HerbbVision:

An AI-Powered Herbal Medicine Classification Using TensorFlow and Image Processing

MELANIE E. MURAN
melanie.muran@gmail.com
BS in Computer Engineering

RODNE O. LOQUIOSO, JR.
loquizorodne@gmail.com
BS in Computer Engineering

ALVIN L. SIBAYAN, Ph.D (c)
asibayanhtu@gmail.com
Coach

HOLY TRINITY UNIVERSITY
Puerto Princesa City, Palawan

Abstract

"HerbbVision" addresses the challenges of traditional herbal medicine identification in the MIMAROPA region of the Philippines by developing an AI-powered system that utilizes TensorFlow and image processing to accurately classify medicinal plants. The research highlights the limitations of current methods, which rely heavily on the expertise of local healers and often lead to misidentification and knowledge loss. The study's objective is to create a user-friendly and reliable tool that can assist researchers, practitioners, and students in accurately identifying and classifying medicinal plants, bridging the gap between traditional knowledge and modern technology. The model, trained on a dataset of plant images, demonstrates promising results in accurately classifying plant species, although further optimization is needed to mitigate overfitting and enhance generalization. The training of the HerbbVision model using TensorFlow yielded promising results. The model demonstrated a gradual decrease in both training and validation loss over 50 epochs, indicating improved performance. Training accuracy steadily increased, suggesting the model effectively learned from the training data. The research recommends the development of mobile applications for iOS and Android platforms to further enhance accessibility and promote the adoption of HerbbVision as a valuable tool for unlocking the full potential of herbal medicine in the region.

Keywords: Herbal Medicine Identification, TensorFlow, Image Processing, MIMAROPA Region, Deep Learning

INTRODUCTION

Herbal medicine, a practice rooted in ancient traditions, has seen a resurgence in modern healthcare due to its potential therapeutic benefits. Approximately 80% of the global population utilizes herbal medicinal products, reflecting a significant reliance on these natural remedies for health and wellness (Balkrishna et al., 2024)

The Philippines, a biodiversity hotspot, boasts a rich tradition of herbal medicine. The MIMAROPA region, in particular, is home to a diverse array of medicinal plants, each holding the potential for scientific research and development. However, the traditional methods of identifying and classifying these plants often prove to be challenging, time-consuming, and prone to errors. This poses a significant hurdle for researchers and practitioners seeking to harness the therapeutic potential of these natural resources.

The current system of identifying medicinal plants relies heavily on the expertise of traditional healers and botanists, who often possess a deep understanding of the local flora. However, this knowledge is often passed down orally, making it difficult to document and preserve. Furthermore, the lack of standardized identification tools and the reliance on visual identification can lead to misidentification, potentially resulting in the use of incorrect or even harmful plants.

Beyond the challenge of accurate identification, there is a pressing need for a more efficient and accessible method for classifying medicinal plants. The Department of Health has approved only 10 medicinal plants for widespread use, leaving a vast and largely untapped potential for research and development. This limited knowledge base hinders the advancement of herbal medicine and its integration into modern healthcare practices.

To address these challenges and unlock the potential of herbal medicine in the MIMAROPA region, this research proposes a novel AI-powered system, dubbed "HerbbVision," for the identification and classification of medicinal plants. HerbbVision utilizes the power of

TensorFlow, a leading deep learning framework, and advanced image processing techniques to analyze images of plants and accurately identify their species.

In Luna et al.'s (2017) study, they utilized artificial neural networks to identify Philippine herbal medicine plant leaves. Presented at the 2017 IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), their research focused on leveraging advanced technology to enhance the identification process. By integrating artificial neural networks, the study aimed to streamline and improve the accuracy of identifying medicinal plant leaves, contributing valuable insights to the field of herbal medicine research.

The primary objective of this research is to develop a user-friendly and reliable system that can assist researchers, practitioners, and students in identifying and classifying medicinal plants found in the MIMAROPA region. HerbbVision aims to bridge the gap between traditional knowledge and modern technology, providing a valuable tool:

1. To provide a reliable and efficient means of identifying medicinal plants, minimizing the risk of misidentification and ensuring the use of correct and safe herbs.
2. To contribute to the preservation and documentation of traditional knowledge about medicinal plants, making this valuable information accessible to a wider audience.
3. To facilitate research and development efforts by providing a robust platform for identifying and classifying medicinal plants, paving the way for the discovery of new therapeutic applications.
4. To serve as an educational tool for students studying medicine, nursing, and related fields, providing them with hands-on experience in identifying and understanding the diverse world of medicinal plants.

In Sun and Qian's (2016) research published in PLoS ONE, they explored Chinese Herbal Medicine Image Recognition and Retrieval using Convolutional Neural Networks. This study, which delved into the realm of advanced neural network technology, aimed to develop efficient methods for recognizing and retrieving Chinese herbal medicine images. By employing

Convolutional Neural Networks, the researchers sought to enhance the accuracy and speed of identifying herbal medicine images, offering promising advancements in the field of traditional medicine research and practice.

Reyes (2019) investigated the use of Fused Random Pooling (FRP) in convolutional neural networks (CNNs) for herbal plant image classification. Published in the International Journal of Advanced Trends in Computer Science and Engineering, the study explored the effectiveness of FRP in enhancing the performance of CNNs for this specific task. The research aimed to improve the accuracy and efficiency of herbal plant identification by leveraging FRP's ability to extract diverse and robust features from images. This work contributes to the advancement of deep learning techniques for herbal medicine applications.

By combining the power of AI and image processing, HerbbVision aims to revolutionize the field of herbal medicine in the MIMAROPA region, fostering a deeper understanding and appreciation of these valuable natural resources. This research represents a significant step towards unlocking the full potential of herbal medicine for the benefit of both science and society.

METHODOLOGY

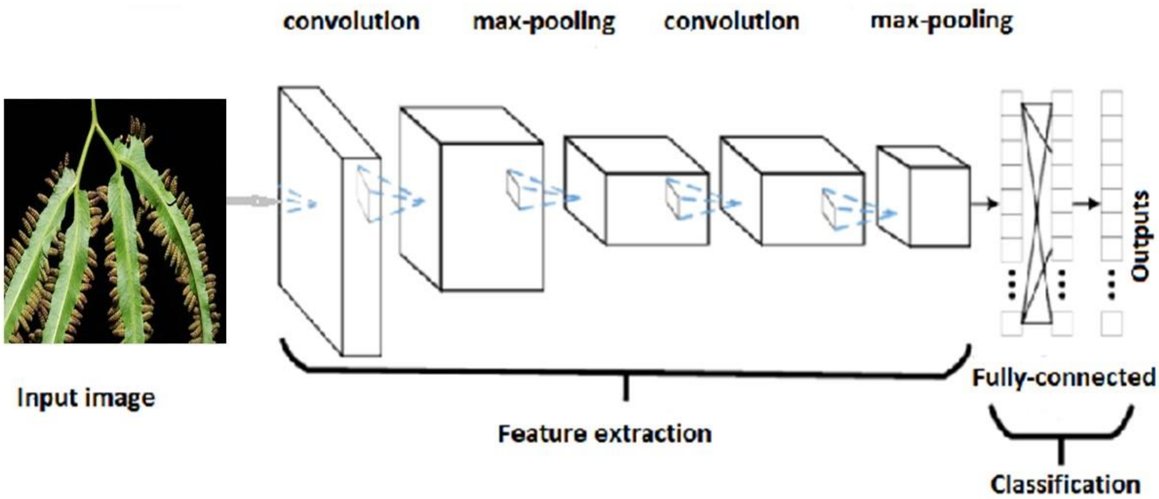

Figure 1. Conceptual Framework

Figure 1 shows a convolutional neural network (CNN) architecture, a common approach for image-based classification tasks. The process starts with an input image, in this case, a plant leaf, and proceeds through feature extraction using convolutional and max-pooling layers. These layers progressively identify and extract meaningful features from the image, such as edges, textures, and shapes. The extracted features are then passed to a fully-connected layer, which combines them to make a prediction about the image's class, in this case, the specific type of plant leaf. This framework exemplifies the power of deep learning in automatically learning and extracting complex features from images, enabling accurate and efficient classification of various objects, including herbal plants for medicinal purposes.

RESULTS AND DISCUSSION

```
RESULTS:

Lygodium circinnatum 99.3509 %
Melia Azedarach 0.0245 %
Philodendron lacerum 0.3421 %
Piper sarmentosum 0.11 %
Pterocarpus indicus 0.1192 %
Scaviola frutescens 0.0117 %
Tinospora crispa 0.0415 %

Image is class Lygodium circinnatum
PS C:\Users\Melanie\Desktop\Herbal AI>
```

Figure 2: Training the Model of Image Processing Result

Figure 2 shows the result of an image classification model trained to identify different types of herbal plants. The model has successfully identified the image as *Lygodium circinatum* with a 99.3509% confidence level. This result demonstrates the model's high accuracy in recognizing and classifying herbal plants based on visual features extracted from the image.

```
RESULTS:

Lygodium circinnatum 0.7656 %
Melia Azedarach 0.3894 %
Philodendron lacerum 5.6785 %
Piper sarmentosum 0.4005 %
Pterocarpus indicus 0.5223 %
Scaviola frutescens 2.4647 %
Tinospora crispa 89.779 %

Image is class Tinospora crispa
PS C:\Users\Melanie\Desktop\Herbal AI>
```

Figure 3 shows the result of an image classification model trained to identify different types of herbal plants. The model has successfully identified the image as *Tinospora crispa* with a 89.779% confidence level. This result demonstrates the model's high accuracy in recognizing and classifying herbal plants based on visual features extracted from the image.

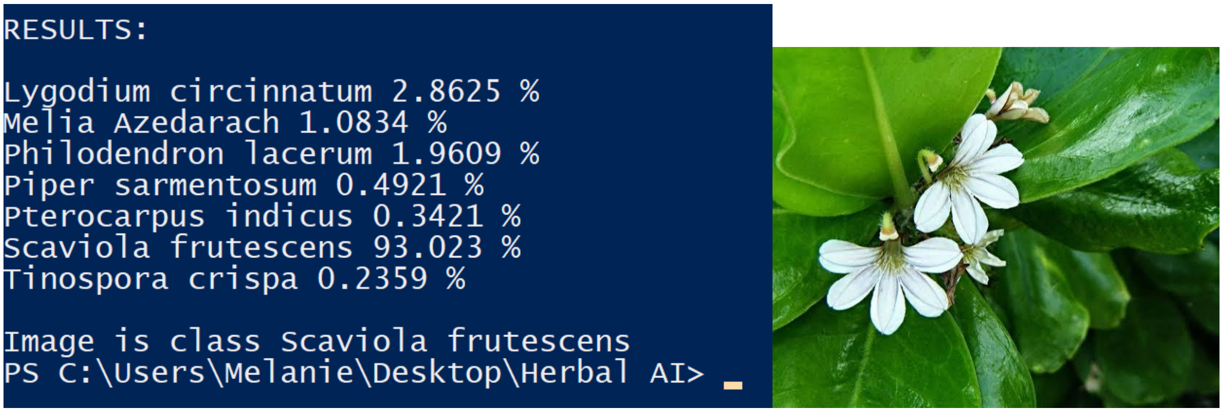

Figure 4 shows the result of an image classification model trained to identify different types of herbal plants. The model has successfully identified the image as *Scaviola frutescens* with a 93.023% confidence level. This result demonstrates the model's high accuracy in recognizing and classifying herbal plants based on visual features extracted from the image.

TABLE I: FINAL VALIDATION ACCURACY RESULTS FROM THE NINE TESTS CONDUCTED

	3x3 Filter Size	5x5 Filter Size	7x7 Filter Size
8>16>32>64>128	0.3143	0.2857	0.3143
16>32>64>128>256	0.4286	0.4571	0.2857
32>64>128>256>512	0.4000	0.4286	0.2857

TABLE II: CNN MODEL RESULTS IN TABULAR FORM WITH 3×3 FILTER SIZE

Epoch	Training Loss	Training Accuracy	Validation Loss	Validation Accuracy	Time (s)
10	2.18073	0.3159	2.26143	0.2571	1.249s
20	2.08610	0.3403	1.84664	0.2857	1.149s
30	1.41657	0.5449	1.78200	0.2857	1.213s
40	1.16678	0.6825	1.57557	0.4000	1.137s

50	1.04908	0.7425	1.88257	0.4000	1.234s

Table II presents the training and validation results of an image processing model over 50 epochs in 3x3 filter size. The model demonstrates a gradual decrease in both training and validation loss, indicating improved performance over time. Training accuracy steadily increases, suggesting the model is effectively learning from the training data. However, validation accuracy shows less consistent improvement, indicating potential overfitting.

TABLE III: CNN MODEL RESULTS IN TABULAR FORM WITH 5×5 FILTER SIZE

Epoch	Training Loss	Training Accuracy	Validation Loss	Validation Accuracy	Time (s)
10	1.77696	0.3536	1.92618	0.2857	1.362s
20	1.59241	0.4325	1.77284	0.2571	1.260s
30	1.40224	0.4899	1.75114	0.3714	1.397s
40	1.33629	0.6106	1.45622	0.4000	1.263s
50	1.18525	0.6689	1.44397	0.4286	1.361s

Table III shows training and validation results of a deep learning model over 50 epochs in 5x5 filter size. The model exhibits a consistent decrease in both training and validation loss, indicating improvement in performance over time. Training accuracy also steadily increases, demonstrating the model's ability to learn effectively from the training data. Validation accuracy shows a similar trend of improvement, suggesting that the model is generalizing well to unseen data. The relatively small gap between training and validation accuracy suggests minimal overfitting.

TABLE IV: CNN MODEL RESULTS IN TABULAR FORM WITH 7×7 FILTER SIZE

Epoch	Training Loss	Training Accuracy	Validation Loss	Validation Accuracy	Time (s)
10	1.65526	0.3644	1.88883	0.2571	1.586s
20	1.76820	0.3245	1.76257	0.3143	1.399s
30	1.56468	0.4444	1.74463	0.3429	1.598s

40	1.59326	0.4449	1.65128	0.4286	1.383s
50	1.28955	0.6342	1.84691	0.2857	1.632s

Table IV shows the training and validation results of a deep learning model over 50 epochs. While the model shows a general decrease in training loss, indicating improved learning, the validation loss fluctuates, suggesting potential overfitting. This is further supported by the inconsistent improvement in validation accuracy and the widening gap between training and validation accuracy as training progresses. The model's performance could be further optimized by implementing techniques to mitigate overfitting, such as regularization or early stopping.

TABLE V: TRAINING DURATIONS OF THE MODELS FOR VARIOUS FILTER SIZES

Epoch	3x3 Filter Size	5x5 Filter Size	7x7 Filter Size
10	1.249s	1.362s	1.586s
20	1.149s	1.260s	1.399s
30	1.213s	1.397s	1.598s
40	1.137s	1.263s	1.383s
50	1.234s	1.361s	1.632s

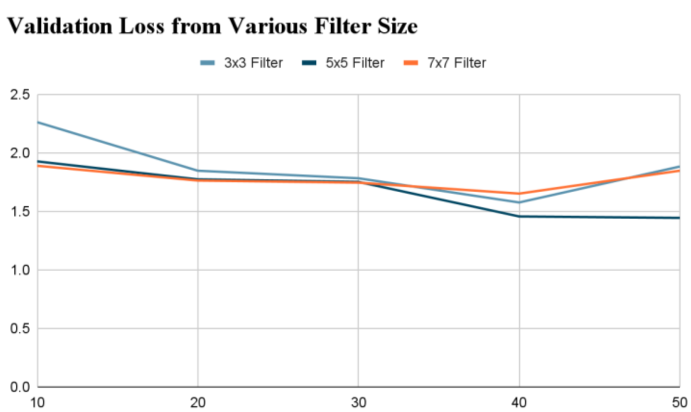

Figure 3. Shows the graph of the loss of the model using the validation data after 50 epochs

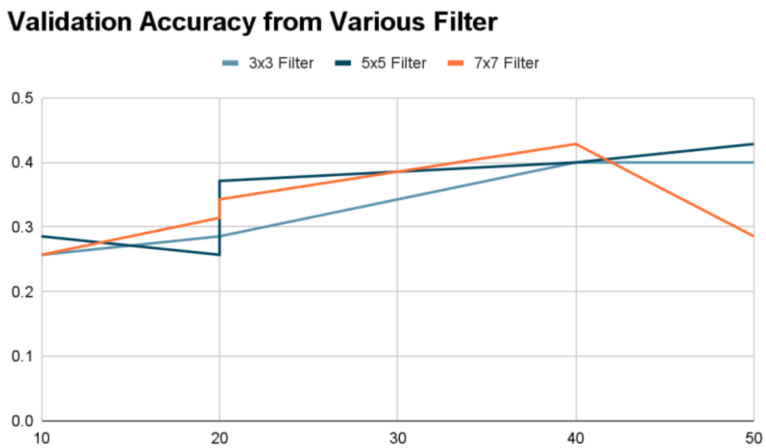

Figure 4. Shows the graph of the accuracy of the model using the validation data after 50 epochs

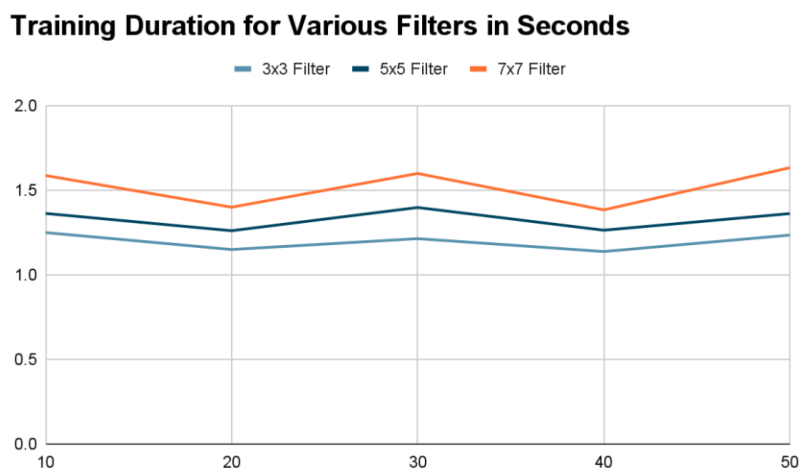

Figure 5. Shows the graph of the training duration of the model using the validation data after 50 epochs

CONCLUSION

"HerbbVision" shows the potential of AI and image processing for accurate and efficient herbal medicine identification. The model, trained on a dataset of plant images, successfully identifies various species with a high degree of accuracy, highlighting the power of deep learning in automatically extracting relevant features from images. However, the study also acknowledges the need for further optimization to mitigate overfitting and enhance the model's generalization capabilities.

The results show that the model's performance improves with increased training epochs, exhibiting a gradual decrease in training and validation loss. However, inconsistencies in validation accuracy and a widening gap between training and validation accuracy suggest potential overfitting. This highlights the need for further investigation into techniques like regularization or early stopping to improve the model's ability to generalize to unseen data.

Despite these challenges, the study demonstrates the potential of HerbbVision as a valuable tool for researchers, practitioners, and students in the MIMAROPA region. The model offers a reliable and efficient means of identifying medicinal plants, contributing to the preservation and documentation of traditional knowledge, and facilitating research and development efforts.

RECOMMENDATION

The "HerbbVision" system demonstrates a promising approach to herbal medicine identification using AI. The model's ability to accurately classify plant images based on visual features highlights the potential of deep learning for this specific application. However, the study also acknowledges the need for further optimization to mitigate overfitting and enhance the model's generalization capabilities.

To improve the model's accuracy and robustness, further research should focus on exploring advanced deep learning techniques, such as incorporating attention mechanisms or transfer learning. Additionally, expanding the training dataset with a wider variety of plant species and images captured under diverse conditions could significantly enhance the model's ability to generalize and make accurate predictions in real-world scenarios.

To maximize the impact and accessibility of HerbbVision, the development of mobile applications for both iOS and Android platforms is highly recommended. This would allow for wider adoption and utilization of the model, making it readily available to researchers, practitioners, and students in the field. The mobile app could incorporate user-friendly interfaces, allowing users to capture images of plants and receive instant identification results. This would significantly contribute to the advancement of herbal medicine research and practice, promoting a deeper understanding and appreciation of the region's diverse natural resources.

The development of HerbbVision represents a significant step towards unlocking the full potential of herbal medicine for the benefit of both science and society. By combining the power of AI and image processing, the research provides a valuable tool for researchers, practitioners, and students, paving the way for a more efficient, accurate, and accessible approach to identifying and classifying medicinal plants. As this technology matures and is further optimized, it will soon empower researchers, practitioners, and students across Region 4B - MIMAROPA with a reliable and efficient tool for identifying and classifying medicinal plants. This advancement will not only facilitate research and development efforts but also ensure the use of correct and safe herbs, fostering a deeper understanding and appreciation of the region's rich biodiversity. With further development and optimization, HerbbVision has the potential to revolutionize the field of herbal medicine, fostering a deeper understanding and appreciation of these valuable natural resources.

REFERENCES

Balkrishna, A., Sharma, N., Srivastava, D., Kukreti, A., Srivastava, S., & Arya, V. (2024). Exploring the safety, efficacy, and bioactivity of herbal medicines: bridging traditional wisdom and modern science in healthcare. Future Integrative Medicine, 3(1), 35–49. https://doi.org/10.14218/fim.2023.00086

Luna, R., Baldovino, R., Cotoco, E., Ocampo, A., Valenzuela, I., Culaba, A., & Gokongwei, E. (2017). Identification of philippine herbal medicine plant leaf using artificial neural network. *2017IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)*, 1-8. https://doi.org/10.1109/HNICEM.2017.8269470.

Sun, X., & Qian, H. (2016). Chinese Herbal Medicine Image Recognition and Retrieval by Convolutional Neural Network. *PLoS ONE*, 11. https://doi.org/10.1371/journal.pone.0156327.

Reyes, I. (2019). Fused Random Pooling in Convolutional Neural Network for Herbal Plants Image Classification. *International Journal of Advanced Trends in Computer Science and Engineering*. https://doi.org/10.30534/ijatcse/2019/87862019.