Ethnosciences Based Augmented Reality on Botanical Garden

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Abstract - Ethnosciences in natural knowledge needs to be developed as a learning material and insight. In the field of education, ethnoscience is not optimal if it is applied in theory or books. Along with the times, the theory of ethnoscience will be displaced by modern technology, therefore the means of knowledge need to be upgraded to more advanced media to gain new experiences, especially for future generations. Researchers are looking for an ethnoscience approach in the field of technology by taking samples of observations of plant species in the Botanical Gardens. The technology used to develop this media is Markerless Augmented Reality based on Android applications. Researchers use 3D plant model objects from plant species in functions for the environment, including: Waste particle absorbing plants; CO2-absorbing and O2-producing plants; Odor-absorbing/removing plants; Plants to deal with flooding; Absorbent/odor depressant plants; Plants to overcome inundation, Groundwater conservation plants; Beach safety and abrasion plants. The results of the implementation and testing of the application are built and run with the android.apk device. This application is called EARBot (Ethnoscience Based Augmented Reality on Botanical Garden) which is an educational application of knowledge about ethnoscience that uses Markerless Augmented Reality technology.

Keywords: augmented reality, botanical, ethnosciences, education, plants

I. INTRODUCTION

Ethnoscience is authentic knowledge in society which is transformed into local wisdom. Ethnoscience integration is obtained from local culture in a learning process [1]. Almost every region has a unique culture with its own uniqueness. Local wisdom that is relevant and contextual has an important meaning for the development of a nation. Especially when viewed from the point of view of cultural resilience because it has an important meaning for the regional identity itself [2]. Culture can be part of the educational process if it is integrated into the learning process by calling it culture-based learning or ethnosciences [3].

Ethnoscience is also included in the knowledge of local natural wealth from flora and fauna that exist in a culture, such as botanical gardens or nature tourism. Botanical gardens have an important function in preserving biodiversity. Botanical gardens can reconnect nature and people, this makes botanical gardens have various values - not only ecological but also social, economic, and cultural values [4]. Botanical gardens can contribute to sustainable education and global conservation with horticultural goals. More than 3300 botanical institutions and public gardens around the world receive more than 240 million visitors per year (Botanic Gardens Conservation International 2018), of which opportunities need a more approach to connecting people with natural knowledge [5].

The botanical garden is a space for cultivating, gathering and studying plants. This green space usually contains a collection of plants arranged in various ways, namely based on (geographic origin, biome, landscape, taxa, function, etc.). Botany is an interesting place for research in the field of environmental psychology and the relationship of behavior to the environment [6]. A large number of plant species are known to be extinct in the Wild but still survive cultivation, especially in botanical gardens [7]. Botanical gardens not only function as taxonomy and systematic research centers, but also play an important role as a source of data on valuable plant ecology such as indications of climate change phenology, plant physiology and plant growth tactics, as well as animal interactions [8].

An ethnoscience approach to natural wealth in botanical tourism will be effective if it is done with technological sophistication. One of the new technologies that have begun to be developed as a creative and innovative medium is Augmented Reality (AR). Augmented reality is a new form of expressive and creative media, where augmented reality can enrich the way humans live in their daily lives and expand the human experience in the real world [9]. AR has recently developed and has been applied in several sectors, for example, e-Commerce, marketing, entertainment and

tourism. AR is used to increase public interest and streamline promotional media [10].

AR applications are used to denote objects and places of interest to a culture, by superimposing virtual content to physical space in which they originally resided. The combination of real and virtual produced by AR can increase people's interest and understanding of content, without the need to intervene or physically damage cultural heritage material sites [11]. Augmented Reality in tourism activities is also defined as commercial smart glasses that facilitate a variety of experiences while on tour [12]. One of the Augmented Reality methods that are widely used today is the Markerless Augmented Reality method. Through this method, users do not need to use markers to display digital elements, so use is quite easy. As recently as involving the world's largest AR companies, Total Immersion and Qualcomm. They have developed markerless tracking techniques such as Motion Tracking, Face Tracking, GPS Based Tracking and also 3D Object Tracking [13].

AR interfaces have been studied extensively over the last few decades, with a growing number of user-based experiments. To realize AR, various technologies have been developed to reduce the sense of heterogeneity between the virtual world view and the real-world view in order to provide an immersive experience to the user [14]. Augmented Reality application about medicinal plants that can display 3D objects from medicinal plants by applying Augmented Reality technology is also a nature education application. In this study, 20 medicinal plants were used [15]. AR is said to be a technological revolution that has a major impact on the tourism service industry. AR also brings the development of digital technology under the layer of reality that makes experiences more interactive and memorable [16].

Travel and cultural heritage icons bring benefits to AR, as there is a lot of additional information that can be conveyed to users in a very interesting and intuitive way. All kinds of multimedia information can be managed and virtual reconstructions, as well as 3D animation, can be overlapped with objects of interest to the user [17]. AR can be used in various forms of education in sub-branches of science studies such as physics chemistry, biology as well as in Mathematics and Geometry and Foreign Language Teaching. A study by Billinghurst and Dunser examined that the efficiency level of AR use in educational settings would show a high degree of interaction in improving the kinesthetic, visual / spatial skills of learners and enriching collaborative problem-solving skills by increasing their level of motivation [18].

This study aims to develop ethnoscience education in the Botanical Gardens using AR, especially knowledge of natural plant species that have a function category for the environment. It is important for tourists to gain knowledge on natural tourism, the solution is by introducing the ethnoscience of natural plants to the botanical garden. The author will conduct observations and research in the Botanical Gardens area of the Purwodadi Botanical Gardens is located in East Java, which is a place for the conservation of natural plants with their preservation. After conducting a thorough research on the ethnoscience of botanical tourism, the next step will be to design a system to be implemented in the form of Markerless Augmented Reality in an Android application. Markerless Virtual Reality possible every object or entire room can be used as an object. Markerless in Virtual Reality is a technology that is more sophisticated than Virtual Reality or Virtual Reality that uses markers. Without a marker, the user can easily use a room without being bound to the markers that have been made on the application [19].

II. METHOD

The botanical garden research in this project is intended to educate students. visitors, as well as the general public with the realization of an application through the use of Augmented Reality, which makes it possible to convey information about various natural plants in the landscape of the botanical garden area. This will provide a symbolic context in which users are stimulated to preserve local memories and identities through natural diversity [20]. This application is called EARBot (Ethnoscience Based Augmented Reality on Botanical Garden) which is an educational application of ethnoscience knowledge using Markerless Augmented Reality technology and 3D models of natural plants based on types of function categories for the environment.

A. Requirements Analysis

The Needs analysis section includes several discussion stages including data collection, requirements analysis, and discussion of environmental plant types by function.

1) Data Collection: Data collection in this study was carried out by several techniques. The techniques used are literature study, previous research and observation of the location of the Botanical Gardens. Where literature studies will present theories from articles, books, journals, and other topics related to Augmented Reality. Furthermore, previous research will provide information about research that has been made before. Completeness of the data also supports the creation of an ethnoscience

model and EARBot design. This application will be displayed in a mobile system by providing several features, namely: Plant ethnoscience information, plant 3D models, and other systems.

2) Requirements Analysis: The application development system that will be built will be based on Android. The first requirement that researchers do is prepare plant types based on function categories and make them in the form of a 3D Model. In addition to these needs, the next stage is to analyze user needs, such as hardware and software specifications that will be used for application development.

3) Plants based on function for nature preservation: Plants have many benefits including for health, medicine or microclimate controllers, plants are also useful as an aesthetic element or beauty [21]. In agriculture, and in plant science in general, many work has been devoted to modeling plants and plant growth in relation to environmental condition [22]. In determining this type of plant, the author will discuss several types of plants that have a function for environmental sustainability, some of which include: Waste particle absorbing plants; CO2-absorbing and O2-producing plants; Odor-absorbing/removing plants; Plants to deal with flooding; Absorbent/odor depressant plants; Plants to overcome inundation, Groundwater conservation plants; Beach safety and abrasion plants. The following is a table of plants that have been classified based on their function for natural preservation, presented in Table I.

B. EARBot Development Design

The development of EARBot started from the observations of researchers on the problem of ethnoscience knowledge that is less modern in today's technological era, therefore an approach was made to create ethnoscience media for knowledge of natural plant species in the form of Applications and AR. EARBot application development is presented in diagram form in Fig. 1.

TABLE I
PLANTS BY FUNCTION

No.	Types of Plants by Function for Nature Preservation		
	Function Classification	**Scientific Name**	**General Name**
1	Waste particle absorbing plants	*Polyalthia longifolia*	Glodogan, Ashoka
2	CO2 absorbing and O2-producing plants	*Swettiana mahagoni*	Mahoni
3	Absorbent/odor depressant plants	*Mimusops elengi L*	Tanjung
4	Plants to overcome inundation	*Samanea saman*	Kihujan, Trembesi
5	Groundwater conservation plants	*Cocos nucifera*	Kelapa
6	Beach safety and abrasion plants	*Nypa fruticans Wurmb*	Nipah Palma

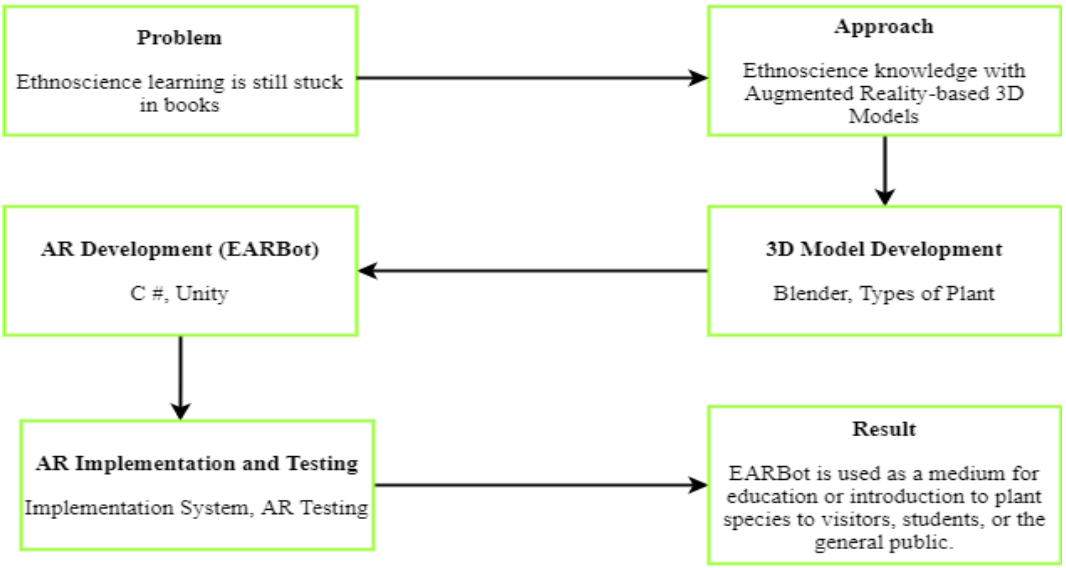

Fig. 1 EARBot Development Diagram

This image will explain the AR program development design starting from determining the objectives of existing problems to achieving the final program results.

1) Problem. Ethnoscience learning is still fixated on books and writings. Seeing the advancement of technology today allows researchers to develop ethnoscience learning models through Augmented Reality to gain new experiences.

2) Approach. Conducting an approach to the public regarding the ethnoscience of plant species with Augmented Reality media in the form of a three-dimensional (3D) model.

3) 3D Model Development. In this research, the Blender software is used to create 3D plant objects. Researchers chose Blender software because it is more user friendly and has complete features. Blender is software for creating 3D visualizations in the form of images, 3D animation, VFX capture, and video editing. Blender can be run on Linux operating systems, Mac OS, and Windows systems. The file and drive memory storage of the Blender software is also relatively small compared to other 3D creation software. The interface used for this software uses OpenGL to provide a consistent experience across all supported hardware and platforms [23].

4) EARBot development. EARBot application development starts from creating an application interface, debugging the application, and then running the EARBot mobile.

5) 3D Development Application Interface. The first step that the researchers took was to prepare a prototype application using Adobe XD CC software. The prototype will be used as a reference in creating an application interface in Unity. Researchers also use Adobe Photoshop CC 2014 as a support in making interfaces. The prototype made includes, the main page (homepage), plant categories, plant types, plant descriptions, AR displays, and others.

6) Application Debugging. In the process of creating an application interface, researchers simultaneously add scripts or code in the C # programming language so that the application can run. The debugging process is carried out when the AR display and function are not as expected. In this process, researchers tested the application on a mobile device.

7) Running mobile EARBot. After the application has been developed, the researcher builds the application in the form of an Android APK. The APK is installed on a mobile device which can then be run according to its function and usage. The following is a figure for running the EARBot application, as shown in Fig. 2.

III. RESULTS AND DISCUSSION

The making of the EARBot application is carried out with various implementations. Researchers prepare a model that will be displayed in the AR application, namely plant objects in the form of written information and images. Next is the stage of making a 3D model of a plant which is done using the Blender software. The following is a figure of the implementation of the 3D plant model which is presented in Fig. 3.

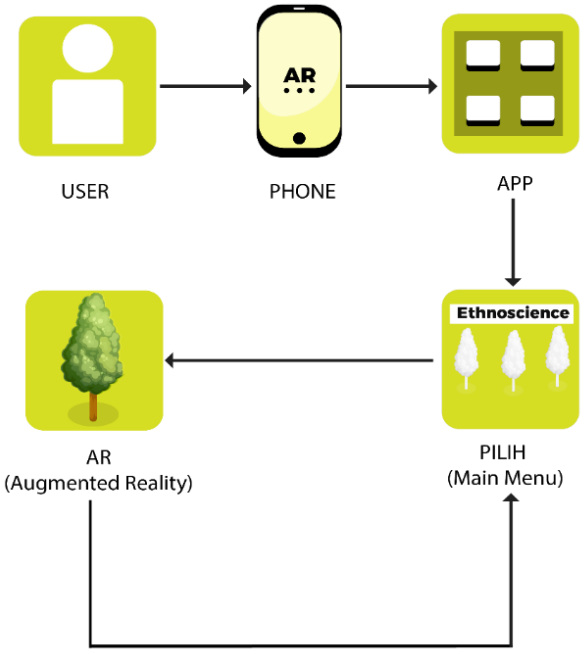

Fig. 2 Running mobile EARBot

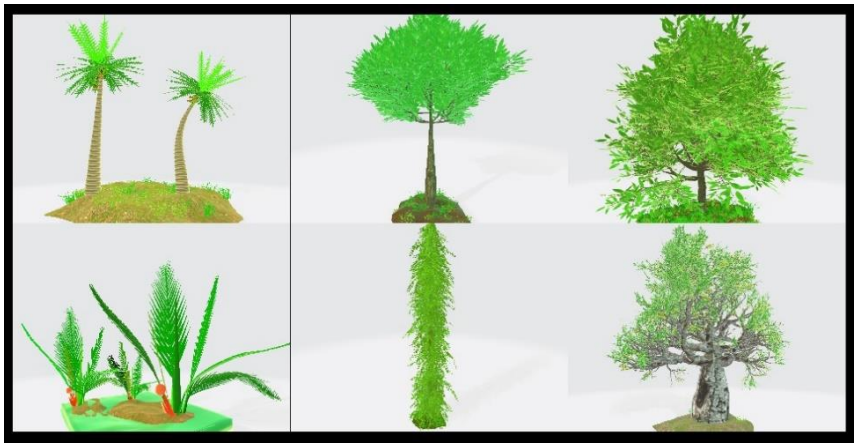

Fig. 3 Implementation of a 3D plant model

This was followed by the creation of an application prototype designed using Adobe XD software, before finally entering the Unity software for interface creation. An example of a prototype application design is presented in Fig. 4 and Fig. 5.

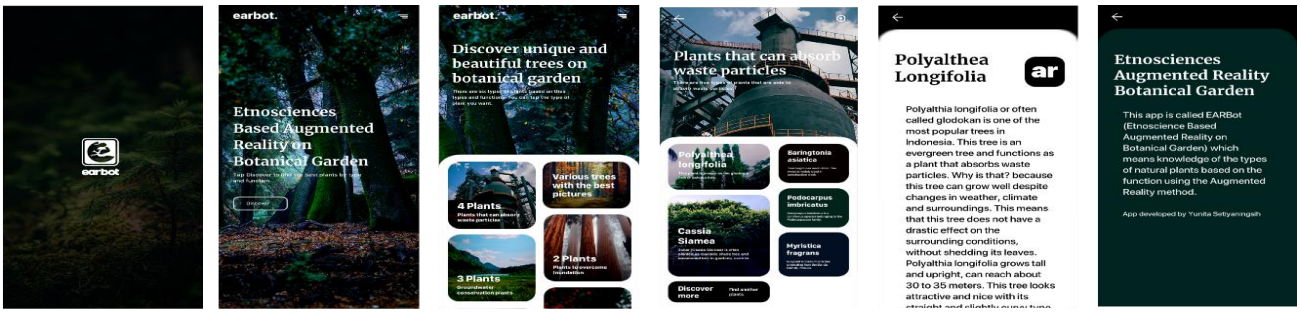

Fig. 4 Prototype of an EARBot App design

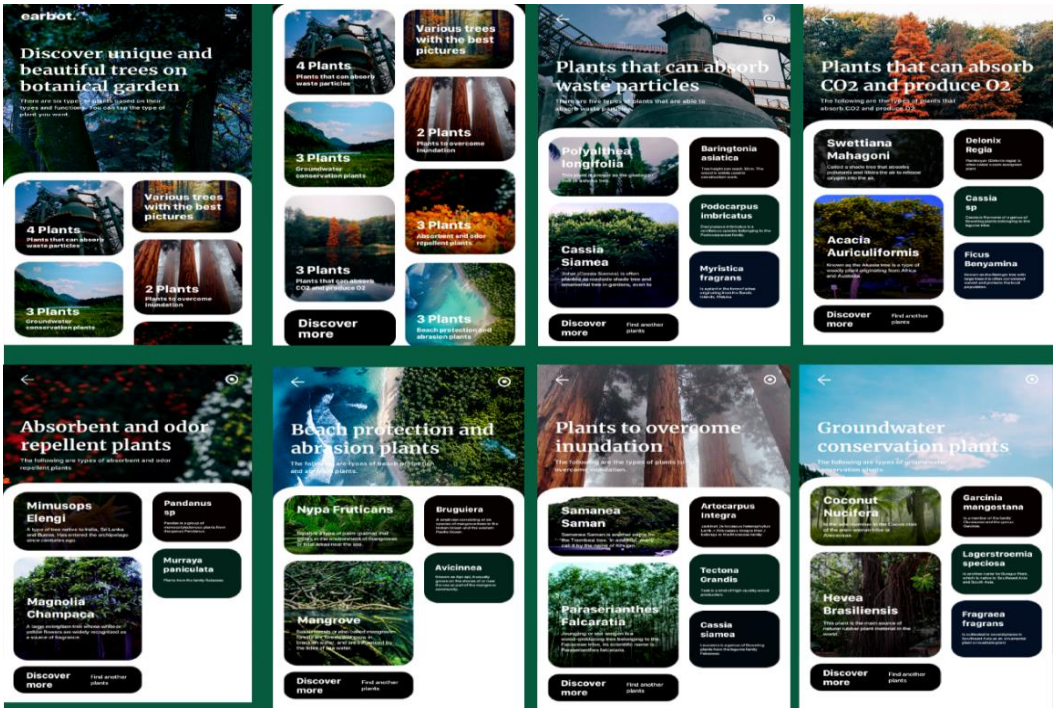

Fig. 5 Prototype of an EARBot App design of plant ethnoscience categories

In Unity software, an application interface is created following the interface design. The interface includes, main page (homepage), crop categories, plant types, crop information, and an AR Camera view. Creating interfaces together with coding and debugging the app to get the expected results. Each application interface element in the Scene or Panel can be connected to one another, including buttons and menus that are created.

The final result of the application can be seen in Fig. 6, while the results of the 3D model can be seen in Fig. 7.

The Android EARBot application features an AR button on the plant information interface. Users can easily press the AR button to view 3D plant models directly without using markers, this application is markerless AR. This is intended for user convenience and ease of access. The table for testing the EARBot App on Android devices is presented in Table II. Next is application testing with one of the Blackbox Testing Methods, this is used to focus on the function of the application. The purpose of the blackbox testing phase is to run all the menus contained in the application, as presented in Table III.

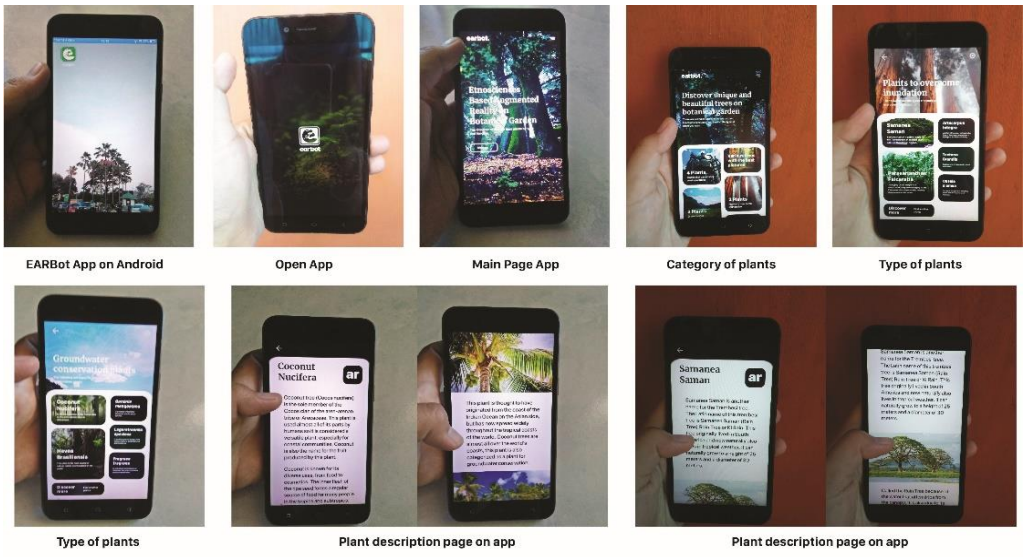

Fig. 6 Test result of the EARBot App on Android smartphone

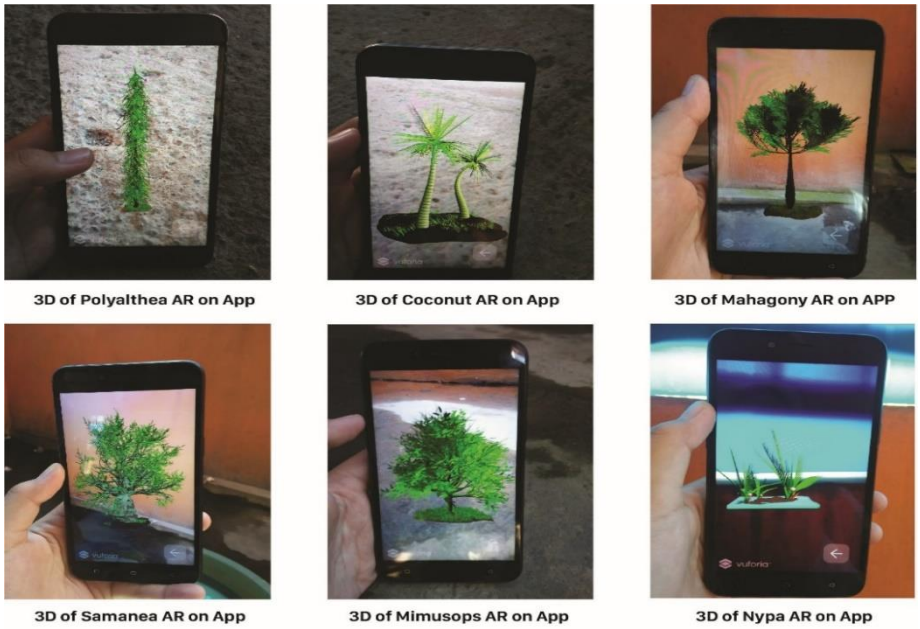

Fig. 7 AR Results 3D Models on Android smartphone

TABLE II
TESTING DEVICE

EARBot App Testing in Devices				
Device	**Android Version**	**Camera Resolution**	**Augmentable Rating**	**AR Detection Result**
OPPO A71 CPH1801	7.1 Nougat	13 MP	Good	Successful
Huawei Nova 2 Lite	8.0 Oreo	13 MP	Good	Successful
Xiaomi Redmi Note 4	6.0 Marshmallow	13 MP	Good	Successful

TABLE III
BLACKBOX TESTING

Testing the EARBot Menu			
Page	**Process**	**Page View Result**	**Result**
Main Page	Press the "Discover" button	Go to page categories of plants by function	OK
Plants Category	Press options button	Go to the "About" and "Exit" menu	OK
Plants Category	Selecting and pressing the plant function category button	Go to the plant names page	OK
Types of Plant	Selecting and pressing the plant name button	Go to plant information page and AR button	OK
AR Button	Pressing the "AR" button	Displaying 3D plant objects in AR	OK

IV. CONCLUSION

This paper has discussed several implementations and tests of the EARBot application which contains ethno-science knowledge of natural plant species based on function categories for the environment, using markerless Augmented Reality technology. Knowledge of plant species is presented in the form of written information and 3-dimensional objects, so that the results of visualizing objects with AR technology can be seen clearly by users. This EARBot application can be used as a means of knowledge of plant species based on Android applications. Further research is expected to be able to increase the development of natural ethnoscience applications, especially plant knowledge for the preservation of the natural environment. In addition, existing ethnoscience applications will be developed into applications that are more user friendly, lightweight, and can provide several more interactive and educative features.

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