Implementation of Augmented Reality Technology: Introduction to Rare Plants for Students

Haris Bayu Bramantya
Yogyakarta University of Technology
Yogyakarta, Indonesia

Adam Sekti Aji
Yogyakarta University of Technology
Yogyakarta, Indonesia

ABSTRACT

Plants that are becoming difficult to find can be classified as rare. Some of the threats include illegal logging, conversion of forest land into other areas, poaching, and illegal trade. Some of these extinction threats can actually be overcome by selective logging, replanting, and also creating protected forests. But there are also plants that cannot survive due to various factors such as unsuitable climate and these plants must become extinct before they can be cultivated. The purpose of making this rare plant introduction application is to help people know what plants are becoming rare or extinct. this application can be useful for learning in schools as a form of technology utilization that can be a good alternative today. by using this application, learning becomes more fun because there is no need to come to a museum or protected forest to learn history. Later this application will run on the user's smartphone by simply scanning the available markers and a 3D object of rare plants will appear.

General Terms

Rare Plants, Application Learning, 3D object

Keywords

Augmented Reality, Marker, 3D Virtual, Application

1. INTRODUCTION

Biodiversity encompasses the diversity and variability of all life on earth, which plays very important role in the maintenance and sustainable development of human society [1]. For plant species of conservation concern, knowledge of changes in abundance through time is a minimum requirement for informed management [2]. Protecting rare and endangered plants is important for maintaining ecosystem structure and function, conserving biodiversity, and even sustaining national economic growth [3]. There isn't much documentation on rare plants, so many people don't know what they look like. The introduction of rare plants is also quite difficult if only through 2d objects such as photos. for this reason, a technology is needed as a new breakthrough in the introduction of rare plants to the public.

Humans have the remarkable capability to decompose scenes into their constituent objects and to infer object properties such as 3D shape and texture from just a single view [4] . In learning media, a clear object of introduction is needed and is able to explain in detail. However, when it comes to specific vision tasks in the real world, it is necessary to obtain 3D information about the spatial coordinates, orientation, and velocity of objects, which makes research on object detection in 3D scenes more active [5]. 3d objects connected with augmented reality technology. While augmented reality (AR) technology is being considered by educators for its potential to help students visualize abstract concepts, currently there are barriers from the high cost of developing complex AR applications [6].

To help the student learning process, an augmented reality technology application about the introduction of rare plants is needed. Experimental results consisting of AR digital visualizations of rare plant recognition to assess the validity of our approach. Analysis of the effect of the AR modules on student learning is still anecdotal at this point in time, but the early evidence is promising [7]. This system was created using the C# programming language using Vuforia SDK and Unity 3D. Unity is not only capable of developing 2D scenes, but also 3D scenes [8]. It is also one of the main AR development engines. The development of this application can help introduce rare plants to the public without the need to come directly to protected forests or museums, this application later only needs to be installed on each smartphone and will display rare plants and their information, and this application can also be a learning medium.

2. RESEARCH METHOD

Systems architecting tools assist in describing and analyzing complex systems and promote the design of better systems through structured analysis [9].
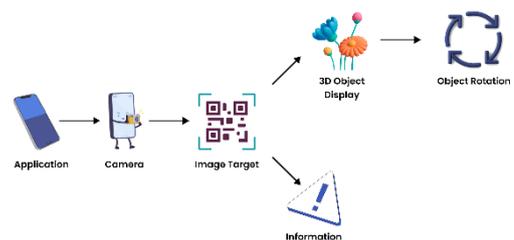

Fig. 1 Architecture Diagram

System development begins with designing an architecture diagram. In the architecture diagram, it is explained that when the application is opened, the camera can scan so that it displays 3d objects and their information. Nowadays, barcodes are used on most goods and materials [10]. with barcodes, information about 3d objects can be stored.

The implementation stage of this research starts from identifying problems related to the research title then collecting data that supports the research. After that, analyze the system that will be made so that it is easier to implement. And finally testing the system created.
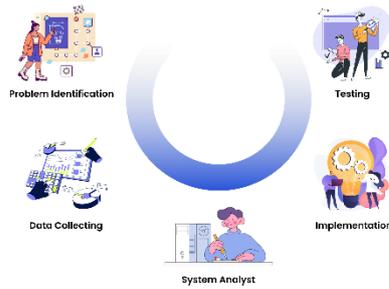
Fig. 2 Research Stages

2.1 Data Collection Procedure

2.1.1 Observation

This method is carried out by conducting a direct review of the object under study. To obtain real data, the author made direct observations at SMP N 3 Gamping.

2.1.2 Literature Study

Conducting a literature search and previous research that has been done on the use of augmented reality in education and similar applications that have been developed to study rare plants. Reviewed relevant scientific publications, journals and articles.

2.1.3 Data Analyst

After collecting the data, the data obtained was analyzed. This analysis includes identifying needs, preferences, and issues that arise from the data.

2.2 System Design Logic

The process of creating a system must go through designing a design model. Almost all of these works need a semantically analyzable model to represent the software architecture design, e.g., a UML class diagram [11]. However, reasoning or verifying the consistency of a UML class diagram is quite challenging [12]. Logic planning contains system design using UML diagrams consisting of use case diagrams and activity diagrams.

2.2.1 Use Case Diagram

Use case diagram is a description of the expected scenario of interaction between users and the system and the functions of the system being built. This AR application for the introduction of rare plants is intended for students in Indonesia.
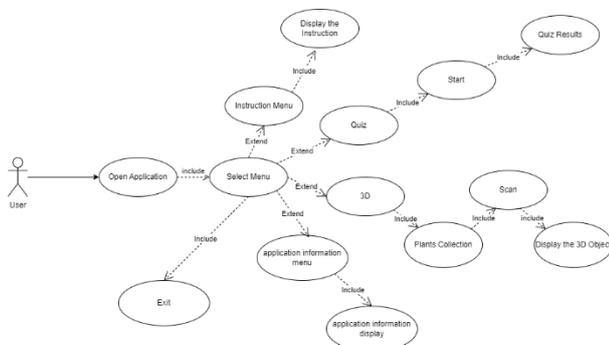

Fig. 3 Use Case Diagram

When the user opens the application, the main menu will appear, the user can select the instructions menu, the menu about the application, the quiz menu, and the 3D menu, if the user selects the instructions menu, it will display instructions for using the application, if the user selects the about menu, it will display information about the application, if the user selects the quiz menu, the user can play the quiz and if the user selects 3D, a collection of rare plants will appear, then if the user selects one of the rare plants, the user will be told to scan the marker and then a 3D rare plant will appear.

2.2.2 Class Diagram

Class diagram or class diagram describes the structure of system objects that exist in the system, including the attributes and methods that exist in the class. In the AR rare plant class diagram formed has 6 object classes including home, instructions, plant collections, scans, quizzes, and about the application.
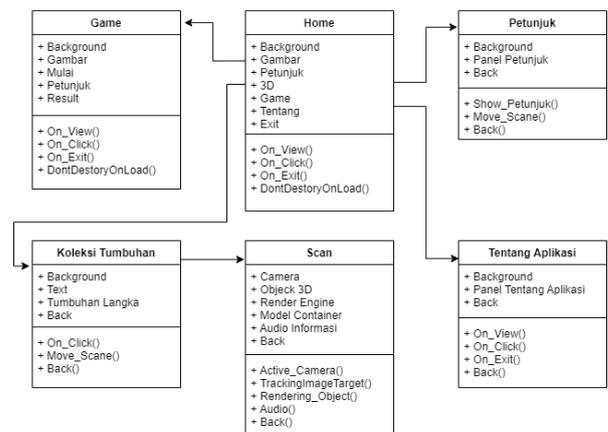

Fig. 4 Class Diagram

2.2.3 Activity Diagram

The design of this activity diagram is to explain the flow of activities in the designed system that involves actions taken by users in using the application. The following is an activity diagram that explains or describes the user's actions in running the application when displaying 3D objects.
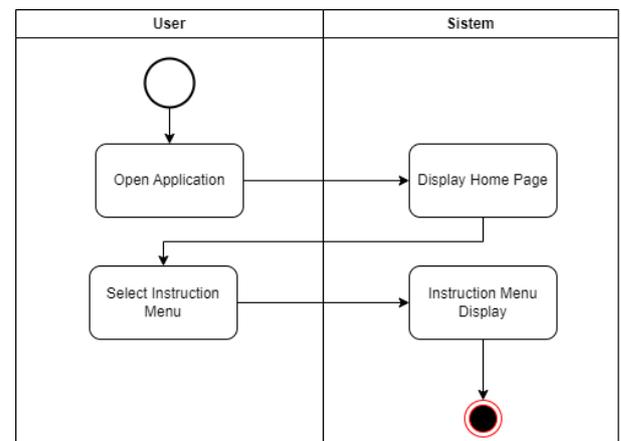

Fig. 5 Activity Diagram Instruction Menu

When the user opens the application, the system will display the main page, then when the user selects the application

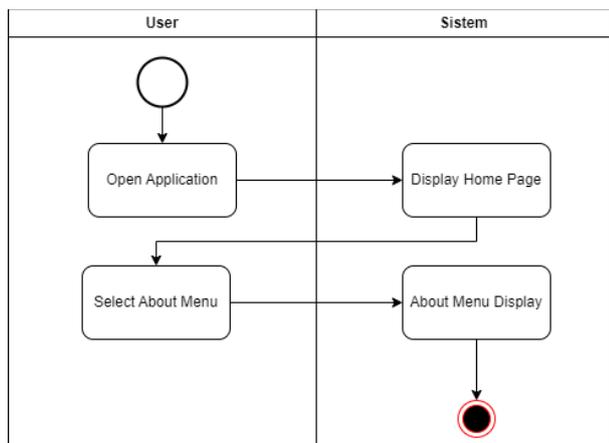instructions menu, it will display the application instructions page.

Fig. 6 Activity Diagram About Menu

When the user opens the application the user will be taken to the main menu then if the user selects the menu about the application it will display a page about application information such as who made it and others.
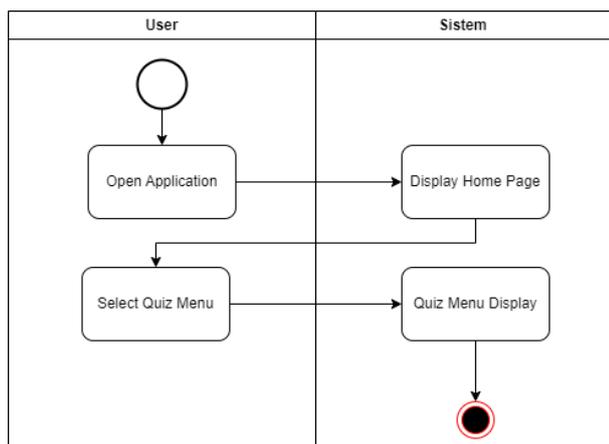

Fig. 7 Quiz Menu

When the user opens the application, the user will be taken to the main menu then if the user chooses the quiz menu, the application will display the home quiz, if the user clicks start then the user can play the quiz.
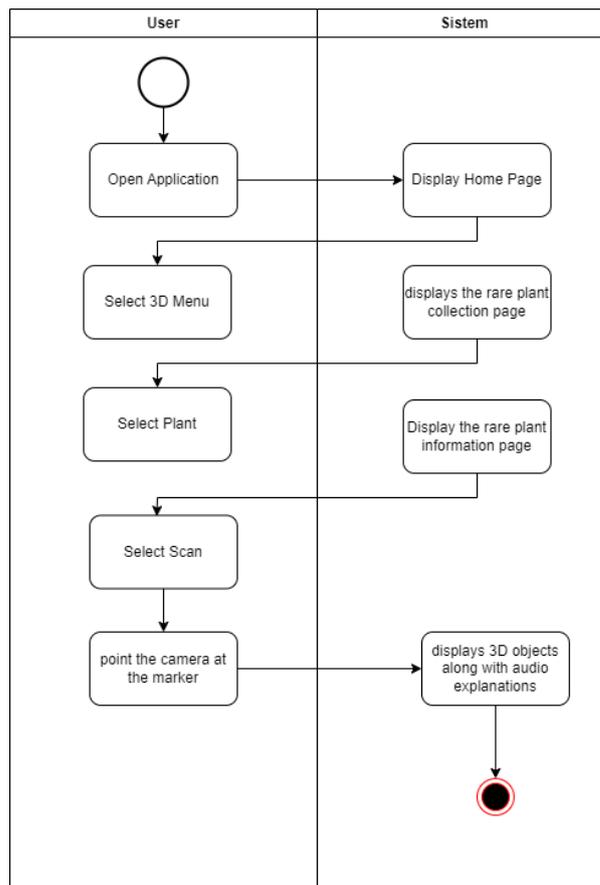

Fig. 8 3D Display

The 3D menu is the main menu of this application which if the user chooses the 3D menu, a rare plant collection page will appear, and if the user chooses one of the rare plants, the user will be told to scan the marker, which if the user has scanned it, a rare plant and its audio will appear.

2.2.4 Sequence Diagram
When the user opens the application, the system will display the main page, then when the user selects the application instructions menu, it will display the application instructions page.
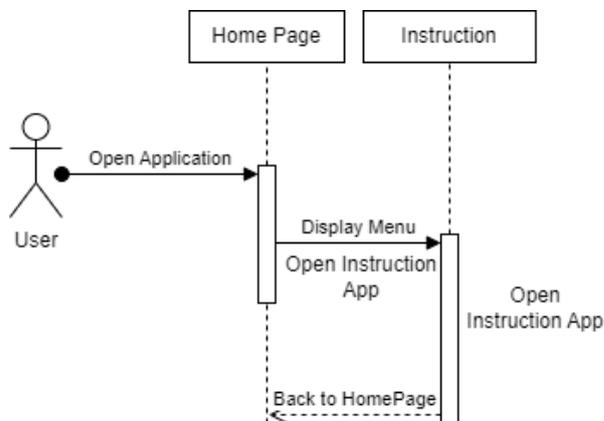

Fig. 9 Instruction Menu

When the user opens the application the user will be taken to the main menu then if the user selects the menu about the application it will display a page about application information such as who made it and others.
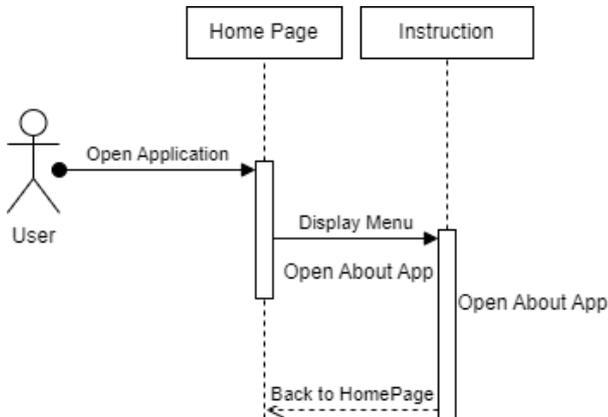

Fig. 10 About Application

When the user opens the application the user will be taken to the main menu then if the user selects the quiz menu, the application will display the home game page, then the user can play the quiz.
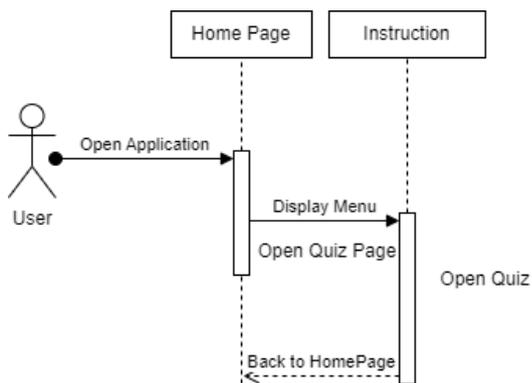

Fig. 11 Quiz Page

The 3D menu is the main menu of this application which if the user chooses the 3D menu, a rare plant collection page will appear, and if the user chooses one of the rare plants, the user will be told to scan the marker, which if the user has scanned it, a rare plant and its audio will appear.
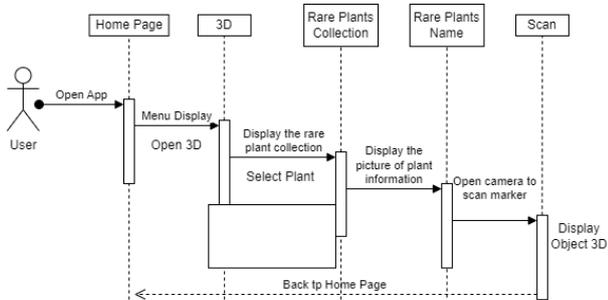

Fig. 12 Menu 3D

2.3 Interface Design

For physical design, Figma application is used to create the user interface, there is a splash screen, menu, scan, about, instructions, home quiz, quiz instructions, and quiz results.

Fig. 13 Wireframe Application

3. RESULT AND DISCUSSION

3.1 Assumptions

This application can be operated using a smartphone. Students can download the application then scan the marker that has been available, then a 3d object of rare plants will appear accompanied by audio explanations and information displayed in the form of text.

3.2 Hypothesis

This hypothesis is based on the assumptions obtained and proven in the research stage. This study hypothesizes that "Application of Rare Plant Introduction with Augmented Reality Technology can make it easier for teachers to support their performance and students can easily obtain learning information".

3.3 Feature

In the application, there are several features displayed on each page.

No	Feature	Description
1	Splash Screen	The initial display of the app when opened runs for 5 seconds
2	Home Page	Displays 3D, Quiz, About, Hint, and Exit buttons.
3	About Application	Display information about this app.
4	App usage instructions	Displays instructions for using the app.
5	3D Collection	Display a collection of 3D objects.
6	Rare Plants Information	Display information about rare plants
7	Object Scanning	Can scan marker objects well and display 3D objects.
8	Quiz Game Menu	Display a home quiz
9	Quiz game menu instructions	Display quiz instructions
10	Quiz Game	Display questions from the quiz
11	Quiz Game Results	Display the results of the quiz that has been done.

3.4 Run an Experiment

In software development, the contribution of each role is needed to run the business process according to the expected goals [13]. After the wireframe is successfully created, the next step is to do the coding. The programming language that the author uses is C#. C# is a high-level programming language developed by Microsoft. With syntax similar to the C language, C# provides powerful capabilities for developing desktop, web, and mobile applications. C# supports the concept of object-oriented programming, which allows users to create structured and modular code. C# also provides easy access to libraries and frameworks useful for application development, and has security features that allow users to avoid errors and protect sensitive data. Development of this application using Unity 3D. Unity's power lies in the fact that it has a number of well-rounded plug-ins, as well as great built-in components such as physics, animation, and path finding [14].

3.5 Implementations

The implementation of the system interface aims to facilitate users in using the system. The implementation of the interface in the augmented reality application of rare plant recognition consists of several system designs as follows.

3.5.1 Home Page & App Usage Instruction Page

The main page is a page that will display the rare plant AR application menu, there are 5 main buttons namely 3D, Quiz, Instructions, About, and Exit, each button is useful for users to make it easier to use.

Fig. 14 Home Page & App Usage Instruction Page

The instructions page is a page that will display instructions for using the application so that users are not confused when using the augmented reality application of rare plants.

3.5.2 About Page & 3D Page

The about page is a page that will display information about the application, which includes the application creator, and the purpose of this application.

Fig. 15 About Page & 3D Page

The 3D page is a page that will display a collection of rare plants contained in the application

3.5.3 Plants Information Page

The plant information page is a page that will display rare plant information in the form of rare plant images, brief information on rare plants, and a scan menu.

Fig. 16 Plants Information Page

3.5.4 Scanning Page Display

The Scan page is a page that will display 3D objects of rare plants, and audio information about rare plants.
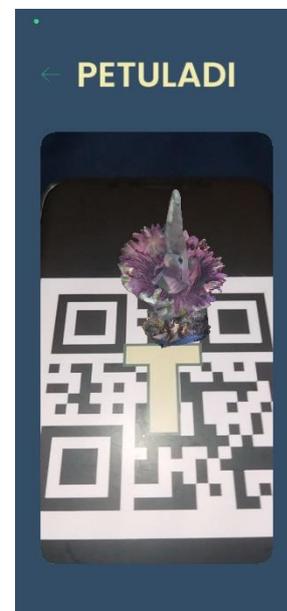

Fig. 17 Scanning Page Display

3.5.5 Quiz Game Display & Quiz Instruction Page

The quiz home page is a page that will contain a Start and Hint Button, the start button will start the quiz, and the hint button will display the game instructions.

Fig. 18 Quiz Game Display & Quiz Instruction Page

The quiz instructions display is a page that contains instructions for using the quiz, so that users can run the quiz easily without confusion when running the quiz,

3.5.6 Quiz Page Display & Result Page
The quiz page display is a page that will be used as a quiz to answer the questions that have been provided and if the user can answer it will get points.
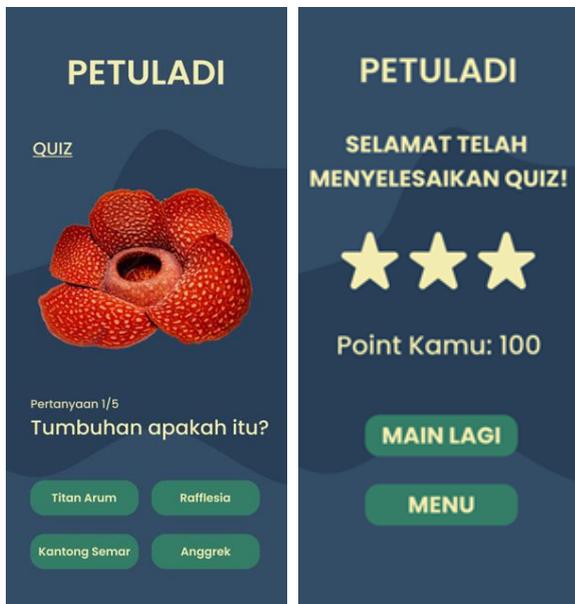

Fig. 19 Quiz Page Display & Result Page

A display containing the assessment score of the quiz results that have been done, if the user gets a score of 100 will get 3 stars, if the user gets a score of 60 get 2 stars, if user get a score below 60 will get 1 star, then there is a button to play again, or return to the main menu page.

3.6 Discussion of Result
Software testing is the main technology to ensure the quality of the software [15]. Test the functionality contained in the

application to ensure all functions run correctly and ensure system consistency as expected.

Table 1 Testing Application

Item Testing	Testing Method	Testing Detail	Status
Home Page	Open application	Display the Hints, About, 3D, Exit menu on the menu page	Successfull
Instruction Page Button	Pressing the instruction page button	Display the application instructions page	Successfull
About Page Button	Pressing the About Page Button	Display the about page	Successfull
Collection Page Button	Pressing the Collection Page Button	Display the Collection Page Button	Successfull
Scan Page Button	Pressing the Scan Page Button	Display the Scan Page Button	Successfull
Audio Explanation	Scanning the 3D object	Audio explanations of rare plants appear when scanning 3D objects	Successfull
Back Button	Pressing the back button	Back to previous page	Successfull
Exit Button	Pressing the Exit Button	The system can close correctly	Successfull

Table 2 Distance Testing

Tested Markers	Distance		
	< 5 cm	5 – 10 cm	> 10 cm
Rafflesia	Successfully Detected	Successfully Detected	undetectable
Kantong Semar	Successfully Detected	Successfully Detected	undetectable
Titan Arum	Successfully Detected	Successfully Detected	undetectable

Based on the test results and analysis of the test results, it can be concluded as follows:

1. Distance greatly affects the object rendering process. AR cameras cannot recognize markers in conditions that are too far away. Conditions that are too far away will make the marker undetectable on the camera, the distance range that the camera can detect on the marker is> 10 cm.

Markers that are directly blocked by objects or other things will not be recognized by the system.

4. CONCLUSSION

Based on the research that has been described by the author, it can be concluded that the application made can display rare plant objects virtually 3-dimensional, and can display detailed information from the 3-dimensional object. This rare plant application can be used as an interesting learning media solution for students and the general public in Indonesia, amidst the turmoil of technological developments that continue to grow at this time this application will be very relevant and efficient.

This system applies augmented reality technology which is part of computer science so that the resulting application is expected to meet user needs in the learning process.

5. REFERENCES

[1]   Y. Xu and R. Zang, "Conservation of rare and endangered plant species in China," iScience, vol. 26, no. 2, 2023.

[2]   K. R. Rominger, A. DeNittis and S. E. Meyer, "Using drone imagery analysis in rare plant demographic studies," Journal for Nature Conservation, vol. 62, 2021.

[3]   Q. Zhou, Y. Wang, Z. Xin, A. Musa and L. Wang, "Mesophytic and less-disturbed mountainous habitats are important for in situ conservation of rare and endangered plants," Global Ecology and Conservation, vol. 44, 2023.

[4]   W. Chen, Y. Li, Z. Tian and F. Zhang, "2D and 3D object detection algorithms from images: A Survey," Array, vol. 19, 2023.

[5]   C. Elich, M. R. Oswald, M. Pollefeys and J. Stueckler, "Weakly supervised learning of multi-object 3D scene decompositions using deep shape priors," Computer Vision and Image Understanding, vol. 220, 2022.

[6]   I. Radu, X. Huang, G. Kestin and B. Schneider, "How augmented reality influences student learning and inquiry styles: A study of 1-1 physics remote AR tutoring," Computers & Education: X Reality, vol. 2, 2023.

[7]   C. Smith and C. J. Friel, "Development and use of augmented reality models to teach medicinal chemistry," Currents in Pharmacy Teaching and Learning, vol. 13, no. 8, pp. 1010-1017, 2021.

[8]   Y. Li and Y. Zhu, "Research on Key Technologies of Garbage Classification Virtual Simulation Game Development Based on unity3d Technology," Procedia Computer Science, vol. 208, no. 2022, pp. 546-552, 2022.

[9]   J. C. Lew and K. M, "Decomposition Relationship Visualization for Executable Architecture Diagrams," Procedia Computer Science, vol. 28, 2014.

[10] S. Elaskari, M. Imran, A. Elaskri and A. Almasoudi, "Using Barcode to Track Student Attendance and Assets in Higher Education Institutions," Procedia Computer Science, vol. 184, 2021.

[11] F. Chen, L. Zhang, X. Lian and N. Niu, "Automatically recognizing the semantic elements from UML class diagram images," Journal of Systems and Software, vol. 193, 2022.

[12] B. D, C. D and D. G. G, "Reasoning on UML class diagrams," Artificial Intelligence, vol. 168, pp. 70-118, 2005.

[13] F. Rokhman and R. Andreswari, "Business process analysis of programmer job role in software development using process mining," Procedia Computer Science, vol. 197, pp. 701-708, 2022.

[14] Y. Li and Y. Zhu, "Research on Key Technologies of Garbage Classification Virtual Simulation Game Development Based on unity3d Technology," Procedia Computer Science, vol. 208, pp. 546-552, 2022.

[15] T. Yumoto, T. Matsuodani and K. Tsuda, "A Test Analysis Method for Black Box Testing Using AUT and Fault Knowledge," Procedia Computer Science, vol. 22, pp. 551-560, 2013.