : rotation, flipping and color shifting are used to enhance data variablitiy and minimize overfitting risk.

1.3 Model Training

This module includes training both the MobileNet and RNN components :

1.4 MobileNet Training :

MobileNet is trained to learn high-level features from plant images. Transfer learning is utilized with pre-trained imageNet weights to speed up convergence and enhance accuracy.

1.5 Rnn Integration :

Features from MobileNet are fed into recurrent neural network (RNN), like an LSTM, to capture temporal or contextual relations in the features domain, thus enhancing classification accuracy.

1.6 Hybrid Model Integration :

This step is dedicated to integrating MobileNet and RNN into one hybrid architecture

1.7 Feature Extraction :

MobileNet is utilized to extract deep feature representations from the input images.

1.8 Contextual Analysis :

The features extracted are then fed into the RNN to identify sequential relationships.

1.9 Integration :

Both parts are integrated followed by fully connected layers, leading to a softmax output for multi-class classification.

1.10 Model Evaluation :

The hybrid model trained is tested using the test dataset to find its classification performance:
Performance Metrics : Accuracy, precision, recall, and f1-score are computed for each of the 40 plant classes.
Confusion Matrix: A confusion matrix is created to display true vs. predicted classification, highlighting where misclassification take place.

6. Conclusion

In conclusion, the hybrid model of MobileNet with an RNN has been found to be the best approach to classifying medicinal plants with a high validation accuracy of 92.94%. The model surpassed both CNN and MobileNet separately, providing better performance and balanced classification for a wide range of plant categories. The CNN performed well but had difficult with some plants, whereas MobilNet had remarkable accuracy and f1-score but had a problem with some categories. The effectiveness of the hybrid approach indicates its utility for real-world application for medicinal plant identification and that combining multiple deep learning strategies can enhance classification accuracy and robustness tremendously. Subsequent studies may also concentrate on improving these modules further and examining other hybrid approaches to optimize performance even more.

Result :

Hibiscus	1.00	0.89	0.94	35
Honge	1.00	0.92	0.96	36
Insulin	0.93	0.97	0.95	29
Jasmine	0.84	1.00	0.91	36
Lemon	1.00	0.92	0.96	26
Lemon_grass	0.93	1.00	0.97	28
Mango	0.79	1.00	0.88	34
Mint	0.96	0.87	0.92	31
Nagadali	0.79	0.94	0.86	32
Neem	1.00	0.79	0.88	29
Nithyapushpa	1.00	0.96	0.98	27
Nooni	1.00	0.90	0.95	29
Pappaya	1.00	0.91	0.95	43
Pepper	0.97	0.97	0.97	32
Pomegranate	0.88	0.93	0.90	30
Raktachandini	0.97	1.00	0.98	29
Rose	0.82	0.93	0.87	30
Sapota	1.00	0.88	0.94	25
Tulasi	0.85	0.97	0.91	36
Wood_sorel	0.91	0.97	0.94	33
accuracy			0.93	1189
macro avg	0.94	0.93	0.93	1189
weighted avg	0.94	0.93	0.93	1189

Fig. 2- Hybrid (RNN + Mobilenet)

Output:

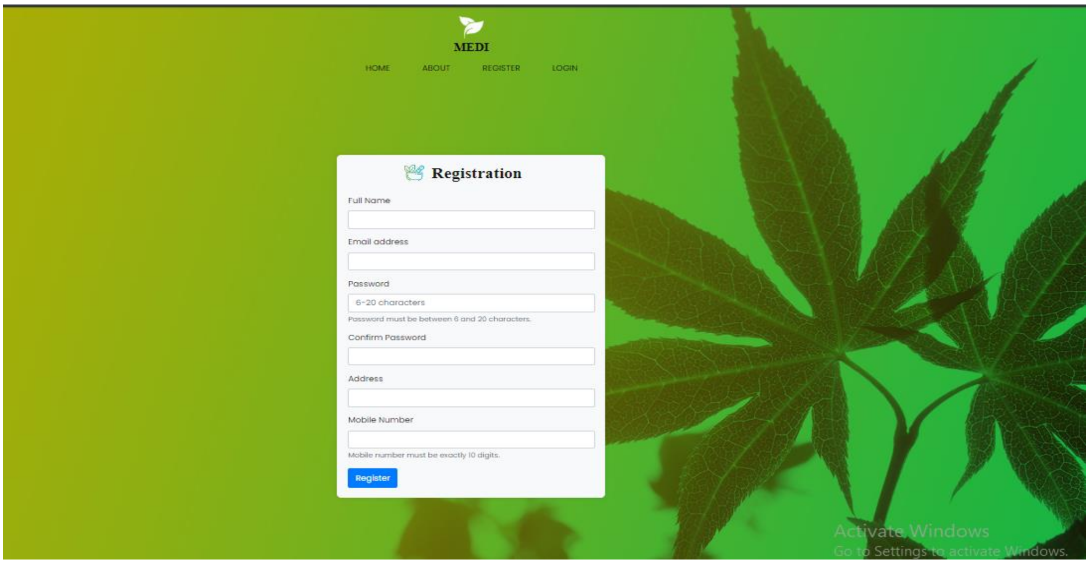

Fig. 3- Registration Page

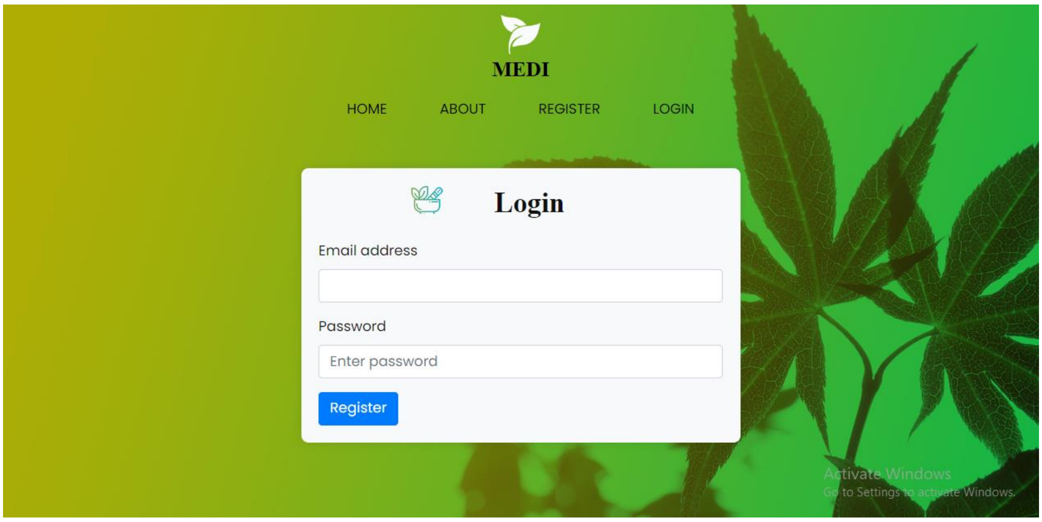

Fig. 4-Login Page

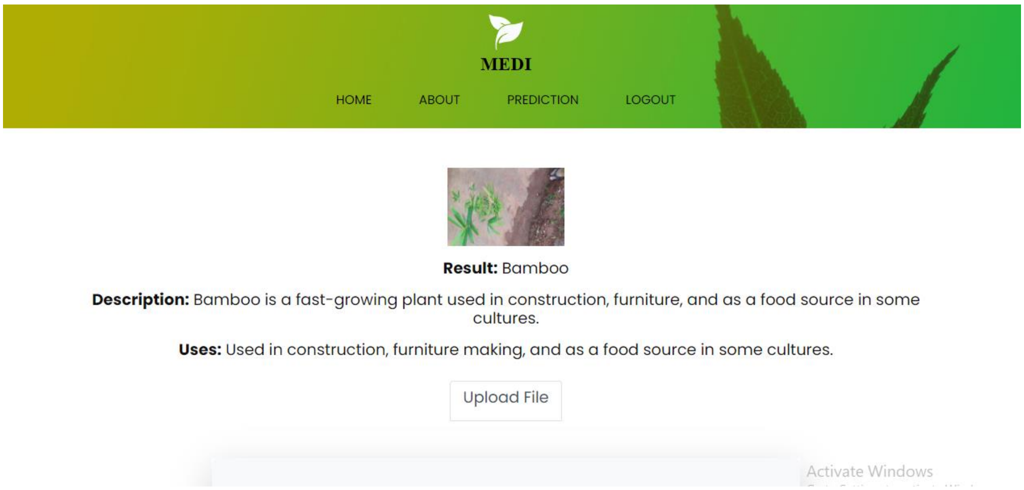

Fig. 5-Result page

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