Virtual gasoline engine based on augment reality for mechanical engineering education

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Abstract. This paper aims to create virtual gasoline engine based on Augment Reality which are used to study working principle of gasoline engine in mechanical engineering of higher education institution. The Application can help participants learn to understand the working principle of a gasoline engine with three-dimensional visualization (3D) through an android smartphone device. The current learning process is still using the practicum module and engine stand to carry out practicum activities, the method makes the participants learn bored in addition to having to share with other students because of limited time practicum that has been determined so that learning activities become less effective. Augmented Reality is a technological innovation that is currently developing where with the technology we can combine virtual objects into the real world directly with the form of three-dimensional (3D). The working principle of the gasoline engine will be presented using a three-dimensional multimedia visualization embedded in the application. The learning module consists of a didactic model and a form of learning. A special feature of this application is the use of three-dimensional visualization that can be operated via desktop computers and smartphones by utilizing the camera facility as a marker.

1 Introduction

Difficulty to teach students concepts and skills about the working principle of gasoline engines in practicum activities. Usually practicum activity begins with the process of introduction of components through observations that require students to disassemble the machine and takes a long time. Although students want to make observations and try to recognize components briefly, they spend only time to disassemble and reassemble.

The fig.1 explain of working principle of gasoline engine is the process of changing the fuel into power through a mixture of air and gasoline is sucked into the cylinder and then compressed by the piston as it moves up, When the mixture of fuel burning air in the presence of lighters from the spark plug is so hot it will produce this combustion gas power pushing the piston down, which moves the piston down freely in the cylinder [1].

In this paper, we propose the application of gasoline-powered simulation for smartphone android using Augment Reality (AR) technology that facilitates the introduction and understanding of the working principle of gasoline engine through 3D model. This simulation application of smartphone-based gas motor allows the transition from augmented reality to portable, daily and inexpensive devices on the outside of the shelves like cell phones. The Mixed Reality (MR) system combines the real world and the virtual world to produce a new environment in which physical and digital objects co-exist and interact [2].

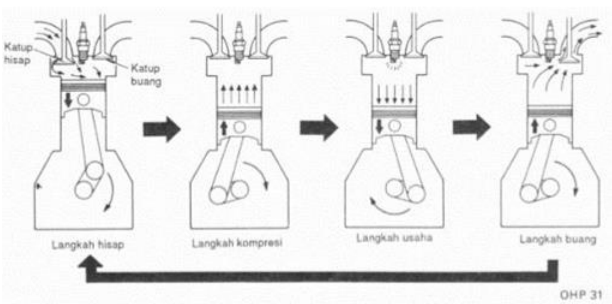

Fig. 1. Working principle of 4 step engine.

The "Mixed Reality" approach with AR markers can display interactive 3D image objects that help students experiment through observations that appear on smartphone displays that incorporate a real environment with virtual objects. Users can make observations from various angles and can be

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interactively controlled, enlarged, rotated and animated in accordance with the actual working principle of gasoline. The purpose of this application is to increase interest in studying automotive engineering skills effectively, efficiently, easily and comfortably from aspects of knowledge, attitudes and basic skills.

Observation activities on the working principle of 4 steps of motor fuel can be done in the workshop with various limitations because the components are covered by engine blocks. Currently Augmented and Virtual Reality (A/VR) technologies can help visualize the working principle to perfection producing original objects (4 stroke 4-cylinder motor). In the process of interaction between users and virtual objects, 3D models can be made more real and integrated on smartphones via Augment Reality, in addition to object interaction between users and virtual objects can be combined between the real environment with the virtual environment [3].

2 Related work

Research related to Virtual and Augment Reality is mostly done in fourth generation technology that combines the visualization of three-dimensional multimedia by utilizing artificial intelligence that can be installed and accessed via android smartphone.

Ufu at all suggesting a source of virtual-based learning and teaching and Augment Reality suggests the possibility of popularizing meaningful content generation learning materials and the reuse of educational resources that are well understood and used as a source of learning and teaching [4]. Ufu discusses educational resources with (not yet) nonconventional interface support, two main, specific challenges associated with reuse emerge. The first is related to revision, remixing and repurposing of REA with AR / RV support: support for constant change attached to REA. By supporting interfacing with VR and AR, this feature becomes a technical challenge as far as the instructional design process is concerned. There is an increase or decrease in complexity when it comes to promoting content changes designed to support VR and AR.

A recent study of the use of AR in civil engineering in various activities undertaken in the field indicates that students express an assessment for the integration of innovative technologies such as Virtual or Augmented Reality in the learning process. Virtual Reality (VR) applications developed by first year students during the introductory classes of the Integrated Master in Civil Engineering for trials on the application of VR and Augmented Reality (AR) in designing game-based buildings. However, the AR app allows participants to use mobile device cameras to recognize the right image. These images were previously stored in the database and through the application, students can visualize and interact with the enlarged school building model5.

Hirve at all in his research implements the convergence of two technologies such as Big Data and augmented reality outlining the implementation and use of algorithms in large Data visualization. algorithms used in previous work or projects focus on two dimensional (2D) views of data visualized by visualization techniques. the possibility of visualizing large Data in three-dimensional view (3D) with Augmented Reality (AR) and its basic principles. The proposed research can be improved in the future by adding and mapping more concepts to large Data and developing advanced algorithms that can visualize data in 3D format and facilitate user understanding [6].

AR technology can help in 3D modelling applications in shopping virtually using smart glasses. Approach virtual reality simulation (VR) to land-based design decisions for AR-based solutions and apply them to order-taking scenarios. Second, we present the results of a simulator study with simulations that are implemented for monocular and binocular head-mounted displays and compare existing techniques to guide attention with our own SWave approach and eye-track integration. Our results show clear benefits for pick-by-vision use compared to pick-by-light. In addition, we can demonstrate that the binocular AR solution outperforms the monocular in the attention-grabbing task [7].

3 The proposed virtual engine gasoline

Interface design is a very important part for users, we propose functional operation of gasoline working system application with 3D model.

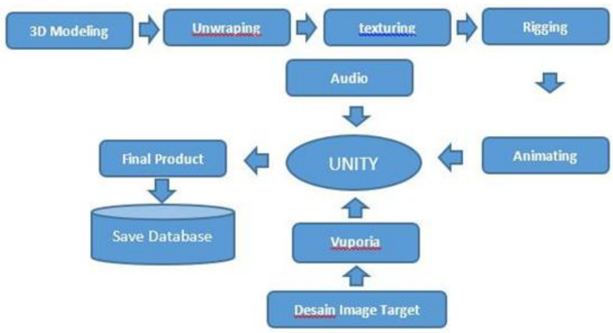

Fig. 2. Design of the proposed application flow.

Fig. 2 gave the overview flow of our proposed application. Figure 2 shows the flow diagram of the simulation application development process starting from the 3D object modelling stage of machine component using blender or solid work such as piston, pulp. Furthermore, the object or component that is made is formed in accordance with its function then done giving the appropriate material to the material look realistic. After all the required components are made and then arranged according to the position of the placement of machine components, the next stage is the process of rigging or bone delivery that serves to animate the object in accordance with the working principle of gasoline motor and then exported to software unity. The next step is to create a marker design with the target image stored in the vuporia database. Finally combine animation and marker in unity by doing the creation of control and script creation program. The last process of making the installation program through android smartphone.

The figure 3 explain of provides an overview of the application usage flow. First of all, the camera captures the real scene into the video stream and identifies the AR marker that is displayed. then, the camera tool measures the distance and estimates the marker's orientation, along with identifying their global coordinates. Finally, they are spread over the markers in real scenes. With the smartphone interface, users can move bookmarks and touch the screen to observe, rotate and animate 3D models in real-time. Users can perform simulated observations by enlarging, rotating 3D models of gasoline engines stored into the database for future use or sharing them elsewhere.

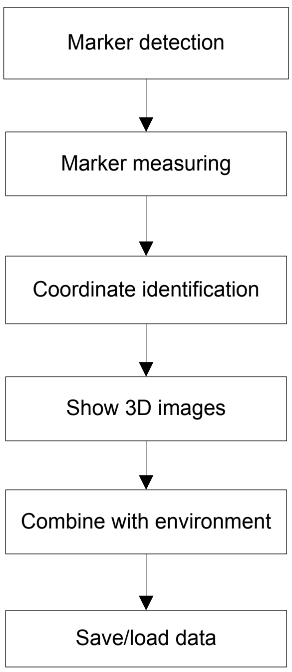

Fig. 3. Implementation of the stages using the application.

There are several advantages of implementing our app on smartphone platforms rather than PC platforms First, everywhere. The phone is just like a portable video camera, which lets people make observations anytime and anywhere, e.g. in the classroom. Secondary, android smartphone applications connect users and cyberspace with touch screen capabilities, which provide greater interactivity in studying the working mechanism of gasoline engines or other automotive techniques. In the past, one could only use the mouse and keyboard. Third, the smartphone offers a natural interface for AR applications, as it allows users to interact (e.g. touch) 3D objects through the screen. This is similar to our daily interactions with real objects. Overall these features enhance users to learn 3D concepts and model 3D objects as easily and naturally as everyday interactions.

3.1 Interface design

The 3D model design of the proposed Application is implemented using the Blender, solidwork, unity and Vuforia Augmented Reality toolkit. Since the Vuforia toolkit is able to recognize the color pattern, we select multiple image object patterns to represent each shape [8].

Fig. 4. Design detail engine cylinder.

Component design picture above is the interface design of gasoline motor component parts in the form of 3D models made using blender tool with realistic material texture [9]. In addition to the ability in modelling 3D blender also features for animation with rigging process.

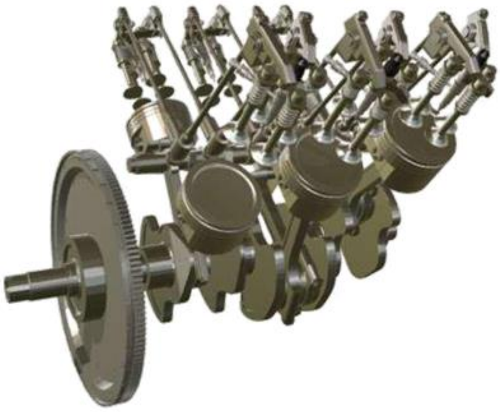

Fig. 5. Gasoline engine design 4 stroke.

3.2 Operation

In this section, we will explain what functions the application provides to simulate the working principle of a 4-stroke gasoline engine. First of all, the user must place a marker of the piece of the machine image, which is the A6 card size print image, on the table as shown in Figure 6. Its central point serves as the origin of the virtual world, which is the reference point of all the gasoline engines.

And then, the user must move the AR marker printed to the desired 3D position by hand. The smartphone video camera keeps track of other machine markers and AR markers used, and then displays the corresponding 3D model of the gasoline engine on the screen. Figure 7 shows the situation when the machine model is displayed and its AR marker orientation.

Fig. 6. Images of marker conditions that have not been identified by the camera.

At this time, the function menu will appear on the right side automatically. In settings, we provide options for left-side users for rotation and right-hand side for zoom in and zoom out and 3D object description notation.

We provide important manipulation functions as shown in Fig. 7, such as rotation (change orientation), translation (change position), scaling (resizing object), displaying and closing notation.

Fig. 7. Situation when the machine model is displayed and its AR marker orientation.

4 Experiment and results

In this section, we will evaluate the performance of the app we propose. A user study has been done to find out how users feel when using our app to observe virtually in a conventional way.

We've invited twenty users and split them into two groups of ten. They are students and most of them take D3 majoring in automobile engineering majoring in sukabumi polytechnic when they participate in this experiment. This user is required to have much experience in using personal computers and smartphones. Each group was told to observe the working principle of a gasoline engine like the example shown in Fig. 8 with different tools: one using the tool we propose while the control group using the actual machine.

We chose a gasoline engine stand engine as an ordinary tool used for control experiments because users have to unblock the engine and arrange it. To make the results more fair and comparable, we provide guidance and steps for both groups that are sufficient for them to observe, recognize components and name each component.

In the experiment, we calculated the time spent by each tester to observe the work system of the gasoline motor 4tak. After that, they were told to fill out the post-experiment questionnaire. They were told to judge a statement, i.e. about their learning experience and use, on a 7-point scale. The more they agree with the statement, the higher they rate it. The statements are listed in Table 1.

Table 1. Question statement.

No	Questionnaire statement
1	The 3D Model Interface Model of the gasoline engine components is very natural.
2	Observations virtually resemble their original form.
3	I can master the tool and learn to observe

	in no time
4	Easy application in installation and used on smartphone android
5	I am satisfied with learning to observe the working principle of gasoline engine
6	I believe that this tool can simulate 3D interactively
7	I want to learn to observe virtually with this app again
8	Quick and accurate marker recognition

4.1 User studies results

The results of user studies are shown in Fig. 8. The users feel the application design has the aspect of 3D model display design is very suitable and attractive. This Augment Reality (AR) simulation application is easy to install on all android based smartphones, as it allows users to learn and recognize components and understand the working principle of gasoline engines by observing a 3D gasoline engine simulation easily enough by identifying the markers that have been created and observed on android smartphone.

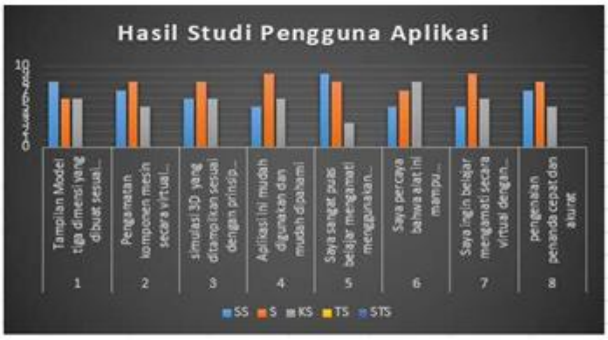

Fig. 8. Result of user studies of simulation applications.

Question 1 asks the user to provide an assessment of the design relevance of the 3D model display of the gasoline engine components made in the actual shape of 75% giving the appropriate rating and 25% less appropriate.

Question 2 asks the user to provide an assessment of his experience in practicing virtual gasoline object observation practice is easy to do or done, the results of the assessment of 70% Users said easy to use and 30% not easy to use.

Question 3 asks users to compare conventional observations and virtual observations as to whether it is in accordance with the working principle of the gasoline engine, 60% of users claim appropriate and 40% stated less appropriate.

4.2 Discussion

The investigation we have done to identify the working principle of gasoline engine gradually by studying the form, model and process in making simulation to assist students in doing practical activities in the form of observation of objects in reality and virtual. Our apps are interactive and allow users to rotate 3D virtual objects through marker identification. Therefore, applications can display engine components such as pistons, valves, gauges with 3D models that can be rotated and simulated interactively.

This provides the ability for the user to align objects with the eyes more easily and detail in making observations. In user studies, some users see the advantages of this kind of functionality and advise us to include this in the next version. However, in the current version we do not provide this capability. We record it as one of our future enhancements. Not least, we will apply the tools we propose in education, entertainment and training. More natural gesture interactions will be implemented using the depth cameras, to allow students and instructors to interact with the content displayed in the room, supporting discussion and collaboration [10].

5 Conclusions

We propose android smartphone applications that offer natural modelling styles with the help of Augmented Reality (AR), which can help students to learn skills and integrate vocational education with 3D models more easily. We adopt a "mixed-reality" modelling approach, so users can learn and practice vocation with the help of virtual technology and Augment Reality.

User studies show that users feel that our application interface design is easier to learn and helps students gain prior knowledge of specific techniques before actually practicing.

We have identified several aspects that help users to learn vocational techniques through built applications, AR application recommendations can then be developed through an integrated cloud-based data plan master to ensure the content of the simulation material is more complete and customized by department.

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