A features determination of an Augmented Reality application with regards to commercial perspective

Voravika Wattanasoontorn
College of Computing
Prince of Songkla University
Phuket Campus
Phuket, Thiland
voravika.w@psu.ac.th

Mathus Theppaitoon
College of Computing
Prince of Songkla University
Phuket Campus
Phuket, Thiland
mathus.b.able@gmail.com

Nattawut Boonsri
Phuket College of International Tourism
Phuket Rajabhat University
Phuket, Thiland
boonsri_nattawut@hotmail.com

***Abstract*— Regarding a commercial perspective, the cost of production of any application always one of the main concerns. In terms of an augmented reality application, both the aesthetic part from the graphic design team and the logical part from the developer team are defined in the early pre-production process for numerous factors. This paper presents a framework aim at decreasing production time with a case study of 'Canvas Kids,' a 3D augmented reality application for kids. By focusing on features determination of the application, the effort estimated with production working days from 5 experts in this field for each feature was compared with the satisfaction score from 42 target users. The satisfaction was studied in five perspectives, including aesthetic, joyful, time spent using the application, the number of functions used, and overall impression. The result shows that with our proposed framework, an augmented reality production team could decrease the production time by features preselected.**

Keywords*— *Augmented Reality, Functional Analysis, Feature Determination, Value Analysis

I. INTRODUCTION

As is generally known that a mobile application market still increasing steadily, and the group of applications for entertainment, such as games, applications for kids, and digital books, gain the most market share [1]. In terms of business by the law of supply and demand, this business is going more complicated. The blue ocean strategy is one of the solutions that the developer team may consider. To build the blue ocean strategy and build a viable business model and ensure that company profits, the sequence of buyer utility, price, cost, and adoption are taking into account. From an application development team perspective, the challenge can be the production cost reduction, which is one of the main concern issues [2]. This paper aims at presenting the new direction of a functional selection regarding a version update for Canvas Kids, an augmented reality application, as a case study. We propose the consideration of the estimated time that will be consumed in comparison with a users satisfaction survey.

Canvas Kids is a 3D coloring mobile application that brings the user step into a new world of imagination by used with its companion coloring paper, as illustrated in Figure 1. Canvas Kids creates 3D images suitable for children who can enjoy coloring and be amazed by beautiful creatures that come alive on the phone screen. Canvas Kids comes with an interactive three dimentional (3D) marker based augmented reality technology. Canvas Kids creates 3D images suitable for children of age two and older. There are some simple steps to get creative with the application start with go to www.canvaskids.info to download a coloring paper, then print it of choosing and get coloring on it. Second, open Canvas Kids application and aim the smartphone camera at the coloring paper. Finally, the application will create an interactive 3D moving character with the choice of colors. We note that an internet connection is needed while using the application and download the coloring paper.

Fig. 1. Overview of Canvas Kids application

Like other applications, since the business model of Canvas Kids is an in-app purchase for each 3D character. So Canvas Kids already produce many sets of characters such as ocean world, funny dessert, zoo land, and dinosaurs. Each set comes with at least eight characters. It means that there are more than fifty characters available for download. The problem of the developer team comes while preparing the new version, which required some news functions. Each new function that will be created will affect every 3d models that currently present at the online stores (Apple store and Google play store), and this means a lot of time and budget consumes. Besides, there is no guarantee that the new function will increase user satisfaction.

II. BACKGROUND

In digital art and application, the experience in 3D environments can be configured by three types: physical, functional, and visual realism [3,4,5], as illustrated in Figure 2. Since this paper deliberately focuses on functional interaction and production time, the description of functional interaction and 3D production in game development, which is the sophisticated part that causes of time required, will be depicted following.

The actions define functional interaction through a user interface by graphic user interface (GUI) widgets, which are pieces of objects that display information navigated by the user. For example, in the golf game to hit the ball user has to control different parameters, the type and number of the golf club, the hit direction, the club-head speed, and the velocity at which a golf club impacts with a golf ball. Figure 3 shows the club-head speed function of three different golf games. All three games have a similar idea to present this action. The

player needs to hold the mouse click and release when the pointer arrives at the intended scale.

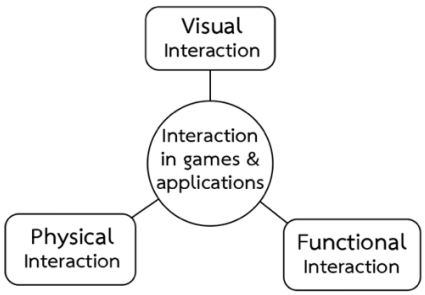

Fig. 2. Type of interaction in games and applications

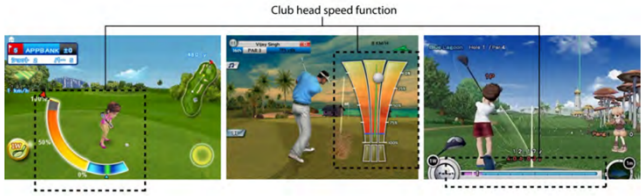

Fig. 3. Club head speed function of three different golf games

Estimating the effort, duration, and cost required to develop and maintain software production is crucial in software production control. Focusing on Software Cost and time Estimation, there are many technics applied, such as parametric model [6], Analogy [7,8], expert judgment [9], group Consensus, etc. According to the differences in details of each software or application, there are some significant requirements to be clarified before the project start. For example, to verify the corrected statement of work (SOW) and project framework, overly optimistic schedule.

Measurement of the effort provides for specific software products such as augmented reality application needs an understanding of the limitations and production framework. Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory [10]. Augmented reality in a mobile application typically connects digital animation to a unique marker, or with the help of GPS in phones, pinpoint the location. Augmentation is happening in real-time and within the context of the environment. In this research, we focus on Marker-based AR, also call it to image recognition, as it requires an individual visual object and a camera to scan it. It may be anything, from a printed QR code to distinctive signs. The AR device also calculates the position and orientation of a marker to position the content in some cases. Thus, a marker initiates digital animations for users to view, and so images in a magazine may turn into 3D models.

III. Research Methodology

This approach was divided into six steps (A to E), as shown in Figure 4. Each step is detailed below.

A. Game functional review

In this step, we have reviewed the functions presented in the augmented reality applications for kids from both App-store and Google Play store. The review focuses only on three dimensional (3D) AR applications. The review of nine applications at 7 June 2019 shows the results of 10 functions which are;

1) *Mini game*: a short video game often enclosed within an application or a game. It may contain different gameplay elements and is often smaller or more simplistic than the application in which it is contained.
2) *Painting*: including the painting onto a marker paper or real time painting onto a three dimensional (3D) in the application.
3) *Talking*: The 3D character can imitate any sentences that the user talks to the application or a form of sound and melody react to the user.
4) *Slam*: refers to Simultaneous Localization and Mapping, which is a concept that 3D model could figure out the physical world, significantly to a flat surface, through feature points.
5) *Navigation*: a function aim to control a character movement.
6) *Reskin*: a function has designs on changing the skin or visual appearance while uses the same model as the previous one. The presentation will be superficial differences by textures.
7) *Throw an object*: a user could throw or feed an object, which can be food fruit equipment, etc., into the character
8) *Animation*: a function allows a character to show a pre-defined animation.
9) Sharing: social media content dispenses that can be image, text, or video.
10) Image Capture: by snap a shot and possession it into the application or mobile.

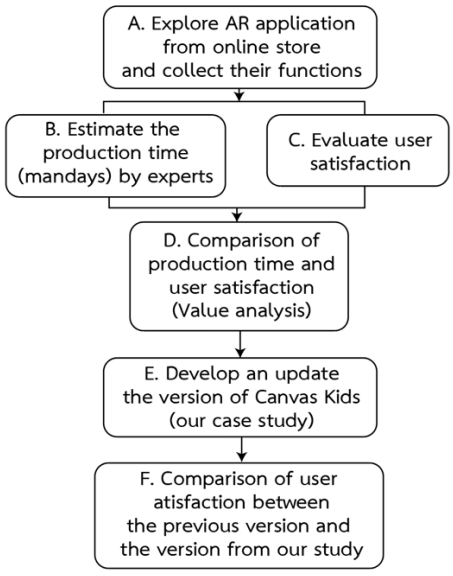

Fig. 4. Study approach

B. Production time estimation

All functions mentioned in the previous section were produced within Canvas Kids application. The application is sent to 5 expert teams, which each team consist of one graphic designer and one developer, and ask for production time estimation by working days (man-days). An expert is qualified

with five years of experience in their field in the game and application industry. The survey results show in Table 1.

TABLE I. PRODUCTION TIME ESTIMATED FOR EACH FUNCTION BY EXPERT

Functions	Estimated Effort (Mandays)					Avg	SD
Mini game	45	30	20	15	30	28.00	10.30
Painting	45	30	20	20	20	27.00	9.80
Talking	20	30	25	15	20	22.00	5.10
SLAM	12	15	15	10	15	13.40	2.06
Navigation	15	12	10	10	12	11.80	1.83
Reskin	12	10	10	10	12	10.80	0.98
Throw an object	10	12	10	8	10	10.00	1.26
Animation	5	7	3	5	5	5.00	1.26
Sharing	3	2	2	1	2	2.00	0.63
Image Capture	2	1	2	1	2	1.60	0.49

The study results, as shown in Figure 7, states that the average production time consuming is between 1.60 to 28.00 man-days, while the standard deviation is between 0.49 to 10.30. The top three of the most time-consuming functions are; mini-game, painting, and talking accordingly. On the other hand, the top three of the less time-consuming functions are; image capture, share an interface to social media, and show animation, respectively.

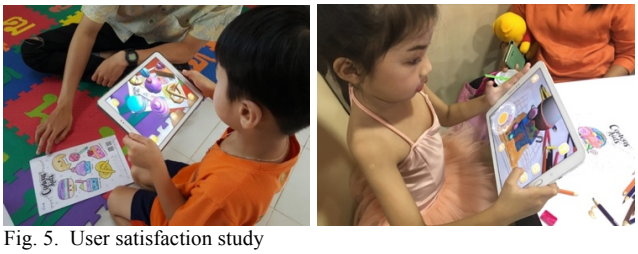

Fig. 5. User satisfaction study

C. *User Satisfaction*

The user satisfaction for each function was studied by 42 children who are between 2 to 11 years old as show in Figure 5. During the study children allowed to use Canvas Kids for five minutes under the observation of a researcher. The researcher identified the satisfaction score by observing and identify the children's emotions in comparison with a scale that was set as present in Figure 6.

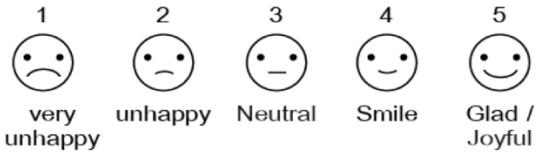

Fig. 6. Satisfaction (smile) scale

The study results, as shown in Table II, states that the average satisfaction score is between 2.95 to 4.10 out of 5.0, while the standard deviation is between 0.50 to 1.07. The top three of the most satisfying functions are; talking, throw an object, and navigation accordingly. On the other hand, the top three of the less satisfying functions are; share an interface to social media, mini-game, and SLAM, respectively.

D. *Value analysis*

By the discussion between the development team, business owner and marketing expert with the comparison results between production time and user satisfaction as shown in Table III are aggregated as follows

1) Despite talking function gain, the highest satisfaction score (4.10 from 5.0), but it takes the most productive time (22 man-days) as well. Therefore, this function was not counted for the next step.
2) The next four functions, including throw an object; navigation, animation and reskin, were interested since they gain a high satisfaction score (from 3.62 to 3.86 out of 5.0) while the production time is acceptable (between 5.00 to 11.80 man-days).
3) About painting and capture, they are already applied to the marker-based augmented reality application, Canvas Kids, as the primary function. Nevertheless, please note that the production time for painting function is the highest one from the function that was listed.
4) The remaining functions were denied because the satisfaction score is less than 3.5 (out of 5.0)

TABLE II. AVERAGE USER SATISFACTION SCORE FOR EACH FUNCTION

	Satisfaction	
Functions	Avg	SD
Talk	4.10	0.68
Throw an object	3.86	0.80
Navigate	3.81	0.55
Animated	3.79	0.77
Reskin	3.62	0.72
Paint	3.60	0.62
Capture	3.57	0.54
SLAM	3.19	0.50
Mini game	3.12	0.82
Share	2.95	1.07

TABLE III. THE COMPARISON OF USER SATISFACTION AND ESTIMATED PRODUCTION TIME (MAN-DAYS) FOR EACH FUNCTION

	Satisfaction		Effort (Mandays)		
Functions	Avg	SD	Avg	SD	Reuse
Talking	4.10	0.68	22.00	5.10	
Throw an object	3.86	0.80	10.00	1.26	*
Navigation	3.81	0.55	11.80	1.83	*
Animation	3.79	0.77	5.00	1.26	
Reskin	3.62	0.72	10.80	0.98	
Painting	3.60	0.62	27.00	9.80	*
Image Capture	3.57	0.54	1.60	0.49	*
SLAM	3.19	0.50	13.40	2.06	*
Mini game	3.12	0.82	28.00	10.30	
Sharing	2.95	1.07	2.00	0.63	*

E. *Version development*

Four functions that were selected from the previous section are defined to be with Canvas Kids as a version of our study. It will be evaluated with a target user to verify the satisfaction compared with the previous version. There are five aspects including aesthetically, joyful, time spending, function usage and overall satisfaction that will be assessed.

Fig. 7. Canvas Kids's Graphic user interface (GUI) of the previous version

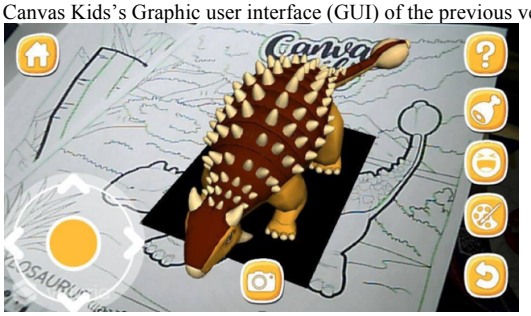

Fig. 8. Canvas Kids's Graphic user interface (GUI) after the study version

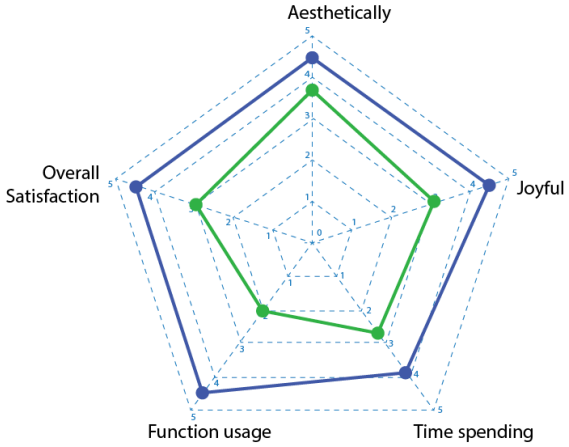

Fig. 9. The spider chart of user satisfaction score of Canvas Kids application both the previous version (in green) and the version after our study (in blue)

TABLE IV. THE COMPARISON OF SATISFACTION SCORE OF CANVAS KIDS APPLICATION BETWEEN THE PREVIOUS VERSION AND THE VERSION FROM OUR STUDY

	Aesthetically	Joyful	Time spending	Function Usage	Overall Satisfaction
Old version					
AVG	3.80	3.10	2.77	2.00	3.03
SD	0.65	0.75	0.76	0.00	0.71
New version					
AVG	4.47	4.43	3.97	4.53	4.50
SD	0.62	0.56	0.91	0.56	0.50

F. Comparison between 2 versions

The comparative of two versions of the Canvas Kids application, the previous version and the version from our study, was assessed with 30 children. Two versions of Canvas Kids were introduced and allowed the children openly used with one of our researchers as an observatory. After 15 minutes, the children were asked questions about the satisfaction in five aspects mentioned in the previous section.

IV. RESULT

The comparison results of two versions of the Canvas Kids application, the previous version, and the version from our study are shown in Table 4 and Illustrate as a spider chart in Figure 9. The results show that generally, the participants satisfy more on Canvas Kids that contain four functions of our study in every aspect.

V. CONCLUSION

Our study proposed the concept of comparison the user satisfaction and production time (man-days) to find the appropriate functions for functional reconstruction in the updated application version. The evaluation results show a good consequence in comparison with the previous version. This concept also can decrease the production time by 28.35% (From 52.48 to 37.6 man-days) in addition to the outcome of user satisfaction scores that can be a benefit to the development team in the future.

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