The Virtual Machinery Workshop: an Immersive Learning Environment

Fearing globalization of education and industrial revolution 4.0, the government through the ministry of research and higher education must be aware of the changes in the education environment. The era of digital and inovation technology to education has brought many challenges for education. The world of 21st Century learning method enhance the student to provide the best quality learning experience to students. Active learning can occur when students are interested in the teaching and learning has been centered in the process of meaningful teaching and learning. The commonly teaching and learning has several challenges for vocational education university: access, create and share information freely, and many media. The process of immersion can increase to 90%.

We present a virtual machinery workshop based on 360-degree environment immersive technology. The learning environment is virtual reality. We carry out web-based learning and the potential immersive learning in education. Our proposed method presented in Section III, we describe the details of our proposed learning application framework. In Section IV, we carry experiments and launch an analysis of the result. Finally, we conclude

1. INTRODUCTION

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Abstract In this article, we have proposed an educational learning platform using 360-degree environment on web-based learning. A platform that personalizes user study. The main objective of this study is to analyze the nature of the added immersive learning in education. Our proposed platform presented by utilizing 360-degree pictures and video technique. The results show that our learning environment enhances user study information through a virtual system.
the paper and discuss our future work at section V.

II. RELATED WORK

With rapid development hardware and software technology of web, virtual reality and smartphone in modern society, it can be utilized as entertainment as well as significantly for learning virtual environments through eLearning. Virtual environment is a way user interact with computer like in real-world intuitively. This virtual environment can be built by taking the real-world scene into pictures and videos in 360-degree. To make a tiled 360-degree virtual reality picture or video, one can resort to either multiple camera setup or partitioning of a single video into multiple frames of smaller resolution. An example of 360-degree picture and tools shown in Figure 1.

Recently, utilizing immersive media has gained increasing popularity among researchers in diverse area. There are several studies related to virtual reality conducted in health curriculum. For Example, Ouellet et al. [3] proposed implementation of virtual reality technology for the assessment of everyday memory, this research enhance neuropsychology learning health care material. Virtual shop helps young and adult learner build memory validity in daily routines. Similarly, Kleinert et al. [4] also presented a framework named an Immersive Virtual Patient Simulator (IPS) for training clinical decision in surgery. IPS prototype build with Artificial Learning Interface for Clinical Education (ALICE) simulator shows high students’ acceptance for supporting daily clinical curriculum. In [6], Harrington et al. described the successful development and evaluation of a 360-degree operative video surgery operation to medically undergraduate students. This new video format demonstrated significant engagement and attractiveness benefit to traditional 2-dimensions format.

The concept of immersive media using virtual reality / 360° video is not a new approach, there are several studies also using this approach. Such as, Gundlach et al. [17] developed a tool for teacher to teach earth science curriculum. This immersive museum learning program simulator successfully attract students to learn earth science material. On the other hand, Zhihan Lv [18] introduced a framework to learn geography curriculum using digital glasses technology as interactive scene semantics. This technology provides 3-dimension virtual reality with global positioning system (GPS). The result of this research shows a promise future research in geographical big data.

There are several factors relevant to the effectiveness of Virtual Reality learning experiences. One is the level of immersion allowed by the technology. A highly immersive VR experience is one that provide sensory immersion. This means the outside world is shut out, reducing distractions away from the content, owing to the use of a head mounted display and headphones. Such an immersive virtual environment may lead learners to spend more time engaged with the content and decreases instances of mind-wandering. Another research shows that solid graphics and higher interactivity are key to effectively engaging learners with the content material. The 360-degree videos are omnidirectional panoramic videos that allow the viewers to pan and tilt in an uninterrupted circle rather than the fixed viewpoint of a traditional video. These videos can be viewed on phones by panning and tilting the phone, or on other devices, like low cost phone-enabled VR headset (e.g. Google Cardboard), or dedicated VR (e.g. Oculus Rift), by turning one’s head similar to exploring the real world. Because viewers 360-degree videos have the agency to look around and explore different parts of the scene, these videos are more immersive than traditional 2-dimension videos, but less than a truly immersive VR learning experience.

Nevertheless, the use of VR technology in education is not without its challenges. For instances, the difficulty and time consuming of using VR applications as reported by Rentzos et al [15], particularly without well design interfaces.

III. PROPOSED METHOD

The method to developed virtual machinery workshop application based on waterfall software development that have five phases such as problem analysis, design, implementation, testing and maintenance. A waterfall software development is a sequential software development process, where progress is seen as continuously flowing down (like a waterfall). Detail of each phases as follows:
1) **Problem Analysis**

This phase is more like requirements engineering. Virtual machinery workshop simulator using 360-degree environment visual and multimedia is supplementary learning material for machinery curriculum. We proposed the system from mainly three aspects as shown at Figure 2 namely learning resource collection, virtual environment and learning material processing and web-based simulator application.

![Figure 2. System Architecture](image)

2) **Design**

Collecting learning material data was done at this design phase. There are three area at machinery workshop had been take for building virtual environment such as introduction area for beginner, medium area and advance area. First part is on the left side of machinery workshop scene. Left part scene is how the user will firstly enter the virtual workshop. The learning resource that could be collected in this part is the basic tools needed by the students. Second part of scene is middle of workshop scenes, at this scene users can explore about intermediate machine and equipment learning material. Finally, last scene part is the scene advance machine and equipment. We collected pictures and videos when teaching and learning activities conducted for next processing phase. The next material collected was manual description about tools and machines equipment was collected in form of text, pictures and videos.

Machinery workshop environment was recorded using a 360-degree dual lens camera with 4096 x 2048 (24fps) video resolution and 2304 x 1296 picture resolution. Pictures and video results collected by 360-degree camera are different than traditional camera. The output file is picture in equirectangular projection. Equirectangular projection represents the sphere as a 2x1 rectangle, where the cartesian X-Y coordinates correspond to the longitude and latitude of the point on the sphere. As a result, there's a lot of warping around the poles.

3) **Implementation**

In order to implement the virtual machinery workshop, first process was creating the virtual environment scenario and second process was inserting learning material as hotspot point. The final virtual workshop shown at figure 3.c where user can explore surrounding by clicking the picture and video detail icon. To move between object and scene, user tilting, panning or zooming virtual application.

A virtual environment learning scenario built by connecting each panorama pictures as shown at Figure 3.a. This learning path is like storyboard for the user. Scenario is a graphic organizer in the form of panoramic images displayed in sequence for the purpose of interactive media sequence. Furthermore, the user explores the environment written in this scenario. Before a picture result produce by 360-degree camera it must be processed into panorama.

![Figure 3. Virtual Machinery Workshop Learning material stitching.](image)
picture or full spherical 360 degree. There are three requirements should be fulfilled to process properly such as the photo must have 2:1 aspect ratio, the Exif XMP tag value "ProjectionType=equirectangular" and they are below the maximum resolution and file size.

After completing the scenario to build virtual environment, then learning material such as texts, pictures and videos inserted to application. These learning materials inserted to application by hotspot point, a red circle in panorama image scene. This point will be shown as picture icon or image icon and located at specific tools or equipment to show the detail of its process.

4) Testing

The last part of the system shows virtual learning material into web based or virtual reality glasses to the user. Simulator application was uploaded to shared web server with apache 2.4 and PHP 5.6 specification. The performance testing was conducted using google chrome developer tools. The performance shown at Figure 4 depict load time around 0 – 6.51 seconds. It shows that the website simulator performance well. The scripting loading time show the most needed time to load into the web browser.

5) Maintenance

Maintenance of the system is the last part of waterfall software development method. In this part, revision and update has been done regarded to feedback from the user when they accessed the web-based application.

IV. RESULT AND DISCUSSION

Virtual machinery workshop application with immersive technology 360-degree view can be accessed through website at [http://bengkel360.prayitno.web.id/](http://bengkel360.prayitno.web.id/) or through virtual reality tools as shown at figure 5. User can explore virtual workshop by tilting and panning surrounding scenes. At upper left figure 5 depict a virtual small world, it gave the user presence of real-world scenery. Then, at upper right figure 5 shown to the user first appearance of the application. This scene was at the front information of machinery workshop polytechnic state of Semarang, when usually people enter the building. Figure 5 lower left is the scene when user click the video icon. It shown a detail of machine in video format. Video was stream from the YouTube to save the space and maintain the bandwidth of web server. Finally, figure 5 lower right shown when user click the picture icon. This used for machine or tools detail in picture format.

Although the volume of 360º videos is likely to increase, further study into the potential information retention of the platform is required. As both engaging and immersive, this novel video platform delivers significant benefits to audiences and may appeal to modern learning styles. The 360º videos may add a new dimension to education including orientations to new environments, team training, and formal-examinations across multiple disciplines.

Figure 4. System Architecture: Upper left and upper right represent machinery workshop in virtual environment. Lower left shows machinery video tutorial in 360 environments. Lower right illustrates the machine details in pictures.

Figure 5. Website Load Performance
V. CONCLUSION

This study has described the successful development of an educationally 360-degree virtual machinery workshop at vocational education material. Compared to handout learning material in classes, the 360-degree virtual learning environment in vocational education can be one of the innovative learning media that supports the teaching and learning process in the aspects of equipment introduction theory and workshop environment. This is based on augmented reality and immersive technology that combines information in the real world into information that can be displayed through a website. Students and users can access information in the form of pictures and videos as if they were in an actual machinery workshop. In the future, we intend to study learning analytics for specific virtual learning environment to obtain more implied information about users learning behaviors.

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