AR mobile tool for Engineering education
User Tutorial

1 APPLICATION OVERVIEW

This application is for improving the quality of teaching in engineering education. The app will display the models required to be taught in engineering courses in the 3D interface. The students will be able to interact with the model using the touch interface to rotate, translate, and scale. In addition, there will be a quiz mode where questions about the model will be asked to access student knowledge.

Navigation Buttons:

Go Home: For starting Homepage of the app

Quit App: To exit from the app.

Tutorial: For this help file.

Engineering 3D Model used: Car engine with many sub-components

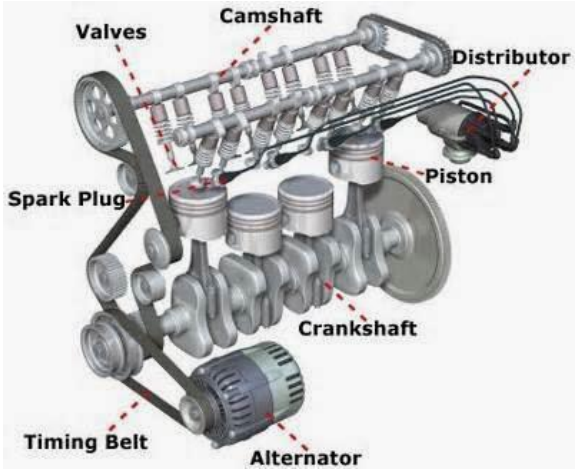

Figure 1: Car engine (Src: https://automoticool.blogspot.com/2017/04/anatomy-of-car-engine.html)

Features available on the 3D model:

1. Rotation: The model can be rotated through X axis and Y axis with the touch on the model.
2. Scaling: The model can be zoomed in or zoomed out with touch on the model.

3. Show/Hide Text button: To show or hide the labels of the car components.
4. Reset button: To reset to the original position after rotation/scaling.

Marker-based object detection:

1. ***Marker recognition***: In a marker-based AR, the camera scans for a specific image pattern in the environment and superimposes the virtual object on top of it. Here a car image is used to track the pattern. Please note that for the marker-based object detection the mobile camera needs to focus on the following car image.

https://drive.google.com/file/d/1LI-i9SCtZIRoOJga_u2vuLCecnC-pDJt/view?usp=sharing

Figure 2: Car image that needs to be downloaded for displaying the virtual model on top of it.

Figure 3: Demo of engine model on top of car (Left), Model labels hidden (Middle), Tire parts on wheel (Right)

2. ***Marker-less Environment:*** In marker-less AR, the virtual object is placed on the surface without using the car model or image.
   For the marker-less object detection, you need to point the mobile camera to the ground and trace the white square bracket as shown in the figure below (marked with the red circle in the picture), and click on it to see the virtual 3D model of the car engine.

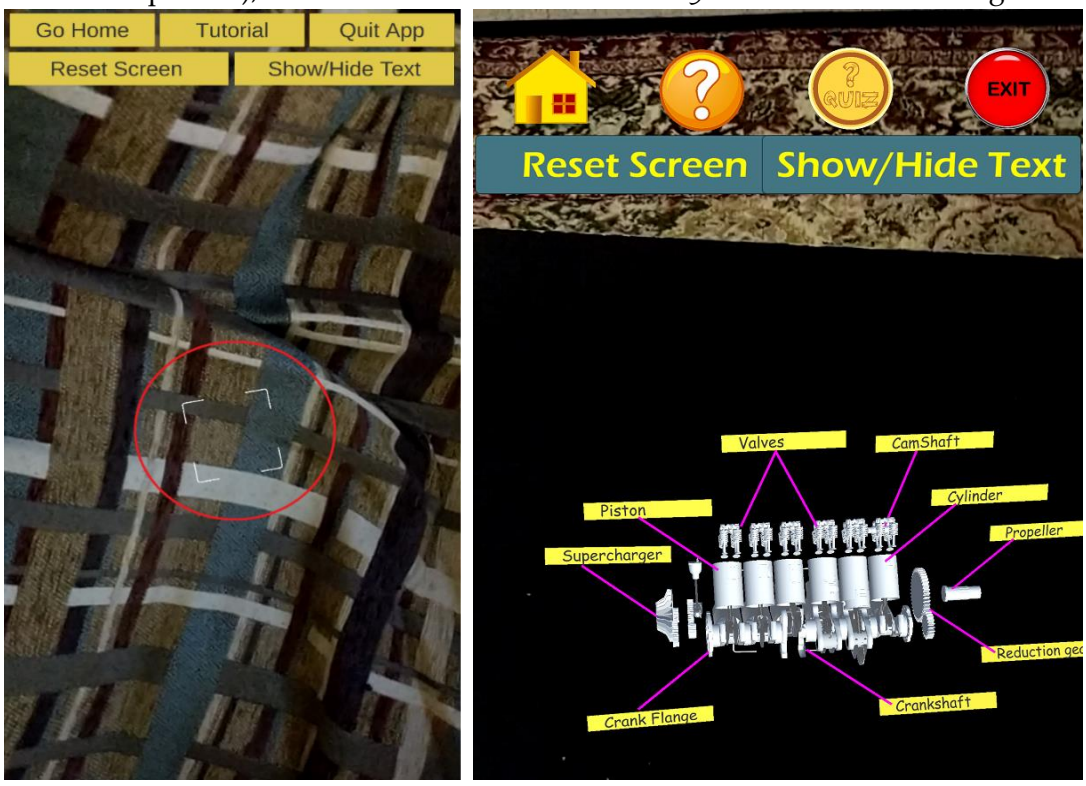

Figure 4— White square to track the ground plane on which the virtual 3D model is projected in the marker-less button in the app (Left – old prototype) and Engine model of top of black board (Right -new prototype)

Quiz:

Quizzes have questions with multiple choices. The correct choice when selected will be marked as green and the score at the left corner will be updated and the incorrect choice will be marked in red. Types of quiz available:

1. ***Simple Quiz :*** Text with images
   Simple quiz will include questions and four options. The question can include an image as a part of the question. (Figure 5-i and ii)
2. ***Interactive Quiz :*** Text with interactive 3D model (can be scaled and rotated)
   Interactive Quiz is for checking the knowledge of the parts of the 3D model. It will include with questions along with 3D model with a field to name the part of the model and the correct answer needs to be selected from the options. (Figure 5-iii)

Quiz Review: At the end of the quiz, this page provides the score of the quiz taken and the correct answers to both the quizzes. (Figure 5-iv)

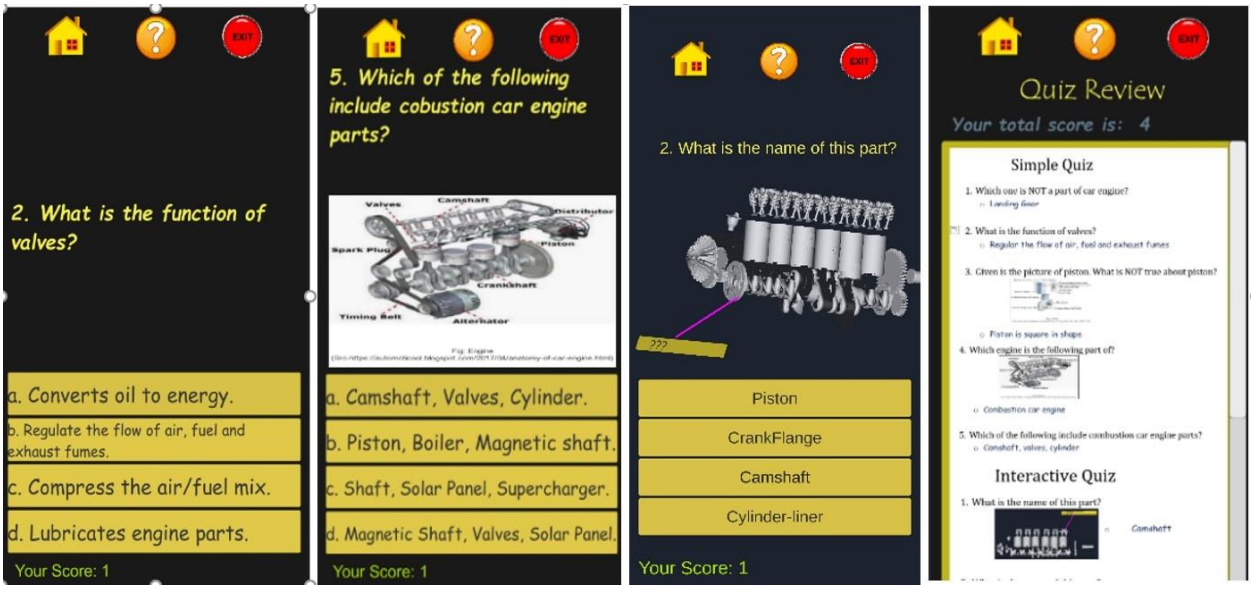

Figure 5- i)Simple quiz with only text, ii)Simple quiz with image, iii)Interactive Quiz, iv)Quiz Review page.

2 INTRODUCTION

Augmented Reality (AR) is a mixed-reality technology that can embed virtual objects in a real environment and provide an interface for interaction between them (Milgram, Takemura, Utsumi, & Kishino, 1995). With the recent development in both hardware and software, innovative technology like augmented reality technology and its applications are proliferating in various fields. The abundance of smartphones with sufficient computational resource, GPS, sensors, network hardware and display screen makes AR technology suitable for educational sector (Dudley 2015), (Chambers, & Worthen, 2019). Researchers have experimented the use of AR in education and found results that AR enhanced learning and provided positive impact on teaching (Chiang, Yang & Hwang, 2014), (Martín-Gutiérrez et al 2015).

In this project, to aid in the ongoing development and experimentation of use of AR in education, an AR based app will be developed. The app will be able to integrate 3D models used in engineering education, mainly electronics and mechanical and allow students to view them in the context of real environment. The project will contribute in the field of educational AR apps by developing a new app as a supplemental tool for improving teaching. The current scope of the project will develop a prototype with limited opensource 3D models, interaction abilities, teaching content and quiz feature.

3 PROJECT OVERVIEW

This project will develop an Augmented Reality mobile application to improve quality of teaching in engineering education. (While this project focus on using 3D models for engineering topics, the models can be for any education topic.) The app will display the models required to be taught in engineering courses in 3D interface. The students will be able to interact with the model using touch interface to rotate, translate and scale. For each model, a help menu will be provided on how to interact with it. Each model will also have a hotspot point on it where students can touch to find more information about that component. In addition, there will be a quiz mode where questions about the model will be asked to access student knowledge.

3.1 Main features

The main features of the project can be listed as follows:

1. Develop an augmented reality mobile app based on Android OS
2. Integrate various 3D models used in engineering education in the app
3. Implement object detection to combine virtual model with real environment (E.g. Engine in a car)
4. Allow students to engage with the model with interactions such as rotation, scaling, translating etc. using touch and device orientation input
5. Provide help, tutorial, demo modes to help students use the tool
6. Provide hotspots on the model to get more information about the part of the model and overall information about the model
7. Provide at least two types quiz based on the models to access student learning
    a. Multiple choice quiz on the overall model displayed
    b. Multiple choice quiz to identify part/points of the model
    c. Track the scores and provide feedback to students
8. Integrate 3D models with more than one component
    a. Allow students to interact each component separately
    b. Also have a mode to see how different components combine to form a larger model
    c. Allow students to view and interact with the components combined

4 REFERENCES

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