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Informative Augmented Reality Based Products and Groceries Scanner

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Abstract: Augmented Reality (AR) are used in applications in retail to achieve the Industrial Revolution 4.0 and retailers can be penalised if they do not display and misplace the price of their products following by the Act of 723 as the shopper's time will be wasted looking for the price with information about the products especially for the Myopic people to read the information. The mobile device Augmented Reality application were design and develop by using a combination of Unity software and Vuforia SDK engine that act as a product and groceries scanner for 15 products in 2 supermarkets by displaying the prices and information of items in the android operating system. The augmented reality application will run by analyzing mobile device camera capturing the motion and display output from the verification and validation method. The AR camera's performance of speed in capturing and recognizing the physical object in a split seconds and it will display the output information when it is in a distance range of 25 cm until 55 cm from the product. The development of the augmented reality application is to help myopic people while purchasing groceries and reduce the time for users when performing shopping activities and this has been approved by the myopic people as the AR application has been tested to 11 different users. In the future, the AR scanner application needs to be upgraded to the iOS operating system and added more output information functions for the users.

Keywords: Augmented Reality Application, Groceries Scanner, Products Scanner

1. Introduction

Malaysia is now in the 4th industrial revolution which is Cyber Physical System with nine digital application industrial technologies. There are advanced robotics, additive manufacturing, simulation, horizontal or vertical integration, industrial internet, cloud, cybersecurity, big data and analytics as well as Augmented Reality. Augmented Reality is an experience of a computer creating objects in real-world surroundings and applying multiple sensory perceptions between computer and human, sometimes having a visual, auditory, movement and smell by using a device for example smartphone, laptop or computer and eye glasses from an application or website [1],[2]. Many types of Augmented Reality

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scope in social media applications have been developed such as in gaming, education, medical, maintenance and retail. Augmented Reality application for retailers are usually use for marketing in business as an advantage in promoting products and services through interesting ways, experiencing the real shopping environment from home [3]. This will help to increase the purchasing to be higher from the usual and easy for the consumer as all the price shown are fixed and they can browse through their budget. This can prevent seller from getting penalized for not displaying the price of the products following by the act of 723 as the shopper's time would be wasted searching for the price with information about the products especially for the Myopic people.

1.1 Aim and Objectives

The aim of this project is to make the consumer feel easy while shopping with an augmented reality application only from their smartphone especially for Myopic people. The application displays prices of products and groceries with the product's name and information on the consumer's smartphone. The smartphone camera will scan the product figure and the Unity Software and Vuforia SDK engine will design and develop the augmented reality application for android operating system. The performance of speed and update data informative Augmented Reality based product application in android operating system and user shopping activities were analysed from 11 user application testing based on the 15 products database and 2 supermarkets.

1.2 Modern Method VS Traditional Method in Retail

The retailing method and activities has been done in the previous era until the present era. There are more evolutions made in the retailing environment to achieve 4.0 Industrial Revolution. In traditional retail, usually customers will pick the item provided by the retailer from the shelf of products with the price displayed on the shelf and pay it at the cashier using cash money. However, several stores introduced self-service methods by using Radio Frequency Identification (RFID) systems for example self-cash desks, interactive displays devices with touch screen, informative touch points and applications (Apps) on the mobile device or smartphone [4]. Some retailers have used or introduced a virtual store based on a computing system which allow shoppers to access products from their smartphone [5]. Market analysis is able to support and increase the demand for experiences and enriched service [4] by introducing these technologies to the retail environment compared to the traditional point sales [6]. The emerging idea of retailing using technologies would reinforce the role of retailers in this economy by improving the quality of consumer shopping experiences. Using technologies in retailing can change the organizational processes, retailing activities and consumer activities while shopping. As customers, they are also able to collect knowledge while shopping with the price knowledge, product knowledge and a retailer purchase concept. This means there is an interaction between retailer and consumer while the consumer makes a purchase in the retailer shop.

1.3 Non-commercialize and Commercialize Product

Many Augmented Reality (AR) mobile application product pricing and information were commercialized in the retail industry such as Walmart App, Target App and GoodGuide App. However, there is also non-commercialize product that had been developed like IBM AR shopping App. The AR scanner application were developed by using Unity software and Vuforia SDK engine for android operating system with AR camera capturing and recognizing a physical object to display the information output. The physical object was used as an AR target because it is easy for the users to capture the AR target without touching the product. However, in the commercialized product, there's only image target of the barcode to display the AR output and only one non-commercialize project used a physical object as an AR target. There are only two AR apps developed for android operating system, those were Target App and IBM AR shopping App.

2. Materials and Methods

The AR scanner application system can be seen from the block diagram of the project while searching and comparing data in the database and vice versa until the results are displayed on the user's mobile phone. The AR mobile application then starts with analysing products or groceries from the mobile camera capture and displays the information that developed by one software and one software development kit (SDK) engine; Unity software and Vuforia engine.

2.1 Block Diagram

Figure 1 shows the block diagram of an informative Augmented Reality based product and groceries scanner. The Augmented Reality (AR) application analyzes Viewfinder motion from the mobile device camera. The AR application analyzes the result by recognizing product's shape and packaging design from the frame captured in slow-motion interval. The frame can be captured from a low-motion interval as the image of the product is clearer than high-motion interval. Next, the analyzing result is sent to the database for comparison of similar data in it with the frame capture of the product. The database then sends the comparison data result to the AR application and displays it on the screen of the user's mobile device. The data displays on the mobile device are the price and information of the product. This block diagram process constantly repeats while the user points out the mobile device camera to the product.

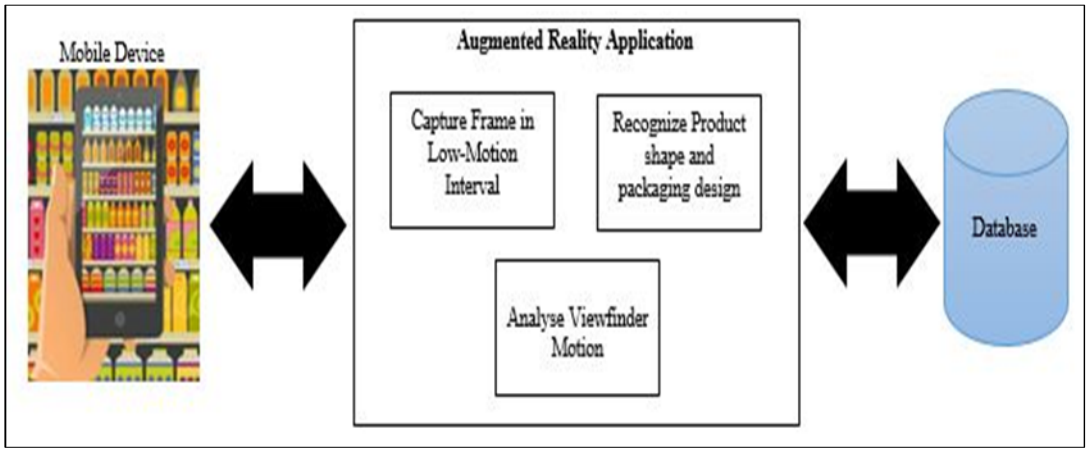

Figure 1: Block diagram of AR application

2.2 Software

a) Vuforia SDK Engine

Vuforia SDK Engine is an augmented reality software development kit to develop augmented reality applications [7] by using image recognition technology to capture the track of the 2D image and 3D object in real time. This is known as a database for the augmented reality application that can display the output from the captured virtual object in a real-world scene. The 3D objects (15 products) need to be scanned physically by the Vuforia object scanner app which provides a visualization of the object features with coverage across the object. The Vuforia SDK Engine supports the development of operating systems such as iOS, Android and Windows [7].

b) Unity software

The Unity software is an Integrated Development Environment (IDE) and cross-platform game engine. It can be developed on various types of operating systems such as Windows, macOS or Linux and can be supported on 25 platforms like Mac, iOS, Android, Windows,

Vuforia and others. The Unity software is an easy engine to develop games, application and movie in two-dimensional (2D), three-dimensional (3D), virtual reality (VR) and augmented reality (AR) that use language C# as a main programming language. While the game creation is successful, the game can also be exported directly to the mobile, desktop or web. The informative AR scanner android application was developed with 5 activity scenes. It has a home menu, description of AR scanner android application (About Us), supermarket options, AR camera for Pasaraya Sejati Sdn.Bhd and AR camera for Samudera Bintang Marketing. Each scene has their own characteristics and functionality but has a link to each other by declaring programming code.

2.3 Testing and Verification

The testing and verification method were applied to make the AR scanner android application function run as expected and smoothly. These testing and verification methods were applied for this project analysis and result. The testing method was made while doing a development of the android application design and function through the physical camera (webcam) of the Unity software especially for the AR camera function with the development of database. The verification method was made by testing the AR android application function in personal mobile devices. It will try to scan every type of 15 products listed as a database in 2 supermarkets. Besides, the function of the AR camera application is verified with 3 parameters such as performance of AR camera capturing physical object with different types of lighting and also performance of AR camera to capture physical object at different distance.

2.4 User application testing

The 11 users were evaluated for the AR scanner application tester in the real-time and real situation by having shopping activities in the both supermarkets that are Pasaraya Sejati Sdn Bhd and Samudera Bintang Marketing with AR scanner application. The experience of the 11 users will be analysed from the questionnaire of Google form.

3. Results and Discussion

The AR application is developed by configuring the database from Vuforia developer as input and developing the output by using a function in the Unity software. The output of the AR application is displayed on the mobile device screen. The verification and validation method have been applied to the finalised AR scanner application before running the user application tester to make sure the AR Scanner application was successfully functioning. Analysis was done using the feedback from the users on Google form after they did application testing in the 2 supermarkets.

3.1 Unit testing

Unit testing method is used while developing the AR scanner application by using a physical camera in the Unity software. This method was applied to make sure the function and output of the AR scanner application were as planned and expected. The testing of the 15 products database outputs in two supermarkets had been done as shown in Figure 2. The physical camera in the Unity software is able to capture and recognise the physical object as well as displays the output product information.

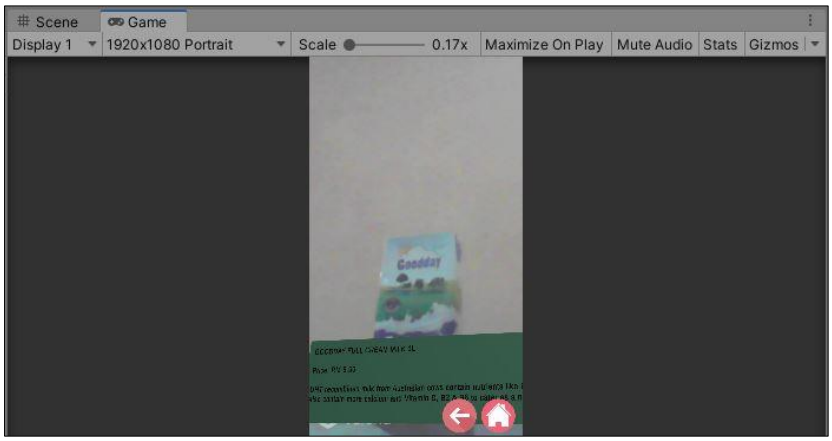

Figure 2: Testing the AR camera with one of product

3.2 Release testing

The release testing method applied in the AR scanner android application will analyse the design and performance of functionality application from the start scene activity until the AR camera scene activity.

a) Difference types density of light

The first condition is analysing the AR camera while capturing and recognising the image of a physical object in three density of light types; normal light, dim light and dark light. Figure 3 and Figure 4 show the product information being displayed while the AR camera pointing at the product using normal light and dim light. The AR camera is able to capture, read and display output for the physical product in these two types of density lighting even though the dim light test takes some time in displaying the product information but the result is good for the performance speed of the output. In the dark light type however, the physical product cannot be captured and read. No output was displayed with this type of light condition. The condition in the dark light can be observed in Figure 5. As an observation, the AR camera performance that captures the physical object depends on the density of the light in the surroundings of the user's AR scanner application.

Figure 3: Normal light

Figure 4: Dim light

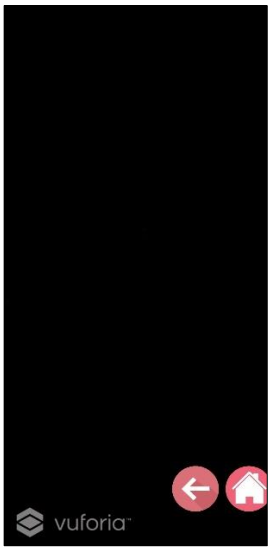

Figure 5: Dark light

b) Distance between physical object

The analysis time taken between the AR camera in capturing, recognizing and displaying output in various distances with different types of physical objects is one of the observations of AR camera performance. In this analysis, the distances were set up starting from 5 cm until 100 cm. Every 5cm, the time taken by an AR camera recognizes a physical object is measured using digital stopwatch with different types of physical objects. The types of physical objects used in this analysis are the biggest physical object (Softlan), smallest physical object (Lady's Choice) and physical object with plastic packaging (Sponge). These types of objects were chosen because each physical object of a product is related to the output result.

Figure 6 shows the time taken by an AR camera to recognize physical objects in various distances. The analysis initial state is that at a distance of 5cm, the time reading taken for the Lady's choice and the sponge are 2.84 seconds and 2.52 seconds. The time it took to read for both is almost 3 seconds. This is because the AR camera was too close to the physical object and it was hard to capture and recognize the physical object. Thus, the time taken for this state to display output is high. On the other hand, the Softlan measured no reading output in the initial state because the physical object and packaging image were too big for an AR camera to capture and recognize. In the next state of 10cm distance and above, the AR camera started to show better performance speed while capturing, recognizing and displaying the output information on the application screen. The time taken to capture and recognise the physical object of three types is between 2 seconds and 1 second.

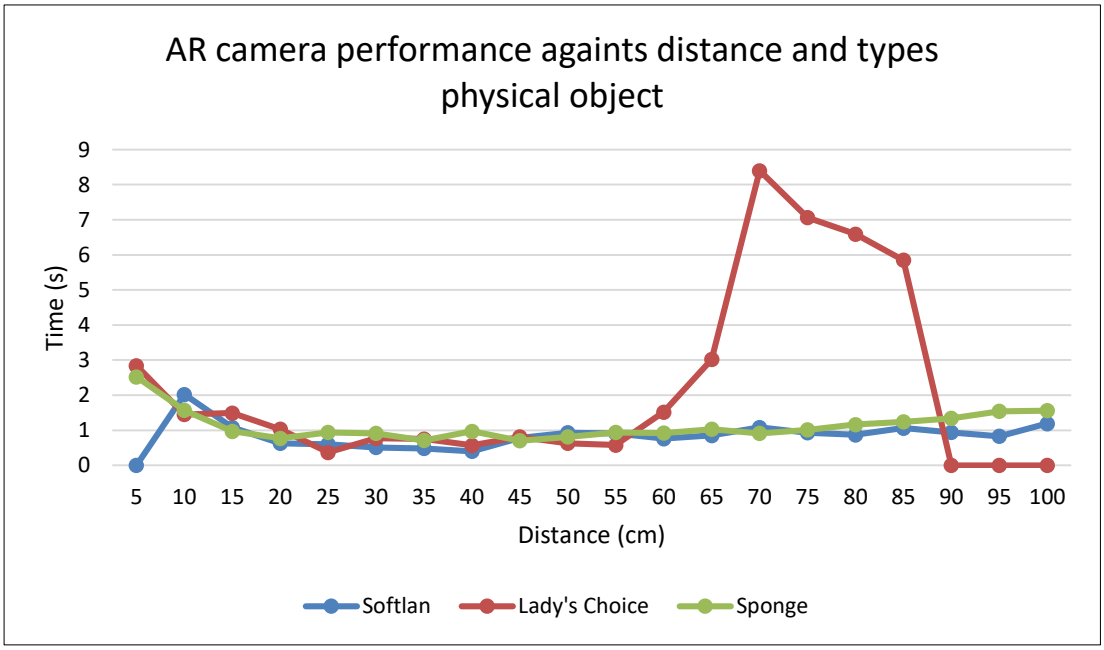

Figure 6: AR camera performance against distance and physical object types

Based on Figure 6, the best distance to capture a physical object is between 25 cm and 55 cm. The AR camera produces the best performance of speed to capture and recognise physical objects due to fast displaying of the output information even in different types of physical objects. In the distance between 25 cm and 55 cm, the time AR camera takes to capture and recognise a physical object is between 0.94 seconds and 0.40 seconds. The time taken on average between this distances is 0.67 seconds. However, the time taken by the AR camera to capture and recognise physical objects increases starting at a distance of 65 cm especially for the Lady's Choice. This is because the AR camera has difficulties to capture the physical object due to the object being far from it. The physical object appears to be small which then makes it

hard to be captured by the AR camera lens. Thus, the time taken reading of the Lady's Choice is higher than other types of objects which is above 3 seconds in this state because of its smallest physical.

Therefore, the AR camera cannot capture and recognize the physical object of Lady's Choice in the distance of 90 cm and above. Meanwhile, the other types of physical objects still can be captured and recognised by the AR camera but the time taken by the AR camera to do so is higher. It can be concluded that the distance of AR camera and physical object gives a huge impact to the performance speed of AR camera in capturing and recognising physical objects especially for the smallest physical object. Bug or error is found if the distance of the AR camera is too far from the small physical and closest to the big physical.

3.3 User testing

There is tester available for users while using the AR scanner android application to analyse the shopping activities community. The tester use beta testing for 11 users who became respondents in testing the AR scanner android application by using their own mobile device and applying it in a real time or real situation while shopping in Pasaraya Sejati Sdn. Bhd and Samudera Bintang Marketing. This personal information of the users is related to the performance of AR scanner android application and the change to their shopping activities. There are seven females and four male respondents with a four age range; one child, six young adults, two middle-aged adults and two older adults. Among these 11 users, there are 2 nearsighted, 3 farsighted and 6 normal eye sight respondents. Personal information such as age and eye sight vision type are important because it impacts the different styles of the respondent's shopping activities. These respondents used a various type of android version for this AR scanner application ranging from Android 4.0 to Android 11.0. However, there are android versions that are not used by respondents and they are Android 5.0 and Android 7.0. The most android version used by the respondents is android 10.0 as it was used by 5 users followed by android version 8.0 that was used by 2 users. Other android versions such as 4.0, 6.0, 9.0 and 11.0 were used by only 1 user.

a) Performance of the AR Scanner application

The performance of the AR scanner android application can be analysed from the user's feedback in the Table 1. 1 of the 11 users gave scale 3 for the running process in their android version while 2 out of 11 users gave scale 2 for the time it takes for the AR camera to open. This may be due to the usage storage in their phone but the AR scanner application functionality runs smoothly on their phone. However, the time taken by the AR camera to recognise and capture the physical object packaging to display the output is faster compared to time taken by the AR camera to open. It can be seen from Q3 in Table 1 that the least scale for the time taken output display is 3 by 3 users. The performance of the AR camera displaying output depends on the density of the light which has been agreed by 7 out of 11 users. While most users agreed (4 users in scale 5 and 4 users in scale 4) that there are some listed products that are hard to capture and recognise their physical object products. The performance of the AR camera in capturing and recognizing physical objects also depends on the characteristics of the physical object such as plastic packaging having light reflection and frozen product being covered with ice.

Table 1: User feedback for the application performance

NO.	QUESTIONS	LIKERT SCALE				
		1	2	3	4	5
1	AR scanner apps can used in my Android version	-	-	1	6	4
2	The time taken of AR scanner app to open mobile camera is fast	-	2	-	6	3
3	The time taken of AR scanner app capture and display output is fast	-	-	3	5	3
4	The performance of AR scanner app displaying output depends on the lighting	-	-	2	2	7
5	Some of product hard to capture and displayed output	-	1	2	4	4

b) Impact AR Scanner application in user shopping activities

The AR scanner android application gave a big impact and also changed the user's shopping activities. This was agreed by most of the users shown in Table 2 that 9 out of 11 users felt easier while shopping due to the AR scanner android application being helpful and that they gained new knowledge about the products from the information given. However, there was 1 user out of 11 who disagreed about the comparison of prices between 2 supermarkets. The user felt it would be easier if there is a table comparison for the prices of the same product type between 2 supermarkets. Meanwhile, 8 out of 11 users, of whom 2 having myopia, felt easy reading the product information given that includes the same price information with the exact price sold in the supermarket. They also agreed that the AR scanner application can save their shopping activities time from unnecessary business.

Table 2: AR scanner application impact to the user

NO.	QUESTIONS	LIKERT SCALE				
		1	2	3	4	5
1	Feel easier while shopping with AR scanner helps	-	-	1	1	9
2	Gain a product knowledge from the information given	-	-	-	2	9
3	Can make comparison price of same product in 2 supermarket	-	1	-	2	8
4	Easy to read the information and price	-	-	-	3	8
5	The price output displayed same as exact price in the supermarket	-	-	1	2	8
6	Save time while shopping because of unnecessary business (find the information product and price)	-	-	-	3	8

4. Conclusion

In conclusion, the Informative Augmented Reality Based Products and Groceries Scanner has been successfully developed 100% as expected using Unity software and Vuforia SDK engine. The design and functionality system of the AR scanner android application is fulfilling requirements of the project development and achieving the objective. The AR camera performance speed captured and recognised the physical object is rapid which is not above to 2 seconds to display the information product with the price shown on the mobile device screen when the user or consumer points the camera to the product without having to touch. The AR camera were able to recognise every 15 physical objects from 2 supermarkets where this trial run has been made to collect the database in this project. This AR application can help people with myopia and reduce the shopper time while shopping, and at the same time they have the product knowledge of the item that has been purchased. However, updates will still be needed for this AR application as the startup of the performance of speed and output function can

still be improved. The functionality and design also need to be improved as more output information can be added such as price comparison table, ingredients description, halal information and other details related.

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