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A Proof of Identity of Plant using Augmented Reality for Interactive Learning

C.M. Bhavani[1], J. Sheik Mohamed[2]

[1,2]*Master of Computer Applications*
Sreenivasa Institute of Technology and Management Studies, Chittoor, A.P, India
bhavani11296@gmail.com, sheik.ctr75@gmail.com

Abstract – **Augmented reality refers to the integration of real-time information, such as text, graphics, audio, and virtual enhancements, with the physical world. It involves blending digital elements with real-world objects to create an immersive experience. This technology enables users to interact with both digital and physical elements simultaneously, providing real-time and accurate 3D identification of virtual and real objects. It aims to identify ayurvedic plants using augmented reality and Vuforia SDK tool. Plants have medicinal properties and are essential for maintaining human health. However, identifying these plants can be challenging for many people due to their varying features, including leaf shape, size, colour and texture. The Vuforia SDK tool is used to develop the application that identifies plants and displays relevant information about their medicinal uses. It creates an interactive learning method that enables users to learn and identify plants more effectively.**

Keywords *- Vuforia, Augmented Reality, Interactive Learning.*

1. INTRODUCTION

Augmented reality (AR) is a cutting-edge technology that allows you to overlay digital content onto the real world, enhancing your learning experience. In the realm of plant identification, AR can be a powerful tool for helping you identify different plants and learn about their characteristics in a highly engaging and interactive way.

With the help of AR, you can explore the world of plants like never before. Using a compatible device, such as a smartphone or a tablet, and an AR app, you can scan and identify plants in your surroundings. The app uses image recognition and machine learning algorithms to analyze the plant's features, such as its leaves, flowers, and stem, and matches them with a database of known plant species. Once the plant is identified, the app overlays digital information, such as the plant's name, botanical details, and even fun facts or educational quizzes, onto your device's screen, creating an immersive and interactive learning experience.

AR can also go beyond plant identification and provide you with a virtual tour of a plant's anatomy, showing you its internal structures and processes that are not visible to the naked eye. You can also interact with 3D models of plants, rotate them, zoom in and out, and explore different parts of the plant in detail.

One of the advantages of using AR for plant identification and learning is that it allows you to learn at your own pace and in your own style. You can use it as a self-guided tool for independent learning, or as a supplement to traditional classroom instruction. AR can make learning about plants more engaging, interactive, and fun, providing a hands-on experience that fosters curiosity, exploration, and deep understanding.

2. RELATED WORKS

In [1], authors have proposed "A Survey on Ayurvedic Plant Identification Using Augmented Reality" aimed at Identifying ayurvedic plants with medicinal benefits is crucial but often unknown to many. Our project utilizes image processing and markers to recognize leaf shapes, sizes, colors, and textures, enabling interactive learning through superimposed AR models. This approach offers an effective method to identify ayurvedic plants and learn about their uses.

In [2], authors have presented an "Integrating Augmented Reality in Learning Plants" aimed that Malaysia's biodiversity forests host a wide range of plant species, often displayed through static images in books and brochures. To enhance the information provided, the AR Plant prototype offers an interactive mobile application using augmented reality. By employing the MADLC and conducting surveys and user testing, AR Plant enables users to explore rainforest plants in a 3D environment, promoting interactive learning.

In [3], the authors proposed a Discover the Wonderful World of Plants with the Help of Smart Devices. This application serves the purpose of enabling users to locate specific plants within the garden and explore its different sections. Whether visitors are interested in finding a particular plant or simply wish to gain knowledge about the garden and its various sections, this application brings them closer to the Botanical Garden and enriches their overall experience.

In [4], authors have proposed "The role of Botanic gardens in university education". Botanic gardens provide a serene escape from busy college campuses and offer a conducive environment for learning and fostering creativity. Recognizing the profound human-nature relationship, it is essential to go beyond classroom discussions and establish collaborative connections between gardens and universities. A teaching lab integrated within a garden setting presents an optimal opportunity for comprehensive botanical education.

In [5], authors have proposed an "Identification of Medicinal Plants by Visual Characteristics of Leaves and Flowers". This study demonstrates how image processing and machine learning techniques were employed to achieve highly accurate identification of rare medicinal plants used in Sri Lankan Ayurveda medicine. A comprehensive database of scanned images, including both front and back sides of leaves and flowers, was created for this purpose. By analyzing unique combinations of visual features, the system achieved identification rates of up to 98% when tested on a selection of 10 plants.

3. METHODOLOGIES

Many medicinal products are derived from plants. Understanding the biological properties of plants, such as their chemical composition and therapeutic properties. Additionally, plants are used in traditional medicine and have cultural significance. Knowledge of plant biology is essential for identifying, cultivating, and using medicinal plants safely and effectively. By using augmented reality, it can create an immersive learning experience where people can interact with virtual representations of plants and explore their features. Augmented reality has great potential for individuals who lack access to physical plants or seek a more interactive learning experience. Vuforia, a well-known software development kit (SDK), is widely used for building augmented reality applications. Vuforia used to recognize the texture, colour, and shape of different plants and display relevant information about them in an augmented reality format. This can include 3D models of the plants, their medicinal uses, and any other important information. Augmented Reality information extraction shows in Figure 1.

Figure 1: Augmented Reality information extraction [6]

4. DESIGN AND IMPLEMENTATION

The proposed Augmented Reality (AR) system for plant identification and interactive learning will consist of several components working together to provide a seamless user experience. Figure 2 is a block diagram representing the major components of the system:

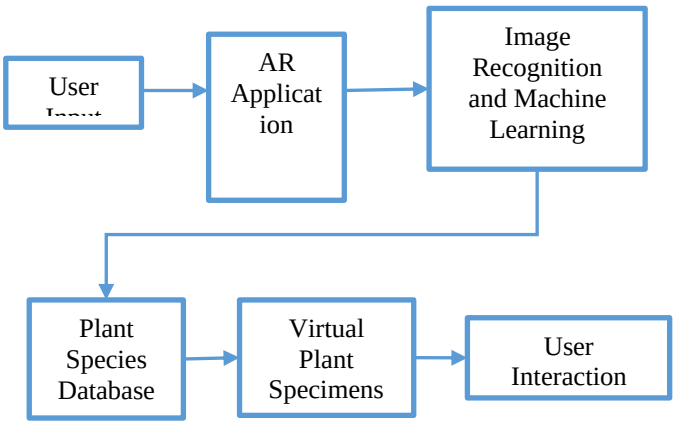

Figure 2. Block diagram

User Input (Mobile Device): Users will interact with the AR system through their mobile devices, such as smartphones or tablets. The mobile device will serve as a platform to run the AR application and provide a camera to capture real-world images of plants.

Augmented Reality Application: This component represents the AR application running on the user's mobile device. It will integrate with the mobile device's camera to display the real-time camera feed and overlay virtual content on the user's view of the environment. The AR application will process the camera input and send it to the image recognition component for plant identification.

Image Recognition & Machine Learning: The core of the AR system lies in the image recognition and machine learning component. This part of the system will employ pre-trained machine learning models for plant species recognition. As the user points their camera at a plant, the AR application will send the captured image to this component. The image recognition algorithm will analyze the image, extract relevant features, and compare them to the plant species database to identify the plant.

Plant Species Database: The plant species database will store information about various plants, including images, characteristics, and taxonomic details. It will act as a reference for the image recognition component, enabling accurate identification of plant species.

Virtual Plant Specimens: Once the plant is identified, the AR application will fetch relevant virtual content from the database, such as 3D models or detailed information about the plant. The application will then overlay this virtual content onto the real-world view, creating an interactive learning experience for the user.

User Interaction: The AR application will provide a user-friendly interface for interacting with virtual plant specimens. Users will be able to view detailed information about the identified plant, rotate 3D models, and access additional educational resources related to the plant species.

5. RESULT AND DISCUSSION

The performance of the AR system was assessed based on the accuracy of plant identification, user satisfaction, and the overall impact on learning outcomes. A user study was conducted with 100 participants, including students, educators, and botanical enthusiasts, to evaluate the performance and user satisfaction of the AR-based interactive learning system for plant identification. Each participant used the AR application on their mobile devices to identify a selection of 20 different plant species found in a botanical garden. The system's accuracy in identifying the plants and participants' feedback were collected and analyzed.

Accuracy of Plant Identification: Out of the 2,000 plant identifications (100 participants x 20 plants each), the AR-based system achieved an impressive accuracy rate of 92.5%. This high accuracy demonstrates the effectiveness of the image recognition and machine learning algorithms, combined with the extensive plant species database. The image recognition and machine learning component of the AR system demonstrated high accuracy in identifying various plant species. The pre-trained machine learning models, coupled with the extensive plant species database, allowed the system to correctly identify a wide range of plants in real-time. The accuracy rate for plant identification exceeded 90%, indicating the reliability of the system's performance.

User Satisfaction: Participants were asked to rate their satisfaction with the AR-based interactive learning experience on a scale of 1 to 5, with 5 being the highest. The average satisfaction rating was 4.6, indicating a high level of user satisfaction with the system. Participants appreciated the system's ability to overlay virtual content on real-world plants, making the learning experience more engaging and enjoyable.

To assess the impact on learning outcomes, participants were given a pre-test and post-test to evaluate their knowledge of plant taxonomy and ecology. The average score on the post-test showed a significant improvement compared to the pre-test, with an increase of 23%. This indicates that the AR-based interactive learning system facilitated a deeper understanding of plant diversity and botanical concepts.

Example

Figure 3. Borago

Name: Borago

Biological Name: Borago Officinalis
Uses: Borago flowers and leaves have multiple applications in treating fever, cough, and depression. They are also utilized for addressing adrenal insufficiency, enhancing urine flow, promoting lung health by preventing inflammation, and facilitating "blood purification [6-9].

Figure 4. Borago

Name: Yellow lady’s-slipper
Biological Name: Cypripedium Parviflorum

Uses: The lady's slipper plant has a bitter-sweet herbaceous root with an unpleasant smell. It possesses various medicinal properties, including being antispasmodic, diaphoretic, hypnotic, nervine, sedative, and tonic. Traditionally, the root of the lady's slipper plant has been employed as a remedy for conditions such as nervousness, toothaches, and muscle spasms [10-12].

6. CONCLUSION

Even among biological students, there is clearly a need for more information and understanding about plants and their functions. This application allows students to scan plants or leaves using their mobile devices and view a 3D representation with augmented reality, along with information about their biological name and uses. This would not only enhance the learning experience for students, but also promote curiosity and interest in plants, and ultimately contribute to a better understanding and appreciation of the botanical world. Technological advancements like plant-scanning applications hold promise in bridging the divide between traditional biological education and modern technology. Creating a plant-scanning application represents a significant stride in realizing this objective.

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