Maritime Safety Education with Augmented Reality (AR) Technology (Case study: Introduction of Ship Safety Plan)

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Abstract—Augmented Reality is a technology that can combine 2-dimension or 3-dimension virtual objects to be added to the real environment and combine them so that they can create mixed realities and project them into real-time. Augmented Reality is a field in which virtual objects are integrated into a real environment in real-time. This technology-based on the android application is applied to facilitate education media and inspection for life-saving appliances on board. All life-saving appliances can be displayed alongside the information and the location of the object. Utilizing AR is possible to be used as educational media to get precise information relating to the locations, objects, and quantity. Therefore, by becoming visible, it is possible to increase the sense of realism and immersion of this technology.

1. Introduction

In general ship arrangements, in some technical considerations, one must pay attention to safety. The safety plan arrangement on a ship is part of the initial stages in planning the construction of a ship, which must meet safety aspects. The safety aspect is very supportive in an emergency while the completeness of the safety aspect includes evacuation equipment, evacuation routes, and various other safety aspects. This information is usually found in the safety plan arrangement. Safety plan arrangements are all general guidelines of the ship relating to the safety instrument information available on the ship. Safety equipment must be available onboard by SOLAS 2004 [3]. Safety plan arrangements are one of the plans of safety equipment already regulated by SOLAS (Safety of Life at Sea). That appliance is safety in learning shipbuilding material, students must understand the shipbuilding process in detail. To understand in detail requires a visual learning pattern that is direct observation of the object of the ship. It is also not easy in practice, because it must go through various permits to the company concerned, the availability of time, and various other aspects. Technology and information are needed to help complete aspects that are difficult to reach so that the learning process can continue to run efficiently and interactively equipment. There is some symbol that has a function as information about safety equipment and the location of the deck.

Learning with multimedia methods is a favorite of most students because it can hone interactive skills by users, one of them with the help of a smartphone as a learning resource. Understanding multimedia, as the integration of more than one media in communicating or combining various media in a computer system. Interactive learning media is an effective computer-based communication system that can create, store, present, and access information again in the form of text, graphics, sound, video, or animation [7]. There are many benefits to learning from using visual media tools to explore the
emotional honesty of individuals, creating effective communication, and providing flexibility in learning activities. The level of popularity of cellular technology is at a constant level and continues to increase in demand. Mobile devices are increasingly showing their use in daily activities, to help facilitate various jobs and can be used as a medium of entertainment. The use of cellular technology as an educational medium expands opportunities for students to be able to improve their learning [6]. Technology smartphones and tablets open up new opportunities for interaction and with the evolution of technology, there are emerging devices with high computing capabilities [7]. As a result, interest in implementing the Augmented Reality (AR) application on cellular systems has increased significantly.

In general, Augmented Reality (AR) is a combination of virtual objects with real objects. For example, it is when a television station, broadcasts a soccer match, is held a virtual object, about the score of an ongoing match. With the help of Augmented Reality technology, the real environment around us will be able to interact in digital (virtual) form. Information about objects and the environment around us can be added to the Augmented Reality system which then displays the information above the real world layer in real-time as if the information is real [2]. Augmented Reality is a combination of the real and virtual world, is interactive in real-time, and is a 3D animation. Augmented reality (AR) aims to take the real world as a basis by combining several virtual technologies and adding contextual data so that human understanding as its users becomes clearer [4][5][9]. AR is a way to improve the quality of the real world and that can be achieved by adding virtual objects above the real world. The biggest advantage of augmented reality is the cost of purchase or zero because it uses conventional hardware that is used in many cases. This contextual data can be in the form of audio commentary, location data, historical context, or in other forms There are several types of tracking that can be used in Augmented Reality: 1. Marker-based tracking: marker-based tracking is an AR method that uses markers to bring up virtual objects. 2. Marker-less: using the marker-less method the user does not need a marker to display virtual objects [1].

With the help of Augmented Reality technology, the real environment around us will be able to interact in digital (virtual) form. The function of augmented reality (AR) is to improve one's perception of the world around them and make a part of the virtual and real world a new interface capable of displaying relevant information that is very helpful in education, training, repair, or maintenance [4][5][8][7]. The potential contained in AR is growing rapidly at the beginning of the millennium era and this is very beneficial for educational media and scientists have further researched for the development of AR to come. Since then, many variations and approaches have been taken in the design of AR used for pedagogical purposes and the need for an overview of what has been learned in the field. This system is very easy and safe to operate by users because it integrates reality with virtual elements. That happens because the movements occur naturally, are easy to learn, and can be as simple as moving a body part or object. Augmented Reality can be useful in any application that needs to display information that is not available or cannot be detected directly by the human senses [10][11][12][13][14][15]. Therefore, by being seen, it is possible to increase the sense of realism and immersion in this technology.

2. Method
2.1. Methodology Flowchart

The method used in this research can be describe in the Figure 1:

2.2. Identification of problem

Identification of the problem is the first step to determine the concern of the research by identifying why the research is done and what the benefits of the research are. In this case, the problem is started because of the needs of advanced educational media to understand the safety plan arrangement With the growth of information and technology, then the research will offer a solution to overcome the problems by developing an augmented reality application for the educational media. There are various problems that will occur in this research process, including In the survey process, there was a problem with the position
of the Meratus Benoa ship, whose position was not necessarily in the port of Tanjung Perak Surabaya. In the Design process constrained by safety equipment on board and 3D design products in augmented reality are not in accordance with expectations.

2.3. Data Collecting

Data collecting is a step to gather the data needs for the application development such as the safety plan arrangement list, and the equipment location on board. It is done by doing a visual survey to one of Meratus Line’s ships which is MV. Meratus Benoa in Tanjung Perak Port. From this activity, it will obtain the required data.

2.4. AR Object Modeling

The object modeling is a step to design of safety plan arrangement 3D model that consists of a ship model, safety plan arrangement, etc. It is done by analyzing the data obtained from the survey that has been conducted.

2.5. Methodology

![Methodology Diagram]

Figure 1. Methodology

2.6. Data Flow Chart

![Data Flow Chart]

Figure 2. (A) A Deck, (B) B Deck, (C) Upper F’Castle Deck, (D) Lower F’Castle Deck
By comparing and sorting the data, then will be obtained the final 3D model of ship’s decks, and safety plan arrangement along with the location and its information. The 3D model will be drawn in Blender which is a free and open-source 3D computer graphics software used for creating 3D models, visual effects, 3D interactive application, etc. Figure 3 is the visualized from blender software that makes a 2D model from a safety plan into a 3D model. The model will be finalized as close as the actual object. After the final 3D rendered, the model will be added to the Unity which is also a free and open-source cross-platform game engine software. The independent object that has been made in Blender such as the ship decks and safety plan arrangement will be put together.

2.5. Application Development

Application Development is the step after the modeling is complete which will later be included in the Android application. The supporting tools used in developing the application are Vuforia SDK (Software Development Kit) as the additional script to be used as the augmented reality plugin.

2.6. Trial

To ensure that the Augmented Reality of ship safety plan is applicable, the trial of application shall be conducted. The trial is a step to run a trial for the functionality check of the application to make it sure that the application can perform its functionality.

It is done when the early version of the application has been made to check any possibilities of bugs or errors. And perform a final check when the final version of the application has been made to ensure the application runs smoothly without any errors when it will be released later

3. Results and Discussion

The result of study shows in Figures 3-6. Figure 3 (A)(B)(C)(D) shows the example of conversions of real of object of equipment to 3D modelling, utilizing blender. All safety components are converted to 3D Modelling, therefore; it is possible to fit with Unity software. Besides a general arrangement of ship is converted in 3D Modelling, therefore; two dimensions of ship can be seen similar with the real condition as shown in Figure 4. In addition, view of front display is created in blender software as shown in Figure 5.

The end result of augmented reality of safety plan is basically as shown in Figure 6. Figure 6(A) is front display of AR of Safety Plan. There are three features consisting start, how to use and about. Figure 6(B)(C) and (D) are the result of utilizing AR for ship safety plan. By touching one of safety plan components, it is possible to see the description of component as shown in Figure 6(D). This figure shows the description of life raft. By utilizing AR application, it is possible to know the safety component on ship.

Application testing is performed to find out the application functionality on several Android devices. The application tested on 3 devices with different specifications and operating system versions. The list of devices can be seen in the Table 1. The aspects tested are consisting of functionality, accuracy, menu and button features.

Based on the Table 2, all devices passed the test in every testing component. It supports different operating system version, screen resolution, and RAM availability of the device. The main feature of the application which is the augmented reality model also can visualize the 4 different decks of ship smoothly without any error or bugs found.

In the testing period, the application was also tested on several 15 students as the user. There are some suggestions obtained from the users for the application that will be shown in Table 3. The scale of
score is from 1 to 10. The lowest score is 1 and the highest score is 10. The result of questionnaires is indicating that AR of safety plan is very good enough (9.1 score) for education media.

Table 1. Table of tested devices

| No. | Specification |
|-----|---------------|
| 1   | Device Name: Xiaomi A6  
     | OS Version: Android 8.0.0 (Oreo)  
     | RAM: 4 GB  
     | Screen Resolution: 6.0”, 1440x2880 pixels |
| 2   | Device Name: Oppo F15  
     | OS Version: Android 9.0 (Pie)  
     | RAM: 3 GB  
     | Screen Resolution: 5.15”, 1080x1920 pixels |
| 3   | Device Name: Xperia Xz  
     | OS Version: Android 9.0 (Pie)  
     | RAM: 4 GB  
     | Screen Resolution: 6.0”, 1080x2220 pixels |

Figure 3. (A) Life Buoy 3D model, (B) Embarcation Ladder 3D model, (C) Line Throwing 3D Model, (D) Life Jacket 3D Model
Figure 4. (A) 3D of ship deck, (B) 3D of Lower F’castle Deck, (C) 3D of A Deck

Figure 5. (A) Creating About Display, (B) Creating Main Display

Figure 6. (A) Main Display, (B) Scanner Display,
Figure 6. (C) LSA Deck Information Display, (D) LSA Description Display, (E) How To Use Display, (F) About Display

Table 2. Test result

| No. | Testing Component                  | Test Device Result |
|-----|------------------------------------|--------------------|
|     |                                    | Xiaomi A6 | OPPO F15 | Xperia Xz |
| 1   | Run the Application                | ✓         | ✓        | ✓        |
| 2   | Open “Start” Menu                  | ✓         | ✓        | ✓        |
| 3   | Open “How to Use” Menu             | ✓         | ✓        | ✓        |
| 4   | Open “About” Menu                  | ✓         | ✓        | ✓        |
| 5   | Scan Markers                       | ✓         | ✓        | ✓        |
| 6   | Zoom and Rotate 3D Model           | ✓         | ✓        | ✓        |
| 7   | Open life saving Equipment Pop-Up  | ✓         | ✓        | ✓        |
| 8   | Open Equipment Information List    | ✓         | ✓        | ✓        |
Table 3. The results of questionnaires responses

| No. | Question                                                        | Score Average |
|-----|----------------------------------------------------------------|---------------|
| 1   | Does the application look attractive?                          | 8.8           |
| 2   | Does the application easy to operate?                          | 9.1           |
| 3   | Is the marker be detected properly?                           | 8.8           |
| 4   | Does it help learning about life saving appliances ?            | 9.1           |
| 5   | Does it increase interest in learning ?                         | 9.9           |
|     | **Score of all criteria**                                     | **9.1**       |

4. Conclusion

Based on the result, the conclusion from this research are:

1. Augmented Reality (AR) application can visualize the Safety plan 3D models of MV. Meratus Benoa on four decks.
2. All life-saving appliances can be displayed alongside the information and the location of the object.
3. Utilizing AR is possible to be used as educational media to get precise information relating to the locations, objects, and quantity.

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