Heart Disease Simulation with Mixed Reality Technology

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Abstract. Heart disease is one of the leading causes of death in the world. Various types of heart disease include Coronary Heart Disease, Arrhythmias, Heart Failure, Heart Valves and Heart Muscle. The Ministry of Health of the Republic of Indonesia calls on the public to be smarter in responding to the terror of heart disease. One of them through the introduction and early prevention of heart disease. As time has evolved, technology has become part of society. One of the things that can be done to prevent and recognize heart disease is to utilize the use of Mixed Reality technology as a medium for learning and learning. The use of Mixed Reality technology used is a device from Microsoft is namely Hololens. By using this tool, the developer can build applications to display 3D objects and their interactions. To interact, hololens use a targetting mechanism based on the view from the user’s side, a circular viewfinder as a cursor that can be directed with head movements and 2 gestures namely airtap and bloom by the user directing the hand forward until the sensor is detected from Hololens. In this case, the researchers visualize the type of heart disease in 3D and interact by applying hand gestures or voice input as interactions.

1. Introduction
Heart disease or in medical terms is called cardiovascular is a condition that occurs when the main blood vessels that supply blood to the heart (coronary arteries) are damaged [1]. The other heart disease is hypertensive heart disease which one of cardiovascular disease. The most of causes of this disease is obesity. As we known, the obesity is there is an excessive lipid or fat accumulation in human body that risky to cardiovascular disease (CVD) and hypertension which make the function and structure in cardiac through significance changing. Therefore, need some measurement to ensure whether human have obesity or not, one of the measurement is determine body mass index grade for people [2]. The hear disease is the number one cause of death in the world. In Indonesia there has been a shift in the occurrence of heart and blood vessel disease from the ninth rank of 1980 to the eighth order in 1986 [3]. In the research [4] revealed the cause of death remained on third position. Various types of heart disease include coronary Heart Disease, Arrhythmias, Heart Failure, Heart Valves and Heart Muscle. With this, through his web-site posted in 2017. The Ministry of Health of the Republic of Indonesia calls on the public to be smarter in responding to the terror of heart disease in the future, one of which is through early recognition and prevention of heart disease, which is expected to be able to help the community to be more vigilant.
As time has evolved, technology has become part of society. One thing that can be done to prevent and recognize heart disease is to utilize the use of technology as a medium of recognition and learning. Learning media can be in the form of heart disease simulation based on the type of disease using Mixed Reality technology. Mixed Reality is a technology that combines cyberspace and real world into a space. Mixed Reality technology itself is able to transfer all virtual objects generated into the real world so that users can interact directly with these objects [5].

In this research, the implementation of Mixed Reality technology in heart disease simulation is applied using Microsoft Hololens. Microsoft Hololens is the first Holographic computer that is run using Windows 10 Operating System that is not dependent on other devices, with Hololens users can actually recognize holographic objects. Users will be able to see a real simulation of the condition of the heart in 3D based on the type of disease and can interact directly.

2. Literature Review
Heart disease is one of the deadliest diseases in the world. The Ministry of Health as the government department that cares about public health urges the public to be more familiar with and prevent heart disease. Meanwhile, so far students and the public can only recognize the types of heart disease from the world of education as well as basic explanations from several people who are experts in their fields. Rather than that, Mixed Reality is promoted to be able to present an interesting picture of information. So that people and students can get to know and learn much more interestingly about heart disease based on the type of heart disease.

In 2017, Juannita [6] conducted research on Human Digestive System Learning for Junior High School students with Android-Based Augmented Reality Features. Where this research utilizes AR to display 3D objects of the organs of the human digestive system and videos of how the digestive system works in the human digestive system learning media application so that it can clarify the material of the human digestive system. In the same year, Jayaputra A. Conducted research on Learning Human Sense of Vision Using Hologram Technology [7]. This research implements Mixed Reality technology using the Hologram technique for a more real interaction on human sight sense objects.

3. Methodology
This research perform several process as shown as Figure 1, which described as follows:
3.1 Input
The user is connected to the application using Microsoft Hololens, Hololens will show the main menu. In this case the user can provide input in the form of interactions such as Hand Gestures, such as airtaps or touches in the air in the form of finger movements or pinching the index finger and thumb. Nor Voice or voice that is a verbal command through the device.

3.2 Process
a. Asset
In process stage, the assets is used to process and model in the form of 3D Heart as an object. While, 2D which will be used as a background, audio heartbeat and also animation which depicted inside of the heart in order to generate the 3D model more real. Then, the assets will be imported to Unity.

b. Unity
This process is needed to make the application running on Hololens properly. This is done to import the default toolkit that has been provided specifically for mixed reality, namely MRTK (Mixed Reality Toolkit). Meanwhile for the kit, there is a scripts that can utilize hololens to recognize input as form of hand gestures and script for voice commands to recognize the environment around hololens.

**Figure 1. General Architecture**
c. **Visual Studio**
After the application creation is complete, then the application will be built with the Universal Windows Platform platform. And generate solution files to be opened in Microsoft Visual Studio. It takes about 15 - 20 minutes to build the application to the Hololens.

d. **Asset**
Next, imported assets will be prepared and modeled by adding commands and scripts to be able to move according to commands in the form of airtap or voice.

e. **Audio Recognition**
Audio Recognition is the detection of sound as input which is used by calling two important components of MixedRealityToolkit-Unity-Master, namely SpeechInputSource.cs which is a script to determine the detected sound and SpeechInputHandler.cs as executing voice commands.

f. **Labelling**
At this stage, each part of the 3D object is labelled according to information data that has been received using GameObject on unity, namely 3D Text. The labeling itself will display the functions of each section.

### 3.3 Output
This stage is the final stage in the form of an output interface that is displayed on the screen where the user can see the appearance of the model that has been made and interacts in the form of hand gestures and voice input on the Hololens device.

#### 4. Result and discussion
Implementation of application animations built using Unity 3D software using the C# programming language. The author chose Unity 3D because Unity has good integrity with Hololens such as a special library for Hololens called Mixed Reality Toolkit-Unity-Master.

##### 4.1 Main Menu Scene Display
This menu is the display that will appear after the Splash Screen from Unity. In this section, there are five main buttons to interact with application using airtap or voice commands. By considering the condition such as form of Heart for Normal Heart button, Ventricular for Ventricular Septal Defect, Mitral Valve for Mitral Valve Prolapse, Help for Help button, and Exit for Exit button. Main menu scene can be seen in Figure 2.

![Figure 2. Main menu scene display](image-url)
Each button has a command. If you press the Heart button, the user will be directed to the next scene which is the Heart scene. Likewise with the other button, if you press the Help button, the user will be directed to the Help panel. Help scene can be seen in Figure 3.

![Help scene display](image)

**Figure 3. Help scene display**

The Help function is to describe the application and explain how to use the application for user. Both the use of buttons, airtap and voice interaction. The last button is Exit, the function is to quit the application.

4.2 Normal Heart Display  
This normal heart display is an advanced panel of the main scene after the user presses the Normal Heart button. In the first view, the heart panel will display a 3D animation of the heart in perfect or complete condition. Normal heart animation can be seen in Figure 4.

![Normal heart animation display](image)

**Figure 4. Normal heart animation display**

Then the user can interact with the heart animation with the airtap or voice command to rotate or rotate the heart to the right or left, so that the user can see the entire heart. The rotation animation can be seen in Figure 5 and Figure 6.
In order to see the inside of a normal heart, the user only needs to do one airtap on a whole heart animation. In this panel, the heart will appear in a split state and display an animation of the inside of the normal heart and the direction of blood flowing in and out. This scene can be seen in Figure 7.

Users can also do voice input in the form of Labels to display labels on each part of the heart. In addition, in this panel, there is a Description button to display the panel description that serves to explain things related to normal heart. Back button to return to the main menu and the Minimize button to hide the description panel that has been opened. The heart labels and description can be seen in Figure 8 and Figure 9.
In position of the heart with a label, the user can also airtap on one of the labels to see the function of each part of the heart listed. This scene can be seen in Figure 10.

To close the panel on the description labels, users can airtap the back icon on the top right of the label description panel. The display will return to the inner model of the heart. After completing with the normal heart panel, the user can see the heart in other types, by pressing the back button or giving a
voice command in the form of Back. The user will be directed back to the Main Scene, and for each panel of other types of heart disease, have a button with the same command on the normal heart panel.

4.3 Testing
After all stages carried out on the system, then the application testing will be carried out. This application testing aims to determine whether the application is made to work well. Testing this application is done using blackbox testing techniques, namely testing the application interface without seeing coding.

This test allows software engineering to obtain a set of input conditions that are fully functional all requirements for a program. Based on the results of black box testing that has been done, it can be concluded that the process is still possible for errors to occur, but functionally the system can already produce the expected output.

Based on testing that has been done, it can be concluded that the display of application of Heart Disease Simulation using Mixed Reality Technology is understand to use. Also, the appearance of objects and interactions carried out went quite well. The testing of this application is carried out to the public and experts in the field of cardiac anatomy. Tests carried out with reference to the results of the questionnaire distributed and graphs of test results are as follows.

| Strongly Disagree | Disagree | Agree | Strongly Agree |

The results of the overall assessment are:

\[ P(S) = \frac{534}{630} \times 100\% = 84.7\% \]

5. Conclusion
Based on the testing of the system implementation we found some conclusions:
1. This study success to display 3D model of Normal Heart, Ventricular Septal Defect and Mitral Valve Prolaps which accompanied by detailed information such as description, label and animation of blood flow for each type of heart.
2. Time is needed to build and generate scene is about 10 second which is effected by device performance.
3. The application is good at receiving by using voice input or commands from user. However, good spellings need attention to avoid mistakes in detecting animated commands.
4. The 3D objects able to integrate with the real world by showing animated movements of the heart's flow.

Acknowledgment
The authors gratefully acknowledge that the present research is supported by Kementerian Riset dan Teknologi / Badan Riset dan Inovasi Nasional Republik Indonesia. The support is under the research grant Deputi Penguatan Riset dan Pengembangan Kementrian Riset dan Teknologi / Badan Riset dan Inovasi Nasional Republik Indonesia scheme Penelitian Terapan Unggulan Perguruan Tinggi 2020 Contract Number 136/UN5.2.3.1/PPM/KP-DPRP/2020.
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