KESATRIA: Jurnal Penerapan Sistem Informasi (Komputer & Manajemen)
Terakreditasi Nomor 204/E/KPT/2022 | Vol. 5, No. 3, Juli (2024), pp. 1404-1412

Augmented Reality Similarietes of Animal and Plant Cell Parts Using Image Tracking

Khoiruddin Hasibuan[1], T Triase[2]
[1,2]Faculty of Science and Technology, Universitas Islam Negeri Sumatera Utara, Indonesia
E-mail: [1]khoiruddin.hasibuan.95@gmail.com

Abstract

The rapid development of information systems technology in the era of globalization, industrial revolution 4.0, encourages various fields to be more innovative and creative, especially in the field of education. The use of information systems in the world of education is expected to make it easier to access fast information and innovative, interactive and informative learning media. Augmented reality (AR) is one of the learning media innovations that combines the visualization of three-dimensional or two-dimensional virtual objects with the real world, allowing users to learn more deeply about a learning object through their gadgets. Augmented reality (AR) uses several tracking methods to display an object, one of which is the marker based tracking method. Where this tracking model recognizes and identifies a maker or target image which then becomes the layout when the virtual object is displayed in the real environment. Then, to create three-dimensional objects, use Blender software sourced from the internet for model parts of animal and plant cells. With this AR application, it is hoped that it will attract the interest of students or visitors to the biology laboratory at the Faculty of Science and Technology, UIN North Sumatra, especially in studying the similarities between parts of animal and plant cells with interactive visualization of the AR application.

Keywords: *Learning media, Augmented reality, Animal and plant cell, Image tracking*

1. Introduction

Augmented reality technology in the learning process can provide a new learning experience and train skills and knowledge in the 21st century[1]. In education, teaching and learning activities require effective and efficient learning media. One learning media that follows technological developments is augmented reality-based learning media. Augmented reality (AR) is a technology used to realize the virtual world into the real world at one time (Alfitriani, et al., 2021)[2]. Currently AR is widely used in the fields of gaming, medicine and image processing, while in the field of education it is still rarely used [3].

In animal and plant physiology biology education, there are several similarities between animal and plant cells. In general, there are six similarities between animal cells and plant cells, namely the cell components of the nucleus, cell membrane, cytoplasm, mitochondria, Golgi bodies and ribosomes [4]. Although there are several differences between animal cells and plant cells, both cells are eukaryotic cells [5].

For students majoring in biology, Faculty of Science, UIN North Sumatra, Stambuk 2020, according to a Google form survey in the form of an essay that researchers conducted on January 23 2024. Biology Students stamp 2020 (almost 99%) stated that they wanted and needed alternative learning media that made it easier to understand the similarities between animal and plant cells and that could explain and explain the visual form of the similarities between the objects of the parts of the two cells. Then more than 60% of them still have difficulty seeing details and understanding the functional similarities of the parts of the two cells.

ISSN: 2720-992X

Augmented reality as an alternative learning media, it is hoped that the biology laboratory of the science and technology faculty of UIN North Sumatra can create more interesting and more advanced learning media by utilizing current technological developments. Especially for students majoring in biology who want alternative learning media to make it easier to understand the similarities between animal and plant cells. This augmented reality learning media will make it easier to explain one by one the similarities between the parts of animal and plant cells by displaying 3D objects of the parts of both cells along with their descriptions. This AR application uses a marker based tracking method where objects will be displayed only if they are detected according to the available target image (marker)..

In previous research entitled "Development of Audiovisual Based Song Education Media on Plant Cell and Animal Cell Material to Increase Students' Interest in Learning in Class Xi High School" the learning media focused on audiovisual in the form of video and sound for high school [6]. In the journal "Creating Augmented Reality (AR) for Learning Cell Organelles in Plants and Animals (Case Study: SMA Negeri 1 Dlingo)" the AR application focuses on introducing models of both cells [7]. And the thesis entitled "Development of Augmented Reality (AR) Based Learning Media on Cell Material" aims to produce and determine the level of feasibility/validity of AR-based learning media on cell material that has been developed [8]. Then what encouraged researchers to develop alternative AR learning media for the similarities of parts of animal and plant cells with Android-based image tracking for biology students at the science faculty of UIN North Sumatra. To functionally test the application, it will be carried out using two methods, namely black box testing and testing with a questionnaire to assess the level of ease of use of the application in achieving learning objectives..

Augmented Reality (AR) is a technology that combines virtual elements, such as images, sounds, and 3D objects, with the user's real physical environment, creating an experience that unites real and digital reality (Chen & Wang, 2021). In AR, digital information is displayed on top of the real world, usually via devices such as smart glasses, smartphones, or tablets[9]. Augmented Reality allows users to view the real world around them through digital devices, while at the same time, presenting additional information in the form of virtual objects, text, or other media overlaid on top of the real view (Dörner et al., 2021) . This technology utilizes the device's camera, sensors, and image processing algorithms to identify and display virtual objects in real-time in the context of the user's physical environment[10].

The use of Augmented Reality learning media is a learning media that can be used as an alternative in learning activities, especially in bacterial material, through Augmented Reality media educators can display types of bacteria that cannot be seen directly without using a microscope[11]. At the tertiary level, Augmented Reality learning media can make it easier for lecturers and students to carry out learning activities. through Augmented Reality which is used via smartphone and connected to the internet, learning can be carried out anywhere and can be used at any time, besides this learning media can enrich the learning experience even though students learn independently[12]. Apart from that, Augmented Reality learning media can help educators and students in creating an innovative and interactive learning atmosphere[13].

This AR application will explain the similarities between animal and plant cells more specifically which have not been included in previous research. Several similarities of animal and plant cells will be displayed together according to the target image of each part of the cell complete with detailed 3D shapes and descriptions of the similarities so that it is hoped that it will be easier to analyze and understand. This research is an effort to develop an AR application in previous research.

2. Reseach Methodology

This research is included in the category of research and development or what we usually know by the abbreviation R&D. According to Salim & Haidir (2019:58) R&D is a series of processes or steps in order to develop a new product or improve an existing product[14]. Several methods used to collect data are:

a) Observasi
Carrying out data collection by direct observation at the Biology Laboratory of UIN North Sumatra and seeing the use of cell information technology to strengthen the data for research. The following observation results are shown in the following table.

Table 1. Observation Data

No	Data	Information
1.	3D Assets	Animal and Plant Cell Models
2.	Description of Eq	Nucleus, Cell Membrane, Cytoplasm, Mitochondria, Golgi Bodies, Ribosomes

b) Interview
Interviewing biology laboratory assistants to obtain information regarding the Biology Laboratory at UIN North Sumatra.

c) Questionnaire
Researchers gave a set of questions and a Google form survey to 2020 Stambuk biology student respondents to provide opinions regarding the use of information technology in the laboratory. A google form survey regarding the use of AR as a learning medium to help with difficulties in identifying the similarities between animal and plant cells that researchers conducted on biology students in Stambuk 2020. So students hope for an interactive learning media that can make it easier to identify similarities between animal and plant cells that can display the similarities of both cells. in 3D complete with descriptions to make things easier for the next generation of students.

d) Literatur study
The author uses books, journals, national and international publications related to research on Augmented Reality, to obtain theories that support solving research problems.

The flow of research carried out to build this application uses the ADDIE model. The use of this model is based on the reason that the ADDIE model can provide a parallel or sequential process starting from data analysis, system design, application, inspection and evaluation[15]. The ADDIE model has several stages, namely as follows:

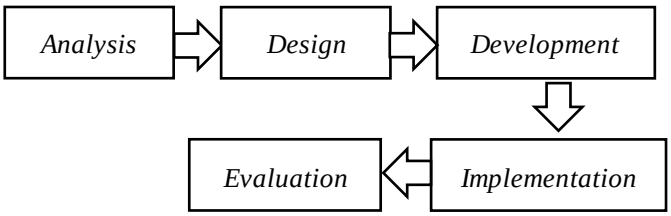

Figure 1. Stages of the ADDIE Model

1. Analysis, In this stage, the main activity is analyzing the need for developing teaching materials for learning objectives.
2. Design, is the stage of making a plan or initial design regarding learning.
3. Development, the stage of the process of developing learning materials.

4. Implementation, is the real stage for implementing the learning system that we have created according to the design and development that we have prepared.

Evaluation, is the final stage to see whether the learning system that is being built is successful or not in accordance with initial expectations. Qualitative research is subjective, the researcher interacts directly towards the object being researched. The language is informal, using personal words. The stated analysis in the form of information and descriptive explanations. Method is a way of collecting data arranged in stages to make it easier to carry out application design and report preparation[16].

3. Results and Discussion

Analysis of the data needed to build this application is needs analysis based on hardware and software requirements. Then the research continued with designing use case concepts and activity diagrams. After the design stage is complete, the application is implemented according to the needs and design. After completing the implementation phase, a testing phase will be carried out using the Blackbox method.

Based on observations and visits carried out by researchers as well as Google Form surveys and direct interviews, an analysis of the use of information technology and the need for information technology-based learning media was carried out on students of the Biology Department, Faculty of Science and Technology, State Islamic University of North Sumatra, they need innovative learning media such as AR in their laboratory to make it easier to identify cells in detail and understand the similarities between animal and plant cells. Augmented Reality (AR) can help biology students in providing alternative learning media, enriching learning and facilitating understanding of complex concepts through visualization of the structural similarities of animal and plant cells as well as interactive and immersive virtual simulations and experiments. It is hoped that this AR system can create a creative learning environment and keep up with current developments in learning media for Biology Department Students.

3.1. System Development

AR applications with image tracking require target images (markers) in the process of placing (tracking) 3D objects. For the target image, researchers used the package for unity in the Vuforia SDK target manager database. The following is an example of a target image that was successfully added to the Vuforia target manager database.

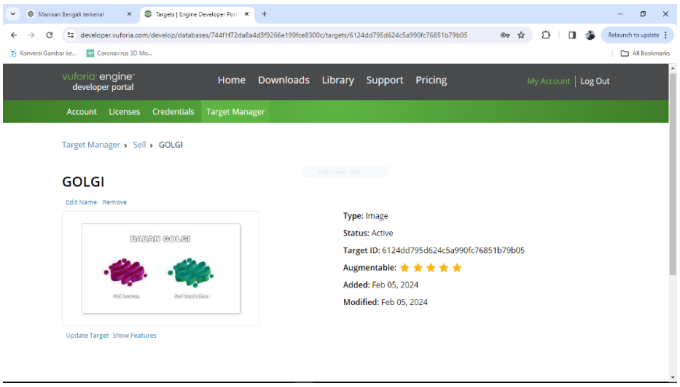

Figure 2. Markers

The image analysis process in Vuforia Target Manager involves several technical stages designed to ensure target images can be recognized and tracked accurately. Vuforia Target Manager analyzes uploaded images by looking for recognizable visual features

such as corners, edges, and patterns. Images with more unique visual features will be easier to recognize and track. The following is a more detailed picture of this process:

Figure 3. Marker Analysis

Vuforia image scoring assigns a score to images based on the number and distribution of detected feature points. Images with more unique and evenly distributed feature points tend to have higher scores and are easier to recognize under various conditions. Images with inconsistent or too few features may not be approved as targets. The algorithm detects prominent feature points in images, such as corners, edges, and texture patterns. These dots are parts of the image that have significant changes in color or intensity and can be identified consistently from different viewing angles. Star ratings use analysis results to provide star ratings. Here is an example of a hypothetical formula that could be used for star ratings.

Total Score = Wk × Number of Features + Wc Contrast + Wd Distribution (1)

W*k* is the weight for the number of features, Wc is the weight for contrast, Wd is the weight for feature distribution. For a total score of ≥5000 and above you get 5 stars, a score of 4000 gets 4 stars, a score of 3000 gets 3 stars, a score of 2000 gets 2 stars, and a score under 2000 gets 1 star.

3.2. Application Implementation

The application implementation used is the 3D cell model, main menu play, download maker, instructions, about and exit. Following are the results of the application implementation.

1. Main page

The main page consists of a main menu and submenu, where Play AR is the main menu and the submenu consists of about, download marker, instructions, and exit.

Figure 4. Main page

2. AR Play Page

In Figure 5, the Play AR page is a page where 3D objects with similarities to parts of animal and plant cells are displayed along with their descriptions.

Figur 5. Play AR page

3. Quiz Page

The Quiz page in Figure 6 contains several questions to test the level of understanding regarding the similarities between animal and plant cells.

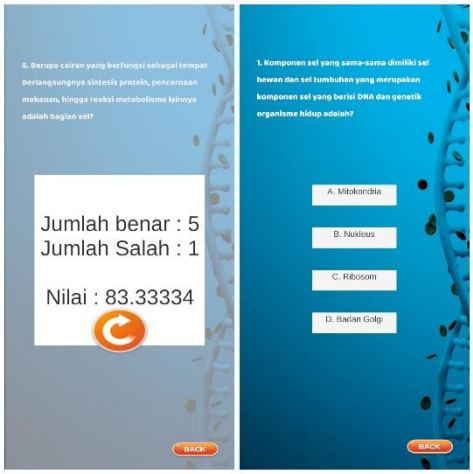

Figure 6. Instruction page

3.3. Application Testing

The Black Box method was used to test this application. This test tests the appearance (UI), functionality, and does not look at what happens in the detailed process. Just know the input and output processes. Testing using an Android smartphone with IPS LCD touchscreen specifications, 120Hz, HDR 10, 450 nits (typ), Resolution 1080x2400 pixels (~395 ppi pixel density), Android OS 10(Q), Qualcomm Snapdraon 732G Chipset, Octa-core 2.3GHz CPU Adreno 618, Internal 8GB of RAM, 128 GB of ROM. The following table shows the results of testing the application menu function:

Table 2. Testing application menu functions

No	Testing	Information	Conclusion
1	Main menu	Displaying Play AR	Succeed
2	Submenu	Displays menus Download Marker, Instruction, About, dan Exit	Succeed

No	Testing	Information	Conclusion
3	Menampilkan 3D Sel	3D Animal and Plant Cell Objects	Succeed
4	Menampilkan Bagian Persamaan Sel	Cell Parts Nucleus, Cell Membrane, Cytoplasm, Mitochondria, Golgi Body, Ribosomes	Succeed
5	Menampilkan Deskripsi	Cell Equation description text	Succeed
6	Mengeluarkan Suara	Sound Description & Backsound	Succeed

Testing was carried out to see whether the scenes or menus created in the AR application with animal and plant cell equations contained errors or not when moving between pages. The next test regarding the distance between the camera and the marker is shown in Table 3 below:

Table 3. Testing the distance between the camera and the marker

Distance (cm)	Expected results	Results obtained	Conclusion
10	3D object equivalent cell parts and their details		Succeed
20	3D object equivalent cell parts and their details		Succeed

Distance (cm)	Expected results	Results obtained	Conclusion
30	3D object equivalent cell parts and their details		Succeed

This test was carried out to test the accuracy of marker detection. Researchers scanned a marker measuring 21 x 29.7 cm which was placed on a flat surface at a distance of 10-50 cm from the smartphone camera to the marker. The results of this test are shown in Table 3. Detection speed is based on marker quality, lighting, optimal viewing distance and angle, as well as device specifications and operating system.

4. Conclusion

According to the research conducted, a conclusion can be drawn about the AR application Similarity of Animal and Plant Cell Parts, namely that the application can perform image tracking on target images that have been configured with the Vuforia SDK. It is hoped that this Augmented Reality application will be an optional alternative interactive learning media that will help make it easier for the 2020 Stambuk Biology Department students to explore the similarities between the parts of animal and plant cells and see the 3-dimensional shape of the two cells in detail and virtually. From the results of the black box testing that has been carried out, this application has passed image tracking and is able to display all 3D objects with similarities to parts of animal and plant cells that you want to display and according to the target image that has been configured with the Vuforia SDK. The star calculation is based on the total hypothetical calculation score of the features and quality of the target image, for scores ≥5000 and above you get 5 stars, scores in the 4000s get 4 stars, scores in the 3000s get 3 stars, scores in the 2000s get 2 stars, and scores under 2000 get 1 star. To provide an example of calculating the detection time of a five-star marker by a camera using Vuforia Target Manager, we must consider several aspects that influence this process. For example, we can measure detection speed based on the camera frame rate, frame processing time by the device, and various other factors. In general, with high-quality marker conditions, good lighting, optimal viewing distance and angle, and powerful hardware, five-star marker detection times in Vuforia Target Manager can take anywhere from milliseconds to several seconds.

This research was conducted to produce an Augmented Reality application using image tracking, which is an AR marker based tracking method. The application was created for the purpose of simply being an alternative learning medium for biology students to explore the similarities in parts of animal and plant cells in more detail virtually. It is hoped that future research can develop this AR application with more interactive and complete features in exploring animal and plant cells as well as a broader scope in biology.

References

[1] K. Berpikir, A. Di, And P. Ipa, "Pemanfaatan Augmented Reality Untuk Melatih," Vol. 10, No. 2, Pp. 131–136, 2021, Doi: 10.20961/Inkuiri.V10i2.57256.

[2] I. K. M. Putra, N. L. P. N. S. P. Astawa, And I. P. Satwika, *Media Pembelajaran Berbasis Augmented Reality "Priarmika,"* Vol. 4, No. 2. 2020.

[3] B. Salsabila, A. Akhyar, A. Setiawan, And D. A. Chandra, "Pemanfaatan Augmented Reality (Ar) Sebagai Media Pembelajaran Kelas Vii Smpn 1 Rambah," Vol. 06, No. 01, Pp. 856–863, 2023.

[4] Citra Larasati, (2021). Biologi 6 Persamaan Sel Hewan Dan Sel Tumbuhan,Https://Www.Medcom.Id/Pendidikan/News-Pendidikan/Vnng1z7b-Biologi-6-Persamaan-Sel-Hewan-Dan-Sel-Tumbuhan, Diakses 19 Januari 2024). .

[5] P. Cell, "Interactive Animation Learning Of Animal And," Vol. 16, No. 2, Pp. 175–182, 2021.

[6] P. Studi *Et Al.*, "Pengembangan Media Education Song Berbasis Audiovisual Pada Materi Sel Tumbuhan Dan Sel Hewan Untuk Meningkatkan Minat Belajar Pada Siswa Di Kelas Xi Sma," No. September, 2021.

[7] S. Angga *Et Al.*, "Pembuatan Augmented Reality (Ar) Untuk Pembelajaran Organel Sel Pada Tumbuhan Dan Hewan (Studi Kasus : Sma Negeri 1 Dlingo) Abstraksi Pendahuluan Metode Penelitian Tahapan Penelitian," Vol. 5, No. 1, 2022.

[8] R. Perdana, "Pengembangan Media Pembelajaran Berbasis Augmented Reality (Ar) Pada Materi Sel Skripsi," 2022.

[9] Chen, Y., & Wang, Y. (2021). Augmented Reality Technology In Education: A Comprehensive Review. Journal Of Educational Technology & Society, 24(1), 1-14.

[10] Dörner, R., Cherek, C., Sedlmair, M., & Butz, A. (2021). A Taxonomy Of User Interfaces For Augmented Reality. Acm Transactions On Computer-Human Interaction (Tochi), 28(1), 1-45.

[11] Q. J. Adrian, A. Sucipto, U. T. Indonesia, And K. Bandarlampung, "Penerapan Ar Dalam Media Pembelajaran Klasifikasi Bakteri," Vol. 0417, No. 1, Pp. 10–18, 2021.

[12] G. N. Pardomuan And A. Sulistyowati, "Pengembangan Media Pembelajaran Augmented Reality (Ar) Untuk Pengenalan Musik Modern Jurusan Musik Gereja Stakpn Sentani," Vol. 6, Pp. 9464–9475, 2022.

[13] S. Angga *Et Al.*, "Pembuatan Augmented Reality (Ar) Untuk Pembelajaran Organel Sel Pada Tumbuhan Dan Hewan (Studi Kasus : Sma Negeri 1 Dlingo) Abstraksi Pendahuluan Metode Penelitian Tahapan Penelitian," Vol. 5, No. 1, 2022.

[14] A. Padat, D. I. Rsud, And W. Wiris, "1 1* , 2," Vol. 5, No. 1, Pp. 98–105, 2023.

[15] Salim, Haidir, 2019, Penelitian Pendidikan Metode Pendekatan Dan Jenis, Jakarta, Kencana.

[16] M. F. Harahap Et Al, "Augmented Reality Pengenalan Raja Kesultanan Deli Medan Berbasis Mobile," Vol. 4, Pp. 5771–5780, 2024.