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Application of Augmented Reality (AR) in T-Shirt Catalog

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***Abstract*—Augmented Reality (AR) is a visual technology that able to provide users with a semi-real time experience. The advancement of mobile phone and camera technology have make the potential of AR emerged. Companies wants high product sales and look more advanced than their competitors. One of the effort is to provide customers with correct experience of their products. Catalog is a tool to market a product. However, paper printing catalog is two dimensional, and has limitation in fully presenting the product. This work, presents the adoption of AR in T-shirt catalog. The application utilized Android mobile phone to view the 3D model of the t-shirt. The user scan the catalog using the android handphone on the paper printing catalog, and they able to view in 3D the different angle of the T-shirt. This application has successfully developed and testing has been made on compatibility and functionality test.**

***Keywords*—AR, Augmented Reality, Marker base, Marker-less based, Catalog, Android, mobile application, advertising**

I. INTRODUCTION

Advancement of smart phone has made the landscape of advertising change rapidly. Advertising in the era of advanced computing has many challenges. Customers have many sources to refer before they decide to buy something. Thus, Augmented Reality (AR) offer interactive advertising that enable customers to experience the products before decide of buying it. The camera embedded with the smart phone has made it possible for AR technology to evolve. IKEA, as a world leading furniture retailer has used AR for advertising (Baier, 2016). They offer an AR application on the smart phone for customers to experience semi real time visualization before purchasing the furniture.

Catalog is a sale aid to describe a product and a must have in any business. T-shirt business has creative elements that might introduce different design based on the customers requirement. Thus, AR offer an outstanding way to satisfy the variation of customer design taste.

Augmented Reality (AR) technology combine real world and computer generated data.There are two types of AR; marker- based and marker-less based (Cheng, 2017). Marker less tracing is focus more on tracing. It depends on the actual surroundings as the target to develop an illusion object. Global positioning system (GPS) is utilized to detect the coordinates or positions zone (Geroimenko, 2012). Basically, marker based AR uses a camera and a visual marker into the value of a virtual object to be displayed into the user's perception of real world. According Geroimenko (2012), the term marker is a photo, symbol or viewpoint of physical world images that offer a specific figure that can be perceived by augmented reality software. The design marker may extend from open one for example, a scanner tag configuration to a disguised one like scene painting or even human face. At that point after a marker has been distinguished and perceived by an augmented reality software application, the product then computes the careful position and introduction of a significant virtual question and executes it into an ongoing situation close to the marker. Normally, fast reaction code is for the most part known by a camera on a smart phone. Marker based is need less processing control and storage computationally and it is normally low-cost to engage compared to kind of tracing (Siltanen, 2012). This work adapt marker- based approach.

II. REVIEW OF LITERATURE

Catalog marketing involves printed form of hand out for retailers to promotes their products (mbaskool.com).Currently, the catalogs has been made available online to reduce cost as well as save the environments. Digital catalog is dominating the advertising industry, which is embedded in online marketing such as in email, social media, website and blog (Sharma, 2018). Online catalog might full fill the customers need in term of understand the product characteristics. However, it cannot provide the customers variation of options (Osborne, 2014).

Augmented Reality (AR) technology has made possible to combine virtual objects and real world by giving chance for the user to interact with the object in real-time (Baratali, 2016). The sub immersive feeling provided by AR technology is an advantage for certain area such as in marketing (Adriant, 2017, Li, 2018), safety in construction (Li, 2018), manufacturing (Doshi, 2017) and tourism (Kounavis, 2012). Developing AR on smart phone is a perfect combination since today's smart phone has all the fundamental requirement for AR development. The basic requirement to develop AR system are camera, graphic capability, GPS compass and mobile accelerometer (Baratali, 2016). Current AR challenge is to convince users, especially the company to believe that AR able to add values to their product (Parvinen, 2018).

Adoption of AR in mobile application is a promising act to boost sale. It is reported that AR based mobile application street guide for The Sunshine Aquarium in Tokyo had yielded a 152% boost in ticket sales entirely as a result of the application (Oser, 2014). Sales for air conditioning units had been raised to 50 million dollar as a results of using AR based mobile app by letting customers visualize air conditioning units in various locations of their homes (Oser, 2014).

In fashion industry, previous works show that AR has adopted to Shoe (Freshness, 2010) and cosmetics (Sarah, 2011). The application of AR on T-shirt is more towards displaying internal organ (Hoang, 2018) (Virtuali-Tee, 2016). Observation from Youtube show that most of the application of AR related to T-shirt is towards fun; the moving picture on the t-shirt (Arloopa, 2017), showing the movement of the internal organ (Virtuali-Tee, 2016) and the moving mortar out of the T-shirt (iTee, 2013). To the best of our knowledge, no previous work reported the application of AR towards serious business like T-shirt design business. Thus, this work presents the initiative of application of AR in T-shirt designing.

III. METHODOLOGY

This section outlines the planning, design, development and testing process of AR T-shirt Catalog. First, the explanation is about the software and hardware used. Then, the design of project flow is illustrated in form of sequence diagram. Next is the development process which consists of four modules; image modelling, capture, recognize and augment module. Finally, the testing phase which consists of functionality testing and compatibility testing.

A. Planning Phase

The planning phase has literature search activity to find clear problem statement, objectives and project significance. This phase also consists of understanding previous work. Knowing the previous work can contribute in determining the hardware and software requirement for the project. Table 1 and Table 2 are the hardware and the software used by this project. Table 1 illustrates the software that has been used. The first software need to be installed and correctly configured is Unity. This platform is needed in order to use Vuforia SDK tools. Vuforia SDK Unity packed is used to handle AR Camera and image target functionality. It also used as image processor to render live video while generate and project the 3D model simultaneously. The next software is the 3D Studio Max. This software is used to model the T-shirt. The Adobe Photoshop is used to draw the T-shirt catalog. Table 2 is the hardware requirement which are smarts phone and Lab top computers to develop and test the prototype.

TABLE 1. Software requirement for AR-T-shirt Catalog

No.	Software	Purpose of the software
1.	Unity	Platform to do animation, change scene, scripting and AR camera tool
2.	Vuforia SDK	To handle AR database, image target and license key manager
3.	3D Studio Max	To model the object, to design the 3D graphics, 3D animation and rendering
4.	Adobe Photoshop	To edit the image for the catalog.

TABLE 2. Hardware requirement for AR-T-shirt Catalog

No.	Hardware	Purpose of the hardware
1.	Smart phones	To test the application
2.	Lab top	To do the programming and report writing

B. Design Phase

The design phase consists of a sequence diagram. The sequence diagram is illustrated in Fig. 1. The diagram shows the event sequences between objects in the application. The actor for this project is the user who want

to design a t-shirt. There are four objects involve; the application, the camera, the catalog and the server. The actor will start the application, then the application will start the camera. The camera will detect the pattern on the catalog; which will then send the data to the server. The server will display the information related to the t-shirt design back to the user/actor.

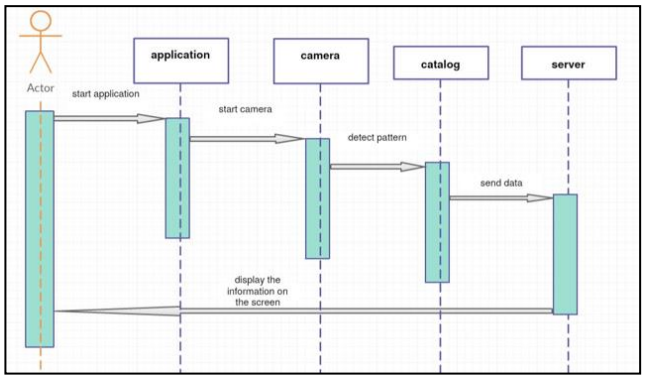

Fig. 1. The sequence diagram of AR-T-shirt Catalog

C. Development Phase

The development phase consists of four modules; image modelling, capture, recognize and augment module.

1) Image Modeling Module

This phase consists of modelling the T-shirt image in 3D form using 3Dx max software. The pattern of the model will be stored in the database.

2) Capture Module

The input is the live video capture the t-shirt catalog from the camera of the smart phone. The module analyzes the camera feed by analyzing each frame in the video. Then, the binary image will be created.The binary images are then processes to detect the AR marker. The T-shirt catalog is the marker. Vuforia SDK will distinguish the marker, then computes position.

3) Recognize Module

The input for this module is the AR marker. Detection of the marker will determine the virtual object position. The location of the AR marker will be the input to do the tracking. The tracking is done by calculating the relative pose of the camera in the real-time. The Vulforia SDK detects and tracks the features that are naturally found in the image itself by comparing these natural features against a known target resource database. Once the Image Target is detected, the SDK will track the image as long as it is at least partially in the camera's field of view. Fig. 2 shows the t-shirt catalog as the image target. The features that has been analyzed is rated as star.

Fig. 2. The Image Target

4) Augment Module

The input for this module are pose calculation and the virtual object to augment. Rendering task happened here. It combines the original images and the virtual components using calculated pose and renders the augmented images on the display screen of the mobile phone [7].

D. Testing Phase

The work performs two testing; functional testing and compatibility testing. The functionality testing is done to ensure that the developed application is working, the compatibility testing is performed on various smart phone manufacturers, module and Android versions.

IV. RESULTS

The following result are obtained after applying and implementing steps in methodology. It consists two parts; the application development results and the testing outcome.

A. Application Development Results

The application development results are presented based image modelling and the AR T-shirt catalog application.

1) Image modelling

The 3D view of the T-shirt has been modeled using 3Dxs Max software. Fig. 3 shows the three views of the t-

shirt; upper view, front view and vertical view of the t-shirt. The3D model view of the t-shirt is at the bottom right.

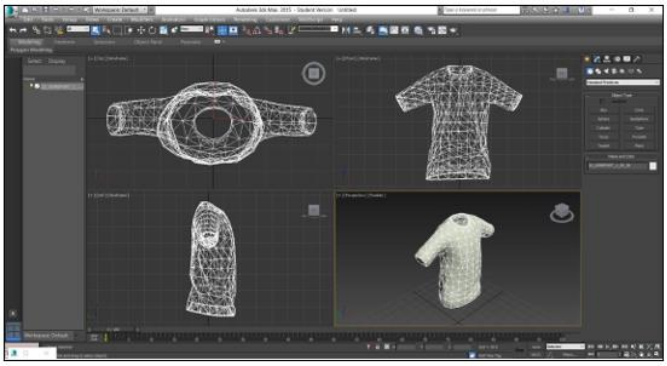

Fig. 3. 3D model of the T-shirt

Texture image mapping has been applied to provide the flexibility for the user to choose choices of designs. Fig. 4 shows the bitmap mapping for applying image texture on the t-shirt model. Fig. 5 shows how the 3D t-shirt model being mapped into a single image. Fig. 6 shows the final t-shirt texture in a single image; which is ready to be used by the user to design own choices of t-shirt.

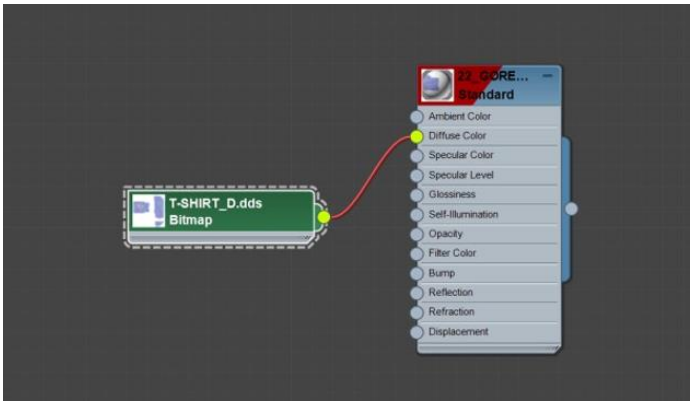

Fig. 4. Image texture of the t-shirt 3D model

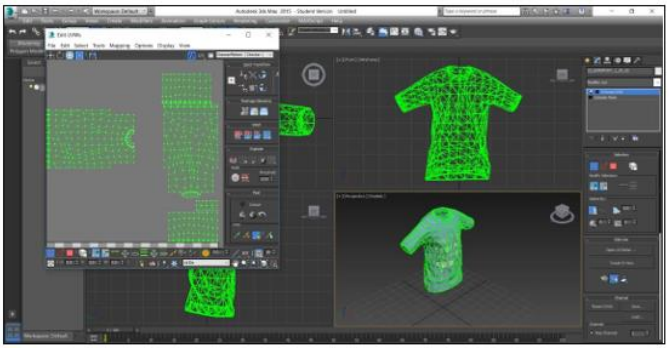

Fig. 5. The 3D t-shirt model is mapped into a single image

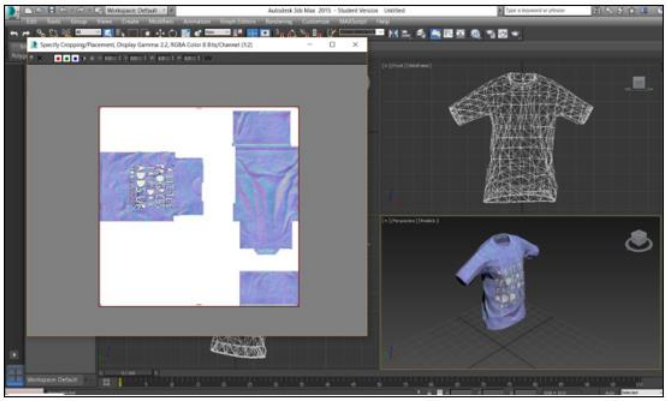

Fig. 6. T-shirt texture design in a single image

2) AR T-shirt Catalog Application Results

Fig. 7 illustrates the main menu of the AR T-shirt Catalog which is installed in the smart phone for the user. It has three buttons; product scan, live texturing and help menu. Fig. 7 and Fig. 8 is done by the user. Fig. 7a and Fig. 7b shows the t-shirt 3D viewing and Fig. 8 is the Live texturing scene.

Fig. 7a. The AR T-shirt catalog main menu

Fig. 7b. The application view after scanning by the user

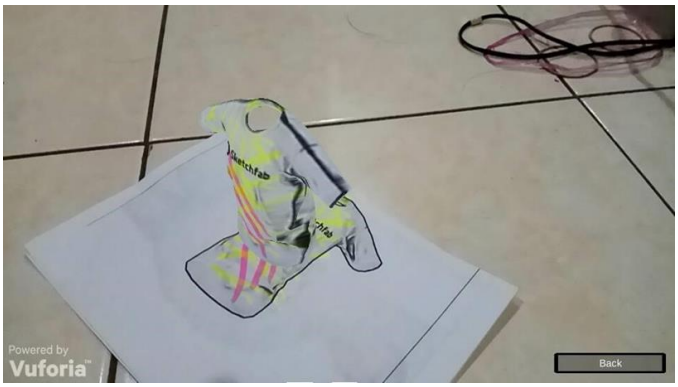

Fig. 8. The Live Texturing Scene

B. Testing Results

Two testing have been conducted; Functionality testing and compatibility testing. Table 3 illustrates the functionality test result for AR-T-shirt Catalog. Six functions of the application had been tested; Scan Now button, Live Texturing button, Back button, Next and Previous button, Camera initialization button and Help Menu button. All the buttons work properly.

Table 4 shows the result of compatibility test for AR-T-shirt Catalog. Eight phone models, with variety of Android versions has been used for the testing. The result shows that all the phone models support the AR T-shirt Catalog application. Table 4 illustrates the functionality test

V. CONCLUSION

This work shares the development of AR based T-shirt designing. The AR marked-based approach has been adopted to develop the application. The application has been successfully developed on Unity Platform. The testing has been done in compatibility and functionality test on Androids phone.

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TABLE 3. Functionality Test for AR-T-shirt Catalog

No.	Function	Expected Results	Pass/Fail
1.	Scan Now Button	Open Augmented Reality scene	Pass
2.	Live Texturing Button	Open Live Texturing Scene	Pass
3.	Back Button	Back to the previous scene	Pass
4.	Next and Previous Button	Shows selection of respective product	Pass
5.	Camera Initialization	Initialize Camera to be used as render camera	Pass
6.	Help Menu Button	Shows a pop-up windows of help menu	Pass

TABLE 4. Compatibility Test for AR-T-shirt Catalog

No.	**Phone**	**Manufacturer**	**Phone Model**	**Android version**	**AR-T-shirt Catalog Support**
1.		Xiomi	Xiomi Redmi note 4	Android 6.0.1 (Marshmallow)	Supported
2.		Xiaomi	Xiaomi Mi5	Android 6.0.1 (Marshmallow)	Supported
3.		Xiaomi	Xiaomi 3 pro	Android 5.1(Lollipop)	Supported

No.	**Phone**	**Manufacturer**	**Phone Model**	**Android version**	**AR-T-shirt Catalog Support**
4.		Wiko	Wiko-robby	Android 6.0.1 (Marshmallow)	Supported
5.		Asus	Zenfone go	Android 4.4 (KitKat)	Supported
6.		Xiomi	RedMi note	Android 5.0 (Lollipop)	Supported
7.		Samsung	Samsung Mega	Android 4.22 (Jelly Bean)	Supported
8.		Yes	Yes Altitude 4G	Android 5.0 (Lollipop)	Supported