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Virtual Veda – Visualize Plants through Augmented Reality

Adarsh R Thimmapurmath[1], Shashank BG[2], Harshith S[3], Sharmila Chidaravalli[4]
Undergraduate Students, Department of Information Science and Engineering[1,2,3]
Assistant Professor, Department of Information Science and Engineering[4]
Global Academy of Technology, Bangalore, India

Abstract*: A unique initiative, Virtual Veda has been conceptualized and designed to add to knowledge besides kindling enthusiasm for the world of flora with Augmented Reality (AR) technology. For instance, an AR service provides a learning environment in which users could discover relationships between medicinal plants that are within a certain ecosystem, realize the significance of those medicinal plants, and become able to judge how to discriminate and maintain those medicinal plants through practical AR experience. Another diversity emphasis in the initiative is the use of audio explanations for inclusivity in the visually impaired. Virtual Veda is all about users being connected to nature in such a way that they are bound to nature more than they were ever and can be environmentally responsible.*

Keywords: Augmented Reality, Biodiversity, Ecosystems, Education Inclusivity, Immersive Experience, Unity, Engine, Vuforia, Blender

I. INTRODUCTION

Augmented Reality (AR) has changed the way we see everything that surrounds us—bridging the gap between the physical and the digital. Virtual Veda uses AR in a sophisticated manner to give the user an experience of botany that a user must have never had. The AR system overlays virtual information on real scenes so that users can see the plants in their real environments, understand their role in the eco-systems, and know who they are.

The background of Virtual Veda has been the burning necessity to create awareness of the importance of biological diversity and the protection of medicinal plants. With the increasing pressure of human activities on ecosystems, the importance of public education on the invaluable role played by plants toward the support of the balance of nature and existence of life on earth is invaluable. Virtual Veda is an educational model that uses AR technology to make the process of learning plants much more engaging and easier for students of any age level to gain knowledge about the many medicinal plants present around them and their uses.

II. LITERATURE REVIEW

Luis Valladares Ríos et al. [1] reasoned that in this act qualitative research, it is studied how didactic materials in AR and VR have influenced higher education, and more importantly, role-playing games. "Licenciaturaen inclusióne ducativa" completed during the 4th semester, where 11 future teachers participated in the study at ISENCO in Mexico. The hybrid learning method was introduced as a result of the COVID-19 pandemic. The data that was collected was through an argument diary, photo analysis, and a questionnaire. The photo analysis illuminated facts on the AR environments and the engagement in students, which complemented the responses from the survey. The quantitative content of both the images and the response of the questionnaire was analyzed for this paper. It is thus our concern to enlighten the reader with respect to these AR and VR role-playing games in higher education and to point out the didactic impact and potential provided by inclusive teaching approaches. The research methodology will be handy in understanding how technology and STEM methodologies are integrated, especially keeping in view the challenges faced in virtual learning during a pandemic.

The methodology applied to the Leaf snap system used for the automatic identification of plant species by Neeraj Kumar et al. [2] uses color-based segmentation focusing on characteristic leaf shapes as the first cue. Other features such as colors, wind patterns, or even flower images are considered inappropriate due to differences or limitations of mobile phone cameras. Leaf segmentation is very difficult to carry out due to shadows, blur, and fine-scale structures and compels the user to capture the leaves against a light non-textured background. The segmentation applies expectation maximization method in the space of saturation values with post-processing steps aimed at reducing false positives and removal of stem of the leaf. The approach adapts successfully to different leaf shapes and colors, thus providing for a quick and interactive solution of plant species identification. The segmental results clearly show the problems sometimes encountered when treating shadows and peculiar leaves.

As recommended by Nur Zahirah Ibrahim et al. (2013), the Mobile Application Development Life Cycle (MADLC) basically consists of the identification stage, design, development, prototyping, and testing. User requirements were captured with a Google Forms survey in which 80 responded, mostly of the age 21-25 (70.1%) and in the form of students (58.8%). The research is on the opinions for a plant-based mobile app via augmented reality. The tasks that a user did during user testing were running the AR Plant app, scanning characters with AR camera scanning, and interaction with 3D plants. Application assessment and usability evaluation using the System Usability Scale (SUS) - an ease of use ten-item measurement scale. The SUS evaluation has received wide acceptance in many industries, to judge user satisfaction and interaction with the AR Plant prototype, ensuring that the evaluation is holistic in the perspective of functionality and experience.

Mythreye Venkatesan et al. [4] defined Augmented reality (XR) as real and virtual environments brought together and interactively connected by the use of technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR). The users will be taken through computer-generated realities where they are allowed to interact with the same. AR extends the digital content into the real world and enhances the perception without replacement of it completely. MR blurs the line between real and virtual allowing the two to interrelate in real time and to enable interaction of the physical and digital objects. The differences between the XR technologies are in immersion, interaction, and data processing. This enriches the AR with markers based on location and triggers while markers play a primary role of reference points for the placing of objects. In marker less AR, the resources can be placed on natural scene markers, dynamically. Motion tracking in VR is inclusive of optical and non-optical means, with optical systems having cameras that are used in tracking location. The knowledge of differences between XR is a big measure to ensure good integration and user experiences within the biomedical field and beyond.

The facet analysis of Jiri Motejlek at al.[5] proposed a taxonomy allowing flexibility in adding new categories and expressing different VR/AR experiences, giving a plural perspective. The faceted construction follows the FURPS+ software engineering methodology, for the sake of simplicity and utility. The classification of educational objective is based on Bloomand#039s taxonomic domains to ensure that there is adequate coverage of educational objectives. System mapping covers hardware and software instruction studies. The categories in each subfield are based on the principle of being parsimonious, comprehensive, and useful for VR development decisions. The taxonomy is helpful for educators, developers, and researchers in the understanding of the aspects of VR/AR hardware, software, educational purpose, and functionality presented in the paper.

Vijayakumar Ponnusamy et al.[6] proposed that the cloud-based augmented reality system was made up of an AR head-mounted display device and a cloud data processing module. And the AR HMD enables farmers to access cloud plant data visualization servers in real-time in order to help them analyze plant diseases. The plant images are captured by the system and classified on the cloud, over which the annotated data is overlayed on the HMD for disease detection. The series used is the MOVERIO BT-350 AR, whose details include a virtual view size of 40", 2GB internal memory, and sensors for its operations. Hence, the processing and storage of data within the AWS cloud platform involve the use of AWS IoT services in maintaining connected devices with communication with the cloud. With the effectively established device gateway, message broker, and rule engine, effective sending and processing will hence be facilitated, an improvement in data reliability and security with excellent performance in plant disease detection and agricultural management activities.

M Julkarnain et al.[7] also mention that the methodology in their study is hybrid, using the qualitative method that involves observation, interviews, and documentations, and applies the quantitative method that includes surveys and literature reviews. Information was obtained from the community's medicinal plants by observations and interviews, while the documentation was photography at the health center. Background information on medicinal plants was from the literature research. Feedback from the respondents was by questionnaires. In this mode, the software followed a prototyping style that includes analysis using various means of collecting data, prototyping using UML and data design, evaluation using stakeholder discussion, coding in C# with Unity, and system testing using black box testing. Such a comprehensive approach ensures understanding how to develop and test effectively the use of medicinal plants.

In this study, "Application of Augmented Reality Portal for Introduction of Medicinal Plants in Taman Herbal Insani Area," by RizkiPermana et al. [8], the study's approach is using the methodology of Multimedia Development Life Cycle (MDLC). Stages involved in the process are: Concept, Design, Material Collecting, Assembly, Testing, and Distribution. Concept stage concludes the determination of goals and specifications. Design refers to the detailing related to the display style of the application. Material Collecting is executed through observation, interviews, and literature review. Definition of assembly is the actual process through which the multimedia objects are put together with the aid of the unity3D and C# tools. Tests include the tests in the form of structure, function, and then the validation. The final stage is the distribution, which includes the evaluation and then the compilation of the integrated product into the format of an android application. This would ensure that, in an integrated way, there is in place a comprehensive approach of systematically developing and evaluating the augmented reality portal that supports the overall introduction of medicinal plants in the Taman Herbal Insaniarea.

This research is going to evaluate the effectiveness of augmented reality (AR) application in teaching environmental education to first-grade students (Georgia Antoniadi et al.[9]). The research questions, therefore, seek to find out if AR-based teaching gives better learning outcomes and conceptual understanding vis-à-vis traditional methods. Convenience sampling was employed, with the AR application being used in one class as an experimental group and traditional teaching being used in another class as a control. Ethical principles were abided by. Driver and Oldham's (1986) constructivist teaching model is being applied, where steps valued are as familiarization, eliciting student ideas, reconstructing ideas, applying new concepts, and revising. The experimental group uses AR on tablet-based activities, while the control group uses traditional visual materials. Evaluation forms were distributed to the participants before and after the intervention in order to measure learning. This holistic approach would allow a discussion and a more in-depth review of an AR application and the impacts it produced on student learning and conceptual development in environmental studies.

Rohman Dijaya et al.[10], proposed that the process of designing Android-based augmented reality (AR) applications involves creating characters and 3D models using tools such as the Vuforia SDK and Blender software. 20 characters are created for medicinal plants, the images of which are uploaded to the Vuforia database for conversion. Blender is used to create 3D models of plants, resulting in 20 objects. These models are presented as two-dimensional images and integrated into the application. The downloadable app combines printed versions of medicinal herbs with story animations and 3D objects using AR technology for Android devices. With Android and an open platform, developers can create versatile applications for various mobile devices, which ensures accessibility and ease of use for users. Through this process, the program perfectly combines virtual and real elements, improving the user experience of herbal research through AR technology.

According to Nur Zahirah Ibrahim et al.[11],The ARPlant prototype changes the way information on Malaysia's rainforest plants is presented by utilizing augmented reality (AR). It goes through steps of proof of identity, planning, coding, prototyping, and testing after the Mobile Application Developmental Lifecycle (MADLC). According to a Google Forms poll, students who are interested in using mobile apps for plant learning are mostly young. System Usability Scale (SUS)-based user testing verifies usability and usefulness. SUS, which was first developed in 1996 and improved in 2008, assesses user satisfaction well. ARPlant links static pictures with dynamic information by immersing users in a three-dimensional environment, promoting interaction with Malaysia's biodiversity and increasing interactive plant learning.

Qianyun Zhu et al.[12],specified that through the integration of digital and real-world data, augmented reality (AR) allows users to communicate with virtual models superimposed on their surroundings. We use Unity 2017 and 3dsMax 2014 to create AR models for Smartphones. Rendering 88 three-dimensional herb plant models, the system consists of a mid-range computer and an autofocus camera. The QCAR algorithm in the Vuforia SDK matches scanned photos with database targets to cause the display of associated 3D models. Unity handles the UI and functionality. All of the information on herbs is combined into annotated text for further reading. Through interactive 3D models, users can investigate the morphology, ecological habits, and species of herbs. By enabling users to flexibly turn and scale representations in real-time, the AR application improves learning experiences and encourages more in-depth involvement with herb plant knowledge.

M Julkarnain et al.[13],stated that in order to collect data, the research uses a hybrid methodology that combines quantitative approaches like questionnaires with qualitative methods like interviewing and observing. Interviews provide insights into the viewpoints of the community, whereas observation include site surveys to locate common therapeutic plants. Visual information collected at Moyo Hilir Community Health Centre is captured in documentation. Studies of the literature shed light on therapeutic herbs. Surveys collect feedback from respondents. The analysis, prototype building, assessment, and system coding phases are followed by the prototype mode in the software procedure of development. A variety of techniques are used in needs analysis, including questionnaires, interviews, documentation, and literature reviews. System as well as data layout using UML & interface design are part of prototype development. Talks about the viability of the prototype are part of the evaluation process with the Health Centre. The completed design is implemented via system code.

According to Gang Zhao et al.[14], the study collected multimedia plant-related data and took pictures of plants using a mobile intelligent terminal. It created an augmented reality (AR) information display module and looked into using AR technology for plant learning. This module scanned specific plants and provided their 3D models and textual metadata in real-time using Vuforia's naturalistic scene-based tracking registration. By interacting with the 3D objects, students could increase their comprehension and level of involvement. Users now have an innovative approach to explore and understand plant-related knowledge thanks to the combination of smartphone technology and augmented reality, which creates immersive and engaging learning experiences. This creative method emphasizes how AR technology may be used in educational settings, especially to improve botanical knowledge and stimulate students' enthusiasm in learning about plants.

L Ya Midak et al.[15], through the integration of technology, engineering, and the natural and mathematical sciences, STEM education fosters critical thinking and communication skills. Learning is improved by augmented reality (AR), which puts study information into visual form. One example of this is the LiCo.School app, which shows 3D molecules. For example, the chemistry of happiness involves neurotransmitters such as serotonin and dopamine. Topics that are related to one another are typically covered in stem lessons; for instance, organic chemistry examines the structure of fragrance molecules and how it affects how one experiences aroma. These cross-disciplinary methods improve instruction and maintain students' interest. Ninety percent of ninth-grade students who tested a smartphone app created especially for this purpose gave it favorable comments, indicating that it is a valuable teaching tool.

Sungin Choi et al. [16] proposed an augmented reality (AR) system for construction with offshore plants. Marker recognition: In this paper, a method for the marker position computation based on image binarization, extraction of shapes, filtering, up-and-coming voting, and codeword decoding has been used to identify the markers in the camera images and to get the IDs and rotation points of them. Marker reproduction:

The paper uses opinion to unbiased calculation to estimate the transformation model that maps 3D directions of the markers from the computer aided design model to the camera coordinate framework. Marker registration: The paper uses a photogrammetric approach to automatically register the markers into the coordinate frame of the computer-aided design by minimizing the reprojection error between 2D image points and 3D model points.AR scene generation: The paper facilitates how augmented reality content is presented in the mobile device, where 3D CAD scenes are well transformed into the camera view using the help of registered markers. In this paper, markers are also used to turn to the camera active when necessary. The AR framework has been evaluated through field test and questionnaire presented in the paper and demonstrates the effectiveness of the proposed system to improve productivity and efficiency for offshore plant construction.

This is how Maria C. R. Harrington and others [17] have presented a case study on design and development of immersive, multimodal interactively virtual environments for AR and VR devices—using, for example, the Virtual UCF Arboretum and AR Eternal Plant Apps. The work introduces the notion of belief related to the accuracy and completeness of logical information imbedded in a virtual environment and legitimized its importance in educative and learning applications. The paper discusses the process of virtual design and development. Data gathering and analysis from a variety of sources that included GIS, drone imagery, plant inventories, population density, bioacoustics, as well as space scientists. 3D plant modeling and review using Maya, Photoshop, Quixel, Substance Painter, and SketchFab

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with iterative input from botanists and scientists. The highlighted advancements in the field of study of human-computer interaction can be summed as follows: creating and refining the virtual environments using Stunning Engine with handle tools and techniques that enhance the realism, interactivity Enhancing a digital field direct and plant outline using WordPress and Sketch Fab to provide external on-line resources for reliable information and 3D models. This research supports different input and output devices such as json,a mouse, touch screen, VR controllers and headsets as part of the plan of interaction with the client and utilization of Unreal Engine. The article synthesizes the results of previous pilot studies and user evaluations in the field of virtual reality applications focusing on the effects, presence, embodiment, engagement, emotion, and learning outcomes.

RizkiPermana et al. [18] proposed the strategy for the expansion of reality entrance application for the presentation of the restorative plants inside the Insani Home grown Garden1. The strategy comprises of the taking after Characterize the objectives, gathering of people, and shared determinations of the application. Construct the storyboard, application interface, flowchart, route structure, and collect the details, pictures, and other media materials concerning medicinal plants from observation, interview, and literature in details. Develop an application based on the design specifications using Solidarity 3D, AR Center, Blender, and C# programming dialect. Test for the basic and useful viewpoints, accounting the independent, tilt, light level, and android determination tests. Compile the application to an apk arrange and evaluate it for ease of use and improvement. The paper employments MDLC (Mixed media Improvement Life Cycle) as the system for the strategy. The results and discussion of the application development and testing will also be illustrated in the paper. The paper concludes that the application is able to visualize the medicinal plants and provide the information and knowledge to the general public with augmented reality portal technology.

Swapnil Likhitkar et al. [19] proposed a framework to visualize the state of a plant based on IoT and AR technology. The framework is constituted by the three main components: sensing, processing, and visualization. The detecting part uses several sensors to screen the basic parameters of an engine of a transport means such as temperature, voltage, current, vibrations, and speed. The preparing component uses a Molecule Photon controller to handle and transfer the sensor information to the Molecule cloud1. Unity and Vuforia engines are used in the visualization to create a sensor data AR application that overlays the data to be presented as digital content over the physical world. The particular machine is uniquely identified with a QR code tag that contains the machine-specific data requested from the cloud. The paper presents the system with a miniature example of a bus engine and how such a system could be applied to different kinds of equipment. The paper points out that the framework can provide a new level of control and knowledge for decision-making and progress the effectiveness and efficiency of the plant.

Nur Zahirah Ibrahim et al.[20] introduces an AR-based mobile application, called AR Plant, which uses Augmented Reality (AR) technology to enhance the learning of rainforest
plants. This application follows the MADLC process, which is categorized into five stages, namely proof, design, development, prototyping, and testing. User opinions on AR technology will be collected using Google Frame, whereas the test on the user will be by the System Usability Scale (SUS) score. The AR Plant application enhancement from AR functionality involved the development of Firebase, Android Studio, Solidarity 3D, Vison, Vuforia, and Blender. Usability for the satisfaction of the user was checked by feedback on the SUS scores from eight users. For the AR Plant application, the average score of 87.81 means it has reached acceptance and even user satisfaction.

III. LITERATURE SUMMARY

Sl No.	Citation	Year	Methodology/ Algorithms used	Observation
1	Valladares Ríos L et.al.,	2023	A qualitative research-action strategy that involved telling micro-stories in augmented reality to promote critical thinking and creativity. Data gathering techniques include questionnaires, argumentative journals, and photographic analysis.	In higher education, self-learning, engagement, and skill development were improved by AR and VRrole-playing games.

2	Kumar N et.al.,	2012	The authors created the smartphone app Leaf snap, which uses visual recognition to identify plant species. To extract and compare leaf shapes from images, they employed nearest neighbors search, curvature histograms, and color-based segmentation. A dataset comprising 184 species of trees was used to assess their system.	The authors claimed that their system outperformed earlier techniques based on Inner Distance Shape Context, achieving high recognition accuracy. Additionally, they showcased the app's popularity and usability, as it has been downloaded by almost a million users. They talked about the difficulties and possible uses of their system.
3	Ibrahim NZ et.al.,	2022	The Leaf snap system uses color-based segmentation to identify plant species based on leaf shapes, overcoming camera limitations and requiring well-lit, smooth backgrounds. It adjusts to leaf shapes and colors, enhancing accuracy and eliminating leaf stems, making it a quick and interactive method.	Although there are occasionally problems with shadows and the specificity of some leaves, the system exhibits high efficiency.
4	Venkatesan M et.al.,	2021	Review of XR technologies, including definitions, principles of operation, and biomedical applications. VR and AR case studies: cardiacsurgery, neurosurgery, andmultiplexed protein image visualization. Cost and complexity analysis: contrasting the difficulties and various XR platforms.	Biomedical visualization—an immersive, dynamic, and cooperative three-dimensional analysis of cellular, molecular, and anatomical data—is improved by XR.XR enhances surgical planning and performance by providing precise, instantaneous, and spatial guidance for intricate procedures.
5	Motejlek J& Alpay E	2021	To create a taxonomy of VR/AR applications using two systematic mapping studies, an existing taxonomy of educational objectives, and a faceted analysis approach	The suggested taxonomy makes it clear how VR and AR should be categorized and makes it easier for researchers, developers, and educators to communicate with each other.
6	Ponnusamy V et.al.,	2021	Using CNN and AWS IoT, an augmented reality system with cloud-based machine learning was developed for on-site plant disease detection.	93% accuracy and 10ms latency were attained for 2000 tomato leaf samples with various lighting and disease conditions.
7	Julkarnain M et.al.,	2021	The authors created an augmented reality-based learning application and gathered data on medicinal plants using both qualitative and quantitative methods. They developed software using the prototype method and evaluated it using the black box testing method.	The respondents gave the application favorable reviews in the categories of display, education, satisfaction, interaction, and music, according to the authors. They also noted that users could learn and comprehend information about medicinal plants with the aid of this application.

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8	Permana R et.al.,	2022	The authors created an AR portal application for the Insani Herbal Garden's introduction of medicinal plants using the Multimedia Development Life Cycle, or MDLC. For the development, they used Blender, AR Core, Unity 3D, and the C# programming language.	To assess the application, the writers ran tests for usability, validation, structure, functionality, and the Android specification. They discovered that the application was valid, well-structured, functional, and easy to use. With support for AR Core, the bare minimum Android operating system needed was Nougat 7.0.
9	Antoniadi G	2023	The authors created an AR portal application for the introduction of medicinal plants using the Multimedia Development Life Cycle, or MDLC. They employed Blender, AR Core, Unity 3D, and C# as their programming languages. They also carried out a number of surveys and tests.	The AR portal application proved to be a viable and efficient means for the authors to visualize and acquire knowledge about medicinal plants. Experts and responders gave the application positive reviews. There were also some shortcomings and recommendations for enhancements in the application.
10	Dijaya R et.al.,	2018	To introduce children to medicinal plants, particularly in Ortho pedagogic education, the authors created an augmented reality app for Android devices1. They created twenty markers and three-dimensional (3D) models of medicinal plants using Blender, Unity 3D, and Vuforia SDK.	The load time, marker detection, and 3D object display of the app were measured by the authors after 50 users tried it. In order to gauge how the user was responding to the app, they also gave out a questionnaire. They discovered that the app can assist kids in identifying and learning about prescription plans.

IV. CONCLUSION

Overall**,** Virtual Veda represents a pioneering attempt to combine technology with environmental education and offers a new approach to the study and study of plants. By offering users an immersive AR experience**,** Virtual Veda promotes a deeper appreciation of nature and encourages sustainable practices to preserve plant biodiversity. With its innovative features such as audio descriptions and personalized plant information, Virtual Veda ensures inclusion and accessibility for all users. As we move forward in the digital age, projects like Virtual Veda remind us of the profound impact technology has on our relationship with nature and the importance of conservation efforts for future generations. Through Virtual Veda, individuals can discover the abundant medicinal plants thriving around their homes and harness their health benefits effectively

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