Reviw Article

Identification of Medicinal Plants by Artificial Intelligence(AI) Applications as per Modern Botany.

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Abstract

Background

Medicinal plants have played a crucial role in traditional medicine and modern healthcare. Medicinal plants have been used in traditional systems like Ayurveda and Indigenous healing practices for thousands of years. With the increasing complexity of plant taxonomy, deforestation, and the manual complex identity of plants, Artificial intelligence (AI) offers an innovative solution.[15]

Aim/ Objectives

To explore how Artificial intelligence (AI) applications help in identifying medicinal plants as per modern botany.

Design/Methodology

This study reviews the functioning of AI-based plant identification apps such as PlantNet, PlantSnap, etc. It focuses on the image recognition and machine learning techniques these apps use highlighting the all-specific botanical parameters analyzed (leaf, flower, Fruit, bark, etc.).[15] Additionally, this study practically analyzed 20 medicinal plants like- Dioscorea bulbifera L., etc. where Artificial intelligence (AI) systems have been successfully applied in plant identifications.

Findings

Tools for plant identification were found significantly, occasionally misidentification still exists. AI-based apps demonstrate high accuracy in identifying medicinal plants by analyzing detailed botanical features, offering faster and more scalable solutions compared to traditional methods. However, certain limitations remain, including data gaps in AI plant databases and challenges with distinguishing between closely related species.

Conclusion

This paper contributes to the understanding of how AI technologies, specifically in modern botany, can advance the identification of medicinal plants. It highlights the integration of AI in botanical research, offering plant conservation, and drug discovery.

Keywords

Artificial Intelligence(AI), Medicinal Plants, Plant Identification Application, modern botany, Pharmacognosy.

Introduction

The identification of medicinal plants using Artificial Intelligence (AI) represents a transformative approach in modern botany. Traditional plant identification methods, often reliant on extensive botanical expertise and manual comparison of plant characteristics, can be time-consuming, labor-intensive, and prone to human error. With the increasing complexity of plant taxonomy and the global demand for natural medicines, AI offers an innovative solution that enhances accuracy, speed, and accessibility.

In modern botany, AI applications leverage advancements in machine learning, computer vision, and data science to automate the process of identifying medicinal plants. AI systems can analyze vast datasets of plant images, genetic information, and chemical profiles to differentiate between species, even those with subtle morphological differences. By training algorithms on thousands of plant species, AI can quickly identify plants from photos of leaves, flowers, or other characteristics with remarkable precision. Furthermore, AI-driven tools are now enabling botanists, researchers, and even laypeople to access real-time plant identification through mobile apps and platforms. [1,3,5]

The traditional identification of medicinal plants is a fundamental process in ethnobotany, taxonomy, and pharmacognosy, relying on knowledge passed down through generations and scientific methods for recognizing plant species. The accurate identification of medicinal plants is crucial for the safe and effective use of plant-based

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medicines, as misidentification can lead to ineffective or toxic outcomes. Below is an overview of the traditional methods for identifying medicinal plants.[4,6]

1. Morphological Identification

Morphological identification is the most commonly used traditional method. It involves examining the physical features of plants, which can be divided into several categories.

Leaves: Shape, size, arrangement (opposite, alternate), venation pattern, and margin type are key characteristics.

Flowers: Structure, color, shape, number of petals, and reproductive parts (stamens and pistils) are important indicators. Flower morphology is one of the most reliable features in plant taxonomy.

Fruits and Seeds: The form, color, texture, and internal structures of fruits and seeds provide crucial identification clues.

Bark and Stem: The texture, color, and external features of bark and stem are often used to distinguish between species, especially in trees and shrubs.

Roots and Rhizomes: The shape, size, and structure of roots and rhizomes are examined, especially for medicinal plants where these parts are used in remedies.[15]

2. Ethnobotanical Knowledge

Ethnobotany plays a critical role in the traditional identification of medicinal plants. Indigenous communities and traditional healers possess detailed knowledge about the medicinal properties of local plants, often based on centuries of experience. In many cultures, plants are classified based on their: *Local names: Medicinal plants are often identified by *local or vernacular names*, which vary across regions.[14]

3. Use of Herbals and Ancient Texts

In many traditional systems, such as *Ayurveda* (India), *Traditional Chinese Medicine* (TCM), and *Unani* medicine, ancient texts and *Materia medica* provide guidelines for identifying and using medicinal plants. These texts describe plants based on their morphology, medicinal properties, preparation methods, and effects on the human body.

AI Technologies

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think, learn, and perform tasks autonomously or semi-autonomously. It is a multidisciplinary field involving computer science, mathematics, cognitive science, and engineering. AI systems are designed to mimic cognitive processes such as problem-solving, learning, perception, language understanding, and decision-making.

Types of AI

AI can be broadly categorized into three types based on its capabilities:

1. Narrow AI (Weak AI)

This type of AI is specialized in performing a specific task. Narrow AI systems are prevalent today and can outperform humans in certain domains, such as speech recognition (e.g., Siri, Alexa), image recognition (e.g., facial recognition), and recommendation systems (e.g., Netflix or YouTube algorithms).

2. General AI (Strong AI)

General AI refers to machines that possess the ability to understand, learn, and apply knowledge across a broad range of tasks, similar to human cognitive abilities. This form of AI remains theoretical and is a long-term goal of AI research. Unlike narrow AI, general AI would be able to think and reason like humans, adapt to new situations, and transfer knowledge from one task to another.

3. Superintelligent AI

This is a hypothetical form of AI that surpasses human intelligence across all domains, including creativity, problem-solving, and social understanding.[15]

Botany in AI Systems for Plant Identification

AI-based systems, especially those using machine learning and image recognition, help in identifying plant species from images. These tools can differentiate between species based on leaf shape, flower structure, and other visual cues.[12]

Plant Identification Application

Plant identification apps are citizen science platform that uses artificial intelligence (AI) to facilitate the identification and inventory of plant species. This app allows the user to classify the plant species with ease. It also helps to take proper care of the green fellows and recognize common issues like pests and diseases. Thus, with the help of a plant identifier app, plant lovers can keep the plants green and healthy and treat their problems.[12]

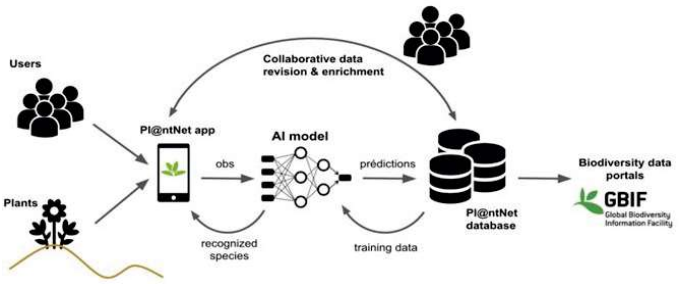
This type of app is based on image recognition and relies on member involvement, so it's important to provide it with quality images. First, a photo is taken and send it to the app. Next, it automatically compares the image to the thousands of images other users have added to its botanical database. Then, the app lets one view a list of potential species that might match. Incombent then "vote" for

the species that seems to be the right one. The algorithm collects that information and analyzes it against the database's images from other users. It then decides the plant's identity and informs you of the decision. This type of app claims its database contains many floras and thousands of plant species.[12]

Examples of plant identification apps

PlantNet, PlantSnap, LeafSnap, iNaturalist, PictureThis, Flower Checker, Blossom, Plantify, Planta, Google Lens, etc.[7,8]

The AI identification process of the Plant Net app.[12]



Some Plant Identification Apps Details' [7,8,9]

1. PlantNet

Price: Free
Devices: iOS and Android
Language: Available in 48 languages

PlantNet is one of the best free plant identification apps that can rapidly and accurately recognize any plant species without additional information or advertisements. The app includes more than 20000 species in its database, which is continuously increasing whenever someone makes a new identification.

However, selecting the appropriate category for identification is essential. The app also allows users to go through their huge directories according to the species, family, or genus.

Features

- Geographical category covering species from all across the globe
- Thematic category for cultivated and ornamental plants
- Micro-projects including particular flora from a local area

2. PlantSnap

Price: Free to use
Devices: iOS and Android
Language: Available in more than 30 languages

PlantSnap offers the best digital interface between nature and people. The app includes a database of more than 500,000 species of flowers, succulents, mushrooms, cacti, and other ornamental plants. It scrolls over 150 million pictures and displays the result with a single click. The platform implements AI for recognizing the plant species, and the users can access it in over 30 languages.

Features

- Offers detailed tutorials for using the app
- Displays the results within two seconds
- Provides information like its origin, genus, maturity size, fruit, and flowers of the plant
- Allows 10 free plant identification every day

3. iNaturalist

Price: Free to use
Devices: iOS and Android
Language: English

iNaturalist is one of the best free plant identification apps for experienced researchers, educators, scientists, academics, community organizers, and others. It is a citizen-centric joint venture of the National Geographic Society and the California Academy of Science.

It also offers opportunities for users to share their observations with the help of social networks. Users record and observe the sightings in the database and confirmed by other users and image-identifying technology.

Features

- No advertisements
- Includes more than 25.6 million observations
- Allows browsing through the nature projects nearby

4. PictureThis

Price: 7 days free trial and premium version as $29.99 for a year
Devices: iOS and Android
Language: Available in 12 languages

PictureThis refers to itself as a "Botanist in a pocket." The artificial intelligence of this plant identification app has already identified more than 27 million plant species with the help of photo submissions of users, and the results are almost 99% precise.

This mobile app for plant identification also offers tips on pest control and watering, among others. The users can enjoy this app for a 7-day free trial, after which they have to select the premium version for a year.

Features

- PictureThis pro plan is for $39.99 for a year
- Social network PictureThis community
- Highly rated app on Apple Store and Google Play Store

5. Leafsnap

Price: Three-day free trial period, $25.99 for a year and $4.99 for a month

Devices: iOS and Android

Language: English

Leafsnap is an extremely user-friendly mobile app for plant identification. It can immediately recognize any species from its database of 32000 plants. The user can also see a brief description related to the plant along with additional site links for more information. The app records all the plants in the user's collection, along with monitoring their growth.

Features

- Unlimited snap,
- Track the upcoming and today's user's tasks,
- Reminders for watering, rotating, reporting, harvesting, fertilizing, pruning, and misting the plants.

4. Methods (Materials and Methods)

1. Plant Samples:-Images: High-quality images of medicinal plants, capturing various parts such as leaves, stems, bark, flowers, and fruits.

2. Equipment and Tools:- Mobile Devices For capturing plant images in the field and installing an Android application from Google Play Store-PlantNet for data processing and medicinal plant identification. Additional data such as geographic location, habitat, and conditions are recorded to complement the image and molecular datasets.

3. Data Preprocessing:-

The PlantNet Application has been installed from the Google Play Store for Android mobiles to identify medicinal plants, after installation and sign-in process pictures have been taken of different parts of plants such as Leaf, Flower, Fruit, Stem bark, and Habits. App Results percentage matching of plants screenshots have been taken. 20 medicinal plant data was matched from various Dravyaguna books and tables prepared for comparison to traditional identification methods with accuracy assumed 100 percent for result analysis.

Table number 1. Results of 20 medicinal plants identified by PlantNet App.[10,11]

Sl. No..	Plant's Common Names	Plant's Latin Names	Family Name	Used Plant's part for App recognition	Assumed Traditional identification accuracy	Found plant's match accuracy percentages (%)
1	Varahi Kanda	Dioscorea bulbifera L.	Dioscoreaceae	Leaf	100	95
2	Tulasi	Ocimum Tenuiflorum L.	Lamiceae	Leaf	100	97
3	Aparajita	Clitoria ternatea L.	Fabaceae	Leaf, Fruits, flower	100	87
4	Manduka Parni	Centella asiatica L.Urb.	Apiaceae	Leaf	100	98
5	Bhumi amla	Phyllanthus amarus Schumacher	Phyllanthaceae	Leaf, fruits	100	92
6	Endri	Bacopa Monnieri L.wettst.	Plantaginaceae	Leaf	100	57
7	Giloy	Tinospora cordifolia (wild) Hook. F.	Menispermaceae	New Leaf, flower, stem	100	38
8	Punarnava	Boerhavia diffusa L.	Nyctaginaceae	Leaf, Flower	100	95
9	Kaner	Nerium oleander L.	Apocynaceae	Leaf, Flower	100	86
10	Saptparna	Alastonia scholaris (L.) R.Br.	Apocynaceae	Leaf, Stem	100	56
11	Kadam	Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	Leaf, Stem bark	100	78
12	Siris	Albizia Lebbeck (L.) Benth	Fabaceae	Leaf,Fruit	100	85
13	Parijat	Nyctanthes arbor-tristis L.	Oleaceae	Leaf, Flower	100	80

14	Amla	Phyllanthus emblica L.	Phyllanthaceae	Stem bark, Leaf	100	94
15	Apamarga	Achyranthes aspera L.	Amaranthaceae	Leaf	100	74
16	Nirgundi	Vitex negundo L.	Lamiaceae	Stem bark, Leaf	100	82
17	Bhringraj	Eclipta prostrata L.	Asteraceae	Leaf, Flower	100	96
18	Kutaja	Wrightia tinctoria R.Br.	Apocynaceae	Leaf, Fruit	100	29
19	Arjuna	Terminalia arjuna (Roxb. ex. DC.)	Combretaceae	Stem bark, Leaf	100	81
20	Chandan	Santalum album L.	Santalaceae	Stem bark, Leaf	100	80

5. Results

The overall accuracy of applications in identifying 20 medicinal plant genera was 79% (95% confidence interval, 38–98%, range for PlantNet Application). The result was analyzed by PSPP Software and the result is a Mean of 79, a Standard deviation is 19.55, and a Standard error mean is 4.37. suitably paired t-test applied for statistical significance and the result is calculated t-value is 4.80, tabulated t-value is 2.93. calculated t-value and tabulated t-value compared and found calculated t-value Biggers thus t-test rule the result is statistically significant.

6. Discussion

The identification of medicinal plants using artificial intelligence (AI) represents a transformative approach in modern botany. Traditionally, plant identification has required the expertise of trained botanists who rely on physical characteristics such as leaf structure, flowers, or bark to classify species. This process, however, is often laborious, subjective, and prone to errors, particularly when dealing with morphologically similar species. AI applications, powered by machine learning (ML) and deep learning (DL) technologies, address these limitations by offering a faster, more accurate, and scalable solution for identifying medicinal plants.

7. Conclusion

The use of artificial intelligence (AI) in the identification of medicinal plants is a revolutionary step in modern botany, offering enhanced precision, speed, and accessibility. AI-based applications leverage advanced techniques such as machine learning, computer vision, and deep learning to analyze vast datasets of plant images and characteristics. These technologies can identify medicinal plants with high accuracy by recognizing leaf patterns, flower shapes, and other morphological features, which are often challenging to distinguish manually.

AI systems also have the potential to process biochemical data from plants, enabling deeper insights into their medicinal properties. Through integrating botanical knowledge with AI, the identification process can extend beyond mere classification to understanding the potential health benefits of lesser-known species. Additionally, AI tools can assist in conserving biodiversity by documenting rare or endangered medicinal plants.

The future of AI in botany holds promise for developing a more sustainable approach to healthcare by facilitating the discovery of new medicinal compounds. However, to fully realize its potential, ongoing research, collaboration between botanists and technologists, and data collection efforts are essential. Overall, AI-powered plant identification marks a significant advancement in both the scientific study of botany and the practical applications of plant-based medicine.

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