Utilization of Augmented Reality for Introduction of a Ship Ballast System

Trika Pitana¹, Muhammad Badruz Zaman², Hari Prastowo², Dwi Priyanta², Nurhadi Siswantoro², Muhammad Dzulfiqar Zakarias²

¹²Institut Teknologi Sepuluh Nopember, Faculty of Marine Technology, Marine Engineering Department

¹trika@its.ac.id

Abstract. In the field of education, virtual reality has major advantages for the transfer of knowledge faster than conventional approaches and allows businesses to provide their workers with an efficient training program. By offering step-by-step guidance to create particular tasks, the Augmented Reality technology will assist during the training process. The knowledge in the AR application is made omnipresent, allowing the worker to be able to obtain the instructions with less effort, understandable and effective, avoiding the faults in the operation of the real ballast system. The process begins by evaluating the current components of the ballast system to understand how to incorporate augmented reality technology to boost the performance of the process. The ballast system is then made into a 3D model, including the proportional dimension and exact position of each part of the ballast system as mounted, and the potential real-world scenario. The outcome of this work is called the application of Ballast Component AR. A testing process is carried out to determine whether the application of augmented reality is prepared for implementation and preliminarily checked during the development stage. The AR framework is fully run and checked by the use of Android smartphones or tablets in the process. To evaluate input from users of the AR application, a questionnaire is used with defined parameters regarding the performance and the usefulness of the application.

1. Introduction

The application in the computing field is one of the latest technical advances that can be applicable to the maritime industry. The advantages based on the application are not limited to promotion, development design for introduction, education and maintenance assistance for marine surveys. The maritime industry will still benefit[1][2]. The application in the computing field is one of the latest technical advances that can be applicable to the maritime industry. The advantages based on the application are not limited to promotion, development design for introduction, education and maintenance assistance for marine surveys. The maritime industry will still benefit from the use of computer technologies such as 3D modelling, animation, virtual reality, augmented reality and computer vision.

In the last decade, the popularity of Augmented Reality (AR) technology has grown in many sectors of use, including the marine industry. Most industries are now looking for a new way of improving organizational efficiency and supplying customers with added value. In the field of education, augmented reality has huge benefits for the transmission of information quicker than traditional
approaches[2][3][4][5]. In addition, AR give alternative way of learning method, which is more interactive, knowledgeable and understandable[6][7].

AR is a device that benefits people to communicate with a virtual state that cannot be defined by the physical environment[6]. AR allows people to perceive or experience the feeling of being in a fictional world from a program that is replicated by a computer. The new advancement in AR today is artificial intelligence on the desktop. Desktop augmented reality desktops are often known by other names such as Window on Planet (WoW) or non-virtual reality. This non-immersive use of augmented reality is much cheaper and produces breakthroughs in the field of training and industrial growth. Augmented reality technologies have the ability to be revealed to the public and can be used in education where computer-based virtual learning environments (VLEs) are presented as augmented reality mobile devices.

Its tools that use to learn are typically restricted to document, pictures and videos. These requirements restrict the ability of students to know the exact shape or structure of a device on board. Via a simulated learning experience created by virtual reality technologies, students can find out how the system's initial state is, without having to visit directly to see the actual situations. Augmented reality technologies offer accessibility by connectivity to education wherever and at any time.

2. Methodology
A study started from data collecting, analysis phase, object creation, trial phases and improvement of AR application. Explanation of every steps of methodology is as follows:

2.1. Data Collecting
Data collection is the data retrieval process that can be used as a guideline while creating a augmented reality program. The data is collected from the shipping company to understand the real component of ballast system. The details taken apply to the components of the ballast structure and should be integrated in accordance with the rules laid down in the classification.

The data ballast system augmented reality application consist of:

a. Ship particular, a document that contains information relating to the ship include length, width, draft, equipment installed, as well as various tanks,
b. General arrangement, a drawing which consist of various rooms inside the ship and several views of the ship,
c. Engine room layout, a drawing of the ship’s engine room that can be used to find out the various components inside,
d. Visual data, data obtained during a visit or survey directly to the ship. The purpose of visual data is to match the ballast system components listed in the drawing with the actual conditions,
e. Brochure, a component brochure that contains details of shapes and sizes. Brochures are needed as a complement to visual data so that the components being modeled are as actual as the actual components.

From the information received, 3D modeling can be done for each object that is then put together in an augmented reality program. Every data will compliment each other in such a way that the augmented reality program representing the ballast structure on board will be rendered intact and proportionate.

2.2. Analysis Phase
The research process starts with the description of each object that needs to be generated in the augmented reality application, based on the data taken at the previous point. The outcomes of this step are references to construct an application and to create objects in an augmented reality application.
2.3. **Object Creation**

The development process of artifacts is the key phase of the augmented reality device. Requirements for such properties must be cleared from the review process. Things that have been developed in an augmented reality program must be checked as quickly as possible to figure out whether or not there are deficiencies.

While using the application to construct a 3D model, Simulated objects are constructed and generated as similar as possible to the actual object as seen in Figure 2. These objects can become an input to the Unity augmented reality application.

2.4. **Trial Phase**

The application process is conducted after the development of the object or the program itself. At this point, a completed application will be reviewed and tested by a minimum of 40 respondents to decide if the application is functioning properly and in compliance with the intent of the application, which is for the education of the ballast system component.

2.5. **Acceptance**

This step decides if the submission has been rendered in line with the requirements of the customer. At this point, the user evaluation questionnaire, which was completed by the respondents, will be evaluated to decide the importance of this application. If the values obtained are as planned, the analysis will continue to the next step, which can lead to conclusions.

3. **Results and Discussions**

The ship that was used in application as a framework is MV. Meratus Benoa is available as an item that can be surveyed to collect the necessary details. MV. Meratus Benoa is a container ship operated by PT. Meratus Line which is used for freight transport on the Surabaya-Semarang-Dumai route.

At this stage there are three objects that being modeled namely, room, components, and piping. The first 3D object modeled is rooms because the room is a place where components and piping will reside. Then, each component of the system is modeled as actual as possible as shown in Fig. 1. The last 3D object modeled is a piping because it had to first put the components in the room. At this point, there are three objects that are being modeled, namely space, components, and pipes. The first modeled 3D object is space since the room is the location where the components and pipes exist. Each part of the device is then modeled as real as possible. The last 3D object to be modeled is a piping since the elements had to be positioned in the space first.

The last step in the development of 3D objects is the 3D development of the ballast structure pipes. Piping modeling is carried out at the last stage since the room and the object are required until they are attached to the pipes and fitted with their accessories. This stage starts by positioning 3D components that have been designed according to the ship drawing in their place. Next is to draw a pipeline that connects to each portion. Several accessories, such as valves and strainers, are also mounted in the pipeline.

After modeling all 3D objects, the next step is to construct the application. The program is designed with Harmony. Unit is a 3D-based game maker program with a free navigation system.
Figure 1. (a) Real object (b) 3D model

Figure 2. (a) Main menu interface (b) Ballast pump marker (c) Ballast pipe marker (d) Ballast tank marker
The primary objective of this application is to research the method of ballast on board. Therefore, the components seen are the components of the ballast system. The component of the ballast system has its own explanation provide the user with details. By using Integration, a description and details will be given to each component of the ballast system. Scenarios and user interfaces can also be generated using Unity.

To run the application, it required to access menu interface as well as the marker as shows in Fig. (a)(b)(c) and (d). The one of marker as shown in Fig. (b)(c) and (d) is required to be scanned by mobile phone and then the result of AR will be shows as Fig. 3 (a)(b) and (c), depending on the chosen marker.

As shown Fig.3 (a)(b) and (c), The user can explore the ship and finding the explanation about ballast system components by interacting with the objects. After the application is completely built, it needs to be tested to determine whether there are errors or deficiencies. In addition, this application also needs to be tested to determine whether the main purpose of this application, which is the application can be used as a learning media of ballast system, is fulfilled. If indeed at this stage it is found that the purpose of the application is not achieved or there are errors or other disturbances, then the application needs to be fixed.

Table 1 Questionnaire Results

| Question No. | Percentage Value | Total Score |
|--------------|------------------|-------------|
| 1            | 95%              | 190         |
| 2            | 73%              | 146         |
| 3            | 63%              | 126         |
| 4            | 76%              | 152         |
| 5            | 74%              | 148         |
| 6            | 73%              | 145         |
| **Total Score** |                  | **907**     |
| **Total Average Score** |            | **76%**     |

Figure 3. Result of AR application (a) Pump (b) Ballast System (c) Ballast Tank
As a form of trial, the application will be run by 40 respondents, which are 38 students and 2 lectures from Marine Engineering Departments. After running the application, each respondent will fill in a questionnaire as a form of input to improve or develop the application to be more suitable for user. During trial of the application, user runs the application by using their smartphones. This will provide information whether the application is compatible with various types of smartphones. But due to the type of the application is APK (Android Package Kit), the application can only be run using android based smartphones.

The user assessment questionnaire consists of six (6) questions. Each respondent gives a value for each question from one (1) to five (5) with the value of one (1) is the lowest value and the value of five (5) is the highest value. With the result explained in Table 1, the questions are:

1. Is the AR display easy to understand?
2. Is learning using AR technology like this more interesting, more helpful and easier to understand?
3. Does the 3D ballast component object model represent the original shape on the ship?
4. Can learning using AR deliver material better when compared to learning through theory?
5. Can the learning using AR adequately describe the situation as learning directly on board?
6. If you are a surveyor trainee / marine student / other practitioner, is this AR application very helpful for learning purposes about ballast components?

Table 1 explains the overall score of the application based on the questionnaires. The highest score is 190 out of 200 in question number 1, which means AR ballast system component is easy to understand as a support in application ballast system component. The lowest score is 126 out of 200 in question number 3, which means AR ballast system are motivating to make a more detail design about the components. However, this only applies to users with maritime scientific background especially marine engineering. However, the total score of user assessment questionnaire is 907 out of 1200.

To evaluate the overall results of the questionnaire, there are several values that need to be determined first. Those value are:

1. The maximum value, by multiplying the largest answer value by the total questions and multiplied by the total respondents
   
   \[5 \times 40 \times 40 = 1200\]

2. The minimum value, by multiplying the smallest answer value by the total questions and multiplied by the total respondents
   
   \[1 \times 6 \times 40 = 240\]

3. The median (Q2), by adding the maximum value with the minimum value and divided by two.
   
   \[((500+100))/2 = 720\]

4. The first quartile (Q1), by adding the minimum value with the median value and divided by two.
   
   \[((100 +300))/2 = 480\]

5. The third quartile (Q3), by adding the maximum value with the median value and divided by two.
   
   \[((500+300))/2 = 960\]

The application will be categorized based on the value of the maximum value, Q3, Q2, Q1, and the minimum value. Score in the range of Q3 and the maximum value will be categorized as excellent (400-500), score in the range of Q2 and Q3 will be categorized as good (300-400), score in the range of Q1 and Q2 be categorized as enough (200-300), and score in the range of the minimum value and Q1 will be categorized as bad (100-200). Based on the results of the user assessment questionnaire, consisting of 6 questions with 40 respondents, can be concluded that AR ballast system components application is good because the total value is 907 which is between the range of median value and the Q3 (720-960).
4. CONCLUSION
Based on the objective of the research, can be concluded that AR Ballast System Component application is able to simulate the condition of ballast system on board by modeling the actual components into 3D object and used with an augmented reality maker application so that the application is able to be used as a supporting device in ballast system learning. Moreover, based on the results of the user assessment questionnaire, consisting of 6 questions with 40 respondents, this application is in the good category because it has total value of 907, which is between 907 and 1200 (maximum), which is an good category. However, further improvements need to be made for better resolution and descriptions of 3D models. Not just that, the use of augmented reality needs to be improved in order to get more functionality on board, such as inspection testing, survey simulation and understanding of other systems.

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