Learning media for human digestive system based on augmented reality

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Abstract. The learning process is an activity that aims to transfer knowledges, including students in junior high school. With the existence of augmented reality-based interactive learning media that enables a more interesting learning process to make students being motivated, excited, and interested in the learning process, especially in humans who use mobile devices. The process of making this application using software Unity 3D is intended for mobile devices with the Android operating system. This medium learning application has features in the form of three dimensional models of every organ in humans and also contains the information about the selected process. Application development in this application is Luther Calculation. With this research, students are expected to be able to consolidate the existing material in three dimensional forms well. And also, reducing the students’ boredom and increasing the students’ learning interest.

Keyword—Android, Unity 3D, Learning Media, Human Digestive System, Augmented Reality

1. Introduction

Augmented Reality (AR) is a technology that adds virtual objects into real environment in real time, so that the boundary between them becomes very thin. Added virtual objects are 2D or 3D objects that are integrated into the real world. AR allows users to view the real environment with virtual objects that added or incorporated. One potential application of AR is currently in the field of learning media or education by utilizing mobile applications.

Mobile-based learning method in biology field is still under development in Indonesia. There are six types of mobile-based learning one of which is Augmented Reality (AR)-based mobile (Adkins, 2014). Seeing the development of mobile Edu-games is increasing, in previous research (NG Weng, 2016) on the application of augmented reality for the topic of Meiosis and Mitosis in Biology subjects in schools, but its application still uses ordinary paper markers and is less interactive, so to complete this research, marker paper is replaced with the images food. In this case, it uses a picture of the pizza printed on the shirt so as if the virtualization of digested food will appear on the wearer’s stomach. The developers begin making AR in Biology field as a simulation in delivering material. In Biology subject, there is a lesson that discusses about human digestive system, it requires students to understand the structure, functions and processes of human digestive system. Giving of materials by using print media such as books will make students more passive at receiving those materials. Printed media which circulating also presents the less clear examples of images that leads to potential misconceptions in to students. Therefore, the learning process becomes less effective and interesting.
In order to improve the effectiveness of understanding the digestive system in humans, it is necessary a mobile application capable of displaying virtual objects into the real world. Therefore, it is necessary to create information to deliver media in the form of a mobile application that can provide additional knowledge about the human digestive system that not only presents reading material, but also presents the interaction to bring more and different experiences to the students.

The objective of this research is the application of Augmented Reality to improve students' perceptions of the materials learning, so that the material presented can be better understood and also avoid potential misconception. The contribution of this research is to facilitate Biology teachers in illustrating the material presented to 8th grade junior high school students in studying the human digestive system, so those students will quickly understand the material of the human digestive system and provide new experiences to students in studying the human digestive system.

Based on that background, the formulation of the problem in this research is how to create a mobile-based teaching media that brings interactivity in delivering material about the digestive system in humans. The scope of this research is applications created for mobile devices with Android operating system, applications intended for 8th grade junior high school students, Augmented Reality features contained in the application of Marker Based Tracking Augmented Reality, Marker (Image) Target is loaded in the form of t-shirts. The Objective of research is interactive teaching app is making interactive augmented reality-based teaching media with visual objects for human digestive system learning media.

2. Research Method
The method used in the research is Luther's multimedia development method (figure 1). This method consists of 6 stages, Concept, Design, Matterial Collecting, Assembly, Testing, Distribution.

![Figure 1. Luther’s multimedia development method.](image)

2.1. Concept
Based on the Luther method, the first step of making interactive learning media is starting with the concept stage. This concept stage begins with the identification of problems through data observation and interviews with one of junior high school teacher in Jakarta. After the primary data of the work is found, then the draft concepts begin to the design process of learning media applications. Concept is the main idea to build this application. The concept is improving students' perceptions of the learning materials by using augmented reality.

2.2. Design
The design of this augmented reality application comes in the second stage of the Luther method. At this stage is the making of storyboard, navigation, and flowchart application.
2.2.1. **Storyboard**
Applications created in the form of augmented reality-based that contain visual objects in the form of 3-dimensional organs of the human digestive system along with an explanation of the function and digestive processes performed by each organ.

2.2.2. **Navigation Structure**
The application navigation structure is created to clarify the user interface design inside the app. The navigation structure used is the hierarchical navigation structure.

2.2.3. **Marker**
The in-app marker is used as a trigger before the occurrence of 3D objects that have been created [2]. Pizza as a picture of the object on the marker is chosen because the research is made offensive about the digestion of food in humans which is certainly related to food and also to the digestion aspect of the t-shirts that are intended not only to be used for applications, but also for daily activities as can be seen in figure 2.

![Figure 2. Marker Implementation on a Tshirt](image)

2.3. **Material Collecting**
The third stage is the material collecting stage. This stage is production process includes the development of asset-making media applications and bringing together all the assets that have been prepared. All of materials asset produced or collected by other sources such as internet. In addition, the material collection process from various sources such as the internet, assets that are not obtained from these sources must be made from 3D modeling to texturing. Modeling is the process of creating object models in 3D in the computer [3]. The process of making 3-dimensional model in human digestive system application is done by using Autodesk Maya 2018.

![Figure 3. Marker Implementation on a Tshirt](image)
After the modeling process is done, the next process is the texturing of the 3D objects, this process is making and giving color and material (texture) on objects that have been modeled before, so it will seem a real impression (figure 3). Giving material or texture on 3D objects will define the appearance and type of material from 3D objects. The process of making texture on the model is done by using UV Editor on virtual.

2.4. Assembly
This stage of developing applications using Unity 3D is a process of merging all the assets that have been created [4]. Based on storyboard, making the application menu on Unity 3D using the function button to be able to move the scene to another scene. The use of the button function to move to another scene is to add a script to be able to move the scene. Script used is SceneLoader script as can be seen in figure 4.

```csharp
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class SceneLoader : MonoBehaviour{

    public void SceneLoad(string name)
    {
        SceneManager.LoadScene(name);
    }

    public void Quit()
    {
        Application.Quit();
    }
}
```

Figure 4. Scene Loader Script

The Load Scene has a function to perform the SceneManager function to move the scene according to the name that is filled in. Therefore, this function is almost used in all scenes within the application

2.5. Testing
The "3Digestive" application test is carried out after completion of the design and finish phases. This stage is the fifth on the Luther method used during the work. Tests conducted to determine whether the learning media applications are running well and correctly in accordance with the expected and in accordance with the concepts that have been made. This test is conducted on the results of the Unity 3D utilization as a supporter of learning media application developers. Testing is doing with 2 stages, alpha testing and beta testing. Alpha testing is a test conducted by an internal team of developers and is done to control the system error and ensure the learning media applications run properly and correctly. If an error is found in the alpha testing stage, it will be done immediately to the error, while the second stage is beta testing is the test conducted by respondents who use this learning media applications that teachers and students. In this test we want to get the influence of the application of augmented reality in learning [5], objects are selected using 3D objects because the use of 3D objects will be more interesting than using 2D objects [6].

2.6. Distribution
After doing alpha testing and beta testing, the next stage is the distribution of products. The distribution of "3Digestive" application product is done by direct application in the form of .apk with shirts containing marker in the form of pizza image.
3. Result and Discussion
3.1. Alpha Testing
At the alpha testing stage, it is testing the game functions to ensure all functions are running correctly in accordance with the concept that has been determined. Testing is done by inviting a user to use the application by team maker. There is only one control object in the application that is the enlargement and reduction of 3D object scale model. After a test with a test scenario on 3D model objects, obtained results (table 1) for the overall buttons on the joystick declared valid and there are no bugs.

| SCENE      | BUTTON    | FUNCTION         | OUTPUT    | RESULT |
|------------|-----------|------------------|-----------|--------|
| Main Menu  | START     | Moving scene     | Scene AR  | Valid  |
|            | INSTRUCTION | Moving scene   | Scene instruction | Valid  |
|            | ABOUT     | Moving scene     | Scene about | Valid  |
|            | EXIT      | Moving scene     | Quit      | Valid  |
| Instruction| All Off instruction | Moving scene | Scene instr2 | Valid  |
|            | All Off instruction | Moving scene | Scene instr3 | Valid  |
|            | All Off instruction | Moving scene | Scene instr4 | Valid  |
|            | All Off instruction | Moving scene | Scene instr5 | Valid  |
|            | All Off instruction | Moving scene | Scene AR    | Valid  |
| About      | About     | Moving scene     | Scene about | Valid  |
|            | All of about Page | Moving scene | Scene menu  | Valid  |
| AR         | Home      | Moving scene     | Scene menu | Valid  |
|            | Info      | Display/Hide Panel | Panel Display/Hide | Valid  |
|            | Esofagus  | Display Objek Name | Name of Object “Esofagus” | Valid  |
|            | stomach   | Display Objek Name | Name of Object “stomach” | Valid  |
|            | Liver      | Menampilkan Nama Objek | Name of Object “Liver” | Valid  |
|            | small intestine | Display Objek Name | Name of Object “small intestine” | Valid  |
|            | colon      | Display Objek Name | Name of Object “Colon” | Valid  |
|            | Anus       | Display Objek Name | Name of Object “Anus” | Valid  |
|            | Bile       | Display Objek Name | Name of Object “Bile” | Valid  |

3.2. Beta Testing
In the beta testing, there are total of 30 respondents. Based on age distribution conducted there are 13 respondents with age 13 years, and there are total 17 respondents at age 14 years, wherein both age (13-14 years) same in 8th grade at SMP N 73 Jakarta. In each statement there are five scales of answers that strongly agree, agree, slightly agree, disagree, and strongly disagree. Then, the results obtained are distributed according to the answers of all respondents, as for the questions to the respondent regarding the conditions of the Start menu button selection, Switching Menu from the Main Menu, Display Menu Layout, Layout of 3D Organ Objects, Display of 3D models of digestive organs, Information displayed on organs, Augmented Reality that attracts learning interest.
Statement of Conditions the selection of the Start menu buttons from the calculation of the percentage of data, the results obtained 30% of the respondents strongly agree, 56.67% agree, 13.33% doubtful, and 0% in the answer disagree and strongly disagree. There are no disagree or strongly disagree answers. This shows that the "3Digestive" application is easy to use.

The statement "Switching menu from the main menu from the calculation of the percentage of data, obtained results 16.67% of the respondents strongly agree, 46.67% agree, 36.67% slightly agree and 0% on the answer do not agree and strongly disagree. This proves the move to the scene scan target image in the "3Digestive" application runs well.

The statement Display Menu Layout from the calculation of the percentage of data, the results obtained 13.33% of the respondents strongly agree, 56.67% agree, 30% slightly agree, and 0% to disagree and strongly disagree. This shows that the lethal menu in the "3Digestive" application can be understood well.

The Statement "The layout of 3D organ objects from the calculation of the percentage of data, the results obtained 15.67% of respondents strongly agree, 60% agree, 23.33% slightly agree, 0% to disagree and 0% strongly disagree. This shows that the placement of 3D objects of human digestive organs is appropriate and easy to understand.

The statement Display of 3D models of digestive organs from the calculation of the percentage of data, the results obtained 20% of respondents strongly agree, 56.67% agree, 23.33% slightly agree, 0% to disagree, and 0% strongly disagree. This shows that users easily see the form of 3D organ models that are in the augmented reality application.

The statement of information displayed from the calculation of the percentage of data, 13.33% of respondents strongly agree, 63.33% agree, 23.33% slightly agree, 0% disagree, and 0% strongly disagree. This shows that the information displayed when the user chooses an organ can be understood well.

4. Conclusion
Developing of interactive learning media applications is successfully done and produce applications that can run on Android-based platform. The resulting application has a visual object feature in the form of 3D models of human digestive organs also contains information on the digestive system that occurs in these organs.

Based on the results of beta testing, the result of applications is from the implementation process of Unity 3D in the making of this application can be concluded from 7 items statement that includes the movement of character controls, the laying of assets, scene shift from scene to scene, which is given when beta testing goes well overall with a total percentage of 71.90% of respondents agreed, and 18.57% stated strongly agree with the implementation of section attached to the statement.

References
[1] Adkins K 2014 Aesthetics, Authenticity and the Spectacle of the Real: How Do We Educate the Visual World We Live in Today? International Journal of Art & Design Education. 33 pp 326–334
[2] Marsono and Mingchang W 2016 I.J. Modern Education and Computer Science Designing A Digital Multimedia Interactive Book for Industrial Metrology Measurement Learning. 5 pp 39-46
[3] Matt B, Cathie H, Nerida M, Austin R and David G 2014 Educational Media International Augmented Reality in education – cases, places and potentials. 51(1) pp 1-15
[4] Weng N G, Bee O Y, Yew L H, Hsia T E 2016 An augmented reality system for biology science education in Malaysia, international journal of innovate computing
[5] MuratAkçayır,GökçeAkçayır,Hüseyin MiraçPektaş,Mehmet AkifOcak 2016 Augmented reality in science laboratories: The effects of augmented reality on university students’ laboratory skills and attitudes toward science laboratories, Computers in Human Behavior. 57 pp 334-342
[6] Hsin H L, Stephen J H Y, Sherry Y C and Wernhuar T 2017 Journal of Educational Technology & Society The Influences of the 2D Image-Based Augmented Reality and Virtual Reality on Student Learning. 20(3) pp 110-121