Design of Virtual Automotive Showroom with Augmented Reality Technology Using The Smartphone

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Abstract – In an exhibition like an automotive showroom, it is usually not possible to display all the features of products directly to potential customers. Displaying products of cars with various colors, for example, had challenges due to several limitations. In this study, the researcher developed an application for smartphones that can interactively display a product of cars with different features in real-time. The development process was using Vuforia and 3D Unity applied in Android system. Customers can change the color of the car and see the animation through an Augmented Reality application. The system provides convenience to customers in obtaining information by displaying an animation of a certain product in real-time and gives benefits to the owner to promote their products uniquely.

1. Introduction

At an automotive show, it is usually not possible to display all the colors of the car directly to the customers due to the limitation of space. There is not enough place to put all cars with a variety of colors and models. It is related to the stocks of cars with different colors that are not available at the moment to be able to be displayed in an event.

IoT is the network of physical gadgets, vehicles, home apparatuses, and different things implanted with hardware, programming, sensors, actuators, and availability, which empower these things to associate and trade information making open doors for more straightforward joining of the physical world into PC based frameworks [10]. Internet of Things cases are chosen since the topic grows quicker than enactment [11]. In this study, researcher developed an application for smartphones that able to show products of cars in different features in real-time. By using the camera on the smartphone that directed to the special marker on a surface, an animation of automobile products would be shown interactively. Here users should be able to change some features, for example, the color of the car through an Augmented Reality application.

Augmented reality (AR) is an advance technology combining virtual objects in three-dimensional (3D0 into a real environment. AR is projecting virtual objects in real-time display. Unlike virtual reality (VR) that entirely replaces reality [1]. Augmented Reality simply adds or injected animated objects in reality [2]. The process of combining virtual objects with real-world objects enables users to access rich multimedia content [3,4] especially when combined with controllers [5,6].

In our Augmented Reality application, animations of certain products such as cars, as well as the markers that can be detected by smartphone cameras were developed. The application should be
interactive and responsive to the user's input. Information on these products should be easily displayed in the form of an interactive 3D animation through the smartphone's screen.

The benefits of this application are to provide convenience to prospective customers in obtaining information on a product by displaying an animation of the product in real-time and also in different varieties. In the end, it provides benefits to the owner in promoting their product in a unique way.

2. Material and Methods

The application was built using the Qualcomm Augmented Reality library (Vuforia) and Unity 3D. Interactive features in this application were the changes in the color of the car. This application was made for the Android Smartphone.

2.1. Augmented Reality

As mentioned before, Augmented Reality (AR) is the combination of virtual models or object with real environment. For example, it is currently in a television show when broadcasting a football game, and there is a virtual object to give information about the score of the match as it is in progress. Augmented reality combines the real and virtual worlds, interactive in real-time, and able to deal with a 3D animation.

The purpose of augmented reality is mainly to attach new information and perspective to an object in a real space. Augmented reality does not produce a simulation of reality just like virtual reality technology. Rather, it takes an object or a real space as the base and include technology that is contextually adding data to deepen one understands of an object. In other cases, augmented reality can be added in the form of audio, location data, historical records, or any other form that can make the user experiences will be more meaningful [7].

2.2. Architecture

Augmented Reality technology architecture is presented in figure 1 below:

![Figure 1. Augmented reality architecture](image)

- **Input**
  Input can be from specific different sources, for example, digital marker, 2D images, 3D images, wifi sensors, motion sensors, GPS, and other sensors.

- **Camera**
  The camera functions as an intermediary for the input of images, markers, 2D, and 3D images.

- **Processor**
  The processors are needed to process the inputs and then process it to the output stage on the screen.
Output can be a Head-Mounted Display (HMD), a monitor, such as a TV monitor, LCD, cell phone monitor, or others.

2.3. Vuforia Software Development Kit
Vuforia is one of software development kits developed to support augmented reality application for mobile devices. Vuforia SDK provides a specific add ons into a Unity 3D called Vuforia AR Extension for Unity. Vuforia is produced by Qualcomm's SDK to support researchers build applications Augmented Reality (AR) in mobile phones (iOS, Android).

Vuforia SDK has successfully used widely in several mobile applications for various platforms. Vuforia provides a method to interact utilizing mobile phone camera as an input device, or as an electronic visual system that recognizes specific pattern and markers. The screen can display a fusion between the real world and the world simulated by the application. In short, Vuforia is the software development kit for computer vision-system AR. There is another model of AR application called GPS-based AR [8] which utilized exact position of the 3D object within the real environment.

2.4. Unity 3D
Unity is basically a game engine that rapidly grows nowadays. Unity comes with a proprietary license, but for development, the license is divided into two: free and licensed. Unity allowed the publication of the application with a free license with some limitation of the features.

Like most other game engines, Unity Engine can process multiple data such as three-dimensional objects, sounds, textures, and so forth. But generally, this engine is more focused on the manufacture of 3D graphics. Other game engines that similar to Unity are NeoEngine, Quake Engine, C4 Engine, GameMaker, Unigine, id Tech 3 engine, id Tech 4 engine, Blender Game Engine, and many others [9].

2.5. Android Software Development Kit
Android is an operating system based on Linux and specifically designed for touch screens mobile devices such as smartphones and tablet computers.

Android SDK is an Application Programming Interface or API in the form of multiple objects into the interface for a specific programming language or includes dedicated hardware to communicate with a particular system. This software includes debugging tools, and some functional utilities which are often bundled as integrated development environment (IDE).

2.6. System Design
At the system design stage, it was determined what requirements needed by the system. In general, the system consisted of various software required to develop animation and then integrate the animation to display it on smartphones screen in real-time.

The design of the system was completed with the built-up as well as built-in applications needed by the system. System testing was done to check whether the application can function to transmit data to a smartphone and followed with appropriate animation and also how long the response time of the marker application. The design describes how the system will work, shown in the form of a flowchart and activity diagram as figure 2.

3. Result
The system was developed using Unity 3D Software with C# programming language in Android Platform version 4.4.4 (Kitkat). The user interface system developed by displaying introduction pages containing:

- Main Menu
  The Main Menu page is the start page of the application, in which four buttons have a function to open a page that has been determined.
Augmented reality is the process of combining the virtual object in a real environment. There was one 3D object that was allocated for the processed Augmented Reality, in this case, a car product with a different color. Users should be able to pick the desired color and then to see how it looks like on a car product they have selected before.

Furthermore, System testing was done first on the marker recognition, as shown in figure 4 followed by displaying object (figure 5).
The size of the object that appears above the marker can be adjusted and rearranged. In this experiment, the object follows the large size of the marker. The bigger marker, therefore, displayed a bigger object.

Users can then interactively switch the color of the object by clicking each related button. An example of the interactive display is presented in next figure 6.

![Marker detection](image1.png)

**Figure 4. Marker detection**

![Display augmented reality object](image2.png)

**Figure 5. Display augmented reality object**
4. Discussion

One of the difficulties experienced by the event organizer in displaying products for the car exhibition is how to present as much information on the cars’ features with limited space. This limitation inhibits manufacturers from showing all existing stock with different types and different colors. Another problem is it is also not common that there is the availability of stock of cars with all different types and colors.

Here we proposed an Augmented Reality technology that assists customers in imaging the displayed product with different features such as types and colors interactively and more easily. The development process was using Vuforia SDK and 3D Unity applied in Android operating system. The 3D objects are created based on the original model. As a result, obtained from this system, it can help car vendors as well as customers, especially car buyers and sellers, to maximize the product display.

The limitation of our system is that it cannot be executed in the area with dim lights. It is related to the marker detection process, where the pattern recognition step requires a very clean and bright environment to detect and to read the marker.

As for suggestions for further development and improvement of this system is to add other types of cars and features (not only colors) to enrich the features of the system and can also be applied to other operating system such as iOS and other.

5. Conclusion

We have successfully developed an application for smartphones that able to show an augmented reality display of cars in different features in real-time such as size and colors, to help car vendors describe the product to potential customers.

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