21ST CENTURY TEACHING AID FOR MARINE ENGINEERING USING AUGMENTED REALITY

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ABSTRACT

The maritime industry is the backbone of globalization that has driven the country's economy. The sector plays a vital role in ensuring the economy is stable for its sustainability. A slight change may have a significant impact. The sustainability of the maritime industry depends on the quality and competence of the workforce. Maritime education and training (MET) are the catalyst to achieve competent and skillful workforce. The MET delivery method combines classroom education, industrial training, and services at onboard ship practice. Students use simulator technology to practice and improve their skills before working onboard a ship or in a real work setting. However, the simulation's accuracy compared to real-world experience is limited due to the oversimplification of maritime structures and processes. The emerging of advanced technology such as immersive technology provides a new way of learning in various fields. This study focuses on developing an image target augmented reality model in marine engineering as a teaching aid module.

Keywords: Teaching aids, Marine Education and Training, Augmented Reality

1.   INTRODUCTION

Education is necessary for humankind. With education, human can increase their self -value and build civilisation. Many specialists, like psychologists, designers, educationalists, and professors, work hard to enhance and improve the education quality for the future generation. Teachers play a significant role in conveying the resources and knowledge to the student. The teaching method and the way the knowledge is delivered are essential. A teaching aid is a tool used by educators to improve classroom instructions and help learners improve and illustrate their learning skills like reading, facts, and ideas, besides relieving anxiety and fears. The common characteristic of teaching aid is mediums that promote sensory engagement and stimulation. Teaching aid can be classified into two types. An example of the first classification system is non-electronic (chalkboards and books) and electronic (PowerPoint, videos, AR, VR, and MR). One of the leading and advancing teaching aids is Augmented Reality. Augmented Reality (AR) is a technology that projects computer-generated augmentations on top of reality [1]. It helps us perform tasks better and more efficiently.

AR bridges the gap between reality and world data and presents it intuitively so that virtual elements resemble current reality. Augmented Reality is the catalyst of Marine Education and training rejuvenation. MET is an educational system that emphasises the relationship between human and the sea and its importance [2]. Traditionally, it focuses on producing seafarers who work on merchant ships. New perspectives will bring cutting -edge knowledge in maritime operation and management, maritime security, maritime finance, maritime archaeology, marine biology, maritime law. This transformation is caused by the demand for the maritime industry associated with global needs. According to Koji Sekimzu, the past

Secretary-General of IMO, mentioned that Marine Education and training is the catalyst to strengthen and sustain the Maritime Industries. Attractive ways of learning should be implemented in marine education and training. Thus, the objective of this study is to study AR application in marine engineering about augmented reality technology has been used in maritime education and training and its effect. Secondly, to develop the Augmented Reality model in marine engineering for marine teaching purposes. This project's augmented reality model is a marker-based and marker-less type of augmented reality. Third, to put augmented reality modelling to the test concerning a specific subject in marine engineering. Students participated in a demonstration to provide feedback on the project. This project exhibited the necessity of augmented reality as a teaching aid in marine education and training, and an effort to apply this method in the current system should be made.

Between overlapping keywords given the conclusion found that using AR as the teaching aid for marine education and training can transform Marine Education and Training (MET). Developing a new system for MET like Web Based Marine Training Environment (WMTE) that combines web technology, virtual environments, e-learning tools and simulation software will create a new style and approach for MET [3]. This system provides continuation training, transition training and mission training, which students will access and accomplish. Next, reduce learning gaps. There are many learning styles, and intuitive learning is one of them. Intuitive learners can understand and remember what they learned by seeing how it works in real-time [4]. MET is a broad field with numerous theories and terminologies. AR provides intuitive learning with visualised teaching materials. A study has shown that AR will enhance information by the interconnection between virtual and real worlds. AR uses a flexible le mobility and accessibility device [5], the smartphone known as Mobile Augmented Reality (MAR). MAR allowed training and classes to be conducted anytime and anywhere with complete constancy and immersive simulation [6]. Traditional MET required students to come to the institution or facility to attend class and training. These technologies improve the educational system that commonly uses laptops and simulators in centralised facilities. Now, the existence of this technology has brought a versatile and ubiquitous style of learning. The transition has occurred from a centralised training facility to ubiquitously [5]. Students can undergo their classes and training using their smartphone s.

Moreover, they reduce costs. AR can reduce direct and indirect expenditure on teaching and training. Conventional MET uses high-value simulators that are expensive by considering their maintenance and operation. This technology is potential for MET as it will give affordable training and education. Lastly, generate well-prepared students. In recent years, the industry has concentrated on the production of highly skilled cadets and future seafarers. AR can fulfil this demand by supplying ubiquitous, compact, and efficient technology that has increased user motivation, interest, and enthusiasm [7]. With MAR in the MET, students can know complex machinery parts, working principles and procedures to assemble and disassemble onboard equipment [8]. MAR will familiarize students with instruments usage before working in real environments.
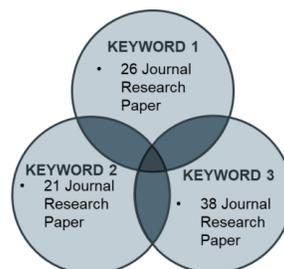

Figure 1 Overlapping keywords

Former United Nations Secretary-General, Ban Ki-Moon, mentioned on World Maritime Day in 2016 that maritime transport is the backbone of globalisation for trading and the economy. This diagram depicts the main goals and roles of maritime industries in terms of growth and long-term development. A competent and professional workforce leads to sustainable industries. Thus, marine education and training have significant responsibilities to produce skilled workers that lead to system protection and efficiency in maritime industries and meet global demand [9]. However, with the arrival of Industrial Revolution 4.0, MET programs and instruments optimisation and effectiveness to satisfy existing and future maritime industries evolving requirements.

The current MET is typically a mixture of theoretical instruction in a classroom and practical training and service at sea through onboard ship practice [5]. Students also use simulator technology to learn and improve their maritime skills before getting on a real ship or work environment. However, the simulation relative to real-life experience includes over-simplifying marine structures and techniques or shortcomings of virtual model coding.

Moreover, the MET is a place for training and assessing professional certificates, required certificates, and formal education [10]. It requires the student to visit this centralized facility. So, it takes many people, equipment, and financing to operate and maintain this facility. This project proposed implementing immersive technology for maritime education and training by producing an Augmented Reality teaching aid that is related to onboard ship equipment. The findings will contribute to the Maritime Industries, considering that Marine Education and Training plays a vital role in producing workforce that will contribute to safe and efficient shipping operations. Optimization and transformation of Marine Education are essential, especially in Malaysia. As a developing country, Malaysia relies on shipping for import and export to sustain and develop the country. Thus, this project is significant. The Marine Education and training system that applies this project recommended approach will change that along with the Industrial Revolution 4.0. Additionally, change and facilitate the learning process as the teacher can provide attractive teaching materials to gain student interest and engagement. Besides, the student will undergo an attractive way of learning that will help them understand the topic learned and will increase their enthusiasm.

2.   RESEARCH METHODOLOGY

3D Development

3D modelling is a computer graphics technique used to produce a 3D digital representation of any object or surface. In this project, a heat exchanger was designed using Autodesk Inventor 2018. Inventor is a platform developed by Autodesk for computer-aided design (CAD). It uses the principle of parametric architecture, which is mainly used to prepare scientific drawings for mechanical purposes. The specification of the heat exchanger is shown below:

Type: TEMA Heat Exchanger with two-part U-Tube type.
Overall Length: 3029 mm
Height: 1195 mm
Breadth: 508 mm

AR Development

The 3D development starts with the designing and assembling of the heat exchanger part by part. Start with the design of the gasket, tube sheet, stationary tube sheet spaces, rand stationary tube sheet, bonnet, shell, support saddle fix and mobile. Final design stage end with the assembly of the heat exchanger

part. This project uses Vuforia and Unity as the main base to create an Augmented Reality model. Vuforia is an augmented-reality (SDK) kit of software developers for mobile devices that allows the creation of applications in augmented reality. It utilises computer vision technologies to identify and view planar images and 3D objects in real-time. Unity is a cross-platform game engine with Unity Technology built-in Optimised Development Environment (IDE). It is used to build online plug-ins, desktop systems, consoles, and mobile devices for video games. This project was built based on two types of Augmented Reality; marker-based and markerless. For marker-based augmented reality experiences, a static image, also known as a trigger photo, must be available for scanning via an augmented reality app on a mobile device. The smartphone scan will cause the pre-prepared supplemental content (video, animation, 3D, or other) to appear on top of the marker.

In comparison to marker-based augmented reality systems, marker-less augmented reality systems do not require tracking of previously designed specific markers or any prior knowledge of the user's environment in order to overlay 3D content into a scene and anchor it to a fixed point in space. The marker-less augmented reality technology enables the generated data to be superimposed on any physical environment. There is no predefined target or base for superimposed virtual objects in this technology.
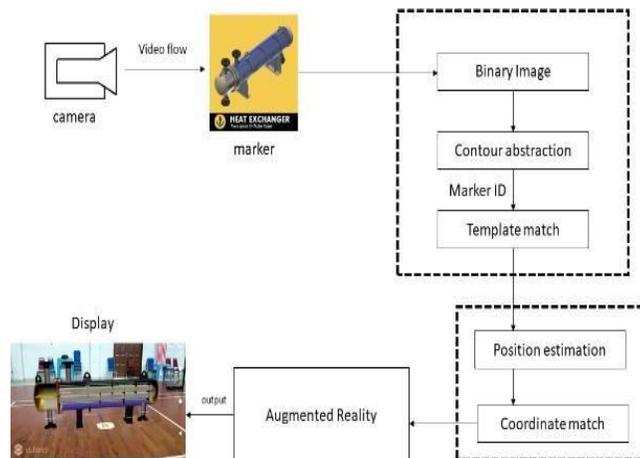

Figure 2 Marker recognition in the marker-based AR technologies

Demonstration

Demonstration is a method conducted by the researcher to illustrate and explain how the project works to the respondents besides engaging with them through discussion. It was conducted for two weeks, starting from 13- 17 April 2021, at Dewan Khatulistiwa UniKL MIMET. The project was demonstrated to 36 students from Universiti Kuala Lumpur Malaysian Institute of Marine Engineering Technology (UniKL MIMET) under the Marine Engineering Technology program. The demonstration had three sessions which are briefing, project demonstration and discussion. Firstly, the briefing. Before the demonstration started, students were explained the purpose of the demonstration conducted and introduced to the heat exchanger on board the ship. Next, every student ran and tested the project with the guidance from the researcher. Finally, the students gave their opinion about the project. Below are the pictures during the demonstration session:

Figure 3 Introduction and briefing session

Figure 4 Project test and run session

Figure 5 Student feedback session

3. RESULTS AND DISCUSSION

It took six weeks to gain results from this project. In this project, the data and results obtained from the development of the augmented reality model for marine teaching purposes and student feedback after undergoing project demonstration.

Augmented Reality model for marine teaching purpose
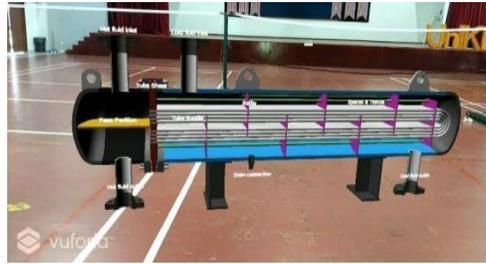

Figure 6 Image tracking concept

Figure 7 Ground plane detector concept

Figure 6 and Figure 7 show the augmented reality model for marine teaching purposes using image tracking & ground plane detector concept. This model includes a cross-section view of the heat exchanger with part labels.

Student Feedback

The student involved in the project demonstration were from Diploma and Bachelor of Marine Engineering Technology program. After undergoing project demonstration, the student provided their feedback and recommendations on the project.

The results of this analysis are summarised as the Rejuvenation of Marine Education and Training through advanced learning. Based on the student opinions, there are three significant findings. Firstly, this project can stimulate student imagination skills—this project is projected in a 3D virtual object. Students can explore the object as it exists in the real environment, taking advantage of 360 spaces. Labelling and cross-section view of the object can strengthen student understanding besides with colorful object its assist visual student in learning.

Secondly, a flexible, effective, and attractive learning method. This project is easy to be used by students and lecturers because it only needs a smartphone and open spaces. Furthermore, the students can learn about actual onboard machinery without going to the workshop that provides flexibility and safety for students, especially during the pandemic, by avoiding gathering and contact. For lecturers, they can provide alternative ways of teaching their subjects that are more interactive by implementing a better learning environment.

Thirdly, it can be applied to various fields of study. This project could be applied to other programmes other than marine engineering technology because this technology only needs a 3D object that will be transformed into an Augmented Reality application.

Student Recommendations

During the demonstration session, students recommended some improvement for the project. In this method, it is essential to upgrade the static 3D virtual object into animation, such as by adding some effects and moving parts on the 3D object to show how it works. Furthermore, they also suggested to include a narrator voice on the project that will explain how the 3D machinery works. This will accelerate students' understanding and increase their interest in learning while using the application. Next, provide more onboard machinery and equipment for the student to access and learn about various machinery that is available or not available in the university.

4.   CONCLUSION AND RECOMMENDATION

Conclusion

The 21st Century Teaching Aid for Marine Engineering Using Augmented Reality (AR) would significantly transform marine education and training. Marine education and training play essential roles in fulfilling demand from maritime industries as well as globalisation. Immersive technology significantly augmented reality could enhance the effectiveness of marine education and training. It has been proven to be the future teaching and learning in marine education and training based on the equivalent of the project result and literature review.

To sum up, this project will be transforming Marine Education and Training via flexible and attractive learning because of the 3D virtual object and portable devices such as a smartphone. Besides, it could reduce learning gaps, especially during the pandemic—the transition from centralised facility to ubiquitous learning where learning can be done anytime and everywhere. Moreover, reducing the direct or indirect expenditure of teaching and training that need to be provided by the university. Lastly, the research is proudly able to nail the overall objectives of this project which are:

i.   To study AR application on Marine Engineering
ii. To develop an Augmented Reality model in Marine Engineering for marine teaching purposes
iii. To test Augmented Reality modelling towards a specific subject in Marine Engineering

Research Recommendation

In general, this project has shown a positive result and feedback. However, the obtained results need more justification further development of the project to enhance the capability of Augmented Reality as the teaching aid for marine education and training. Further work to improve on this project is suggested on the concept and devices.

For concept, several improvements can be made by applying animation on the virtual 3D object. Moving parts and effects on the 3D model make it looks real besides making communication and interaction memorable and immersive and adding user interaction features. These features allow the student to rotate and interact with the 3D object, such as rotating the 3D object and button that will assemble the 3D machinery object part by part once the student clicks on it. Narrator features, which means having someone explain to students during learning could strengthen their understanding of what is learned. Via narrator features, while observing the 3D machinery object, a narrator voice will explain how the machinery works.

Moreover, when applying Augmented Reality to the real object, this concept adds a virtual effect on the actual object, for example, the pumps. Using devices when the application detects the parts of the pumps will show the parts name with the explanation. It also provides dissemble instruction of the machinery part by part.

Finally, it is recommended to operate the project on various devices available such as android and iOS to analyse its capability in numerous mediums.

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