

Developing Augmented Reality Hybrid Marker using Pictorial Quick Response Code for Community Products



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Abstract: Applying augmented reality technology correctly helps businesses grow and attract more consumers, but using the marker that is the QR code does not directly interpret. On the other hand, if using pictorial markers, although they can convey meaning, it still takes time to process to extract the hidden information. This paper proposes to develop the hybrid marker for augmented reality by mixing the community brand image with the QR code for community product entrepreneurs, and develop the mobile application for scanning the hybrid marker then respond to the augmented reality content in several styles. The hybrid marker was generated into two modes. The opacity layer mode was set the opacity value of QR code to 55%. And overlapping mode is designed to invert the pixel color between pictorial band image and QR code. This system was evaluated in black-box testing. As a result, the efficiency of the hybrid marker and mobile application is the highest level of user acceptance while being used in this system.

Keywords: augmented reality, community product, pictorial marker, QR code.

I. INTRODUCTION

Applying the right technology platform for a business will help create benefits for existing markets and emerging markets [1][2]. Especially in business or marketing that uses modern technology as a tool to help increase efficiency and capability in the business even more. Currently, modern technology plays an important role in making devices and tools as capable as computers but smaller in size, such as notebooks, tablets, and smartphones, which help in presenting digital information in various forms, including images, audio, and videos to look like augmented reality (AR) [3]. Resulting in consumers being able to receive information in a variety of digital formats more easily. The investment and implementation of Augmented Reality is one way of achieving competitive advantages in marketing and completeness. Therefore, marketing with AR will open up new perspectives of the business world on devices that create sensory experiences through all five senses [4].

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Augmented reality technology is an innovation that helps present two-dimensional and three-dimensional virtual objects under real-world results. It has a form of work or display similar to the presentation of virtual technology in science fiction movies in the past, but only today can be created and used in the form of human-computer interaction (HCI) [5]. AR consists of the marker, the camera as a scanner, a program or application, and a database for storing links and virtual data that must be displayed in the real environment. In general, there are two popular methods of creating an AR marker: Quick Response (QR) code marker and Pictorial marker.

For QR code marker, it is two-dimensional code which includes the information and machine can read this code. It was first designed and released in 1994 by Denso Wave in Japan for use in the automotive industry [6] and is still being used extensively both commercially and non-commercially to this day. Because the QR code can compensate or correct errors caused by display errors or print QR codes on various media by itself. There is also a specification hidden in the code without losing the time to read or interpret the code. It does not want to rely on the database to store data in these codes at all. This information in the QR code cannot be perceived by human vision. Therefore, it is necessary to translate the QR code then get a lot of hidden information.

For pictorial marker, it is a picture or image which has meaningful content on human sight [5]. But this marker requires a database for storing information that needs the processing time or detection time [7], unlike the QR code marker. This research has the concept of applying the integrated AR marker between QR code and community brand images that community entrepreneurs use to create stickers for products. Customers can recognize that this hybrid marker is a brand image that can be interpreted by itself and can be scanned or detected as a QR code that will display various information as the product owner wants to present to the consumers. Therefore, this article aims to improve the image brand that the community product owners currently use and apply it to the QR code to enable the community brand to be an augmented reality marker that can be detected quickly and meaningful to help promote the market for community products in another way.

II. RESEARCH METHODOLOGY

A. Data collection

In this work, the researcher collected data and needs of community product entrepreneurs, consisting of 30 people, by using a branded picture from each entrepreneur with the information they need to present the information in the form of AR technology for use in publicizing, promoting, and publicizing their community products to the consumers.

For data collection methods, the researcher used face-to-face interviews directly with entrepreneurs.

B. System analysis and design

At this stage, the collected data is analyzed to find the system requirements for creating the hybrid marker and the ability of mobile applications for marker detection and display of the information style.

The consistency of the hybrid marker design and mobile application features were analyzed by five experts in the field of information technology and marketing. The Index of Item-Objective Congruence (IOC) is used as a guideline for grading and evaluating the content of the system design and the hybrid marker, IOC can be calculated in (1) [8]:

$$IOC = \frac{\sum R}{N} \tag{1}$$

Where:

$\sum R$ is the total of scores by each item of system design.

R is the score assessed by each expert for each item of system design.

N is the number of experts in total.

In interpreting the results of the evaluation with the IOC, the maximum value of IOC is 1. If the IOC has a value of 0.5 or higher, it is considered that the evaluation topic is expertly agreed and the content of the design suitable for development in the next phase [9][10]. In this work, all evaluated topics and criteria content indicators are equal or higher 0.8. It means the all features and hybrid marker design met the objective and were suitable for use in the mobile application development.

C. Development of hybrid marker for the community products

This research develops by applying QR code overlaying on existing community brand images from entrepreneurs to be placed in a hierarchy for quick scanning but still gives the meaning of community brand images. The developed hybrid marker is possible for both color and black and white images. There are two mode of hybrid marker was designed in this system.

First, the overlapping mode, this mode is used to invert both pixel color that overlapping between QR code and pictorial band image. There are three steps for generating this hybrid marker. The first step is to overlap both images in two layers, similar to the initial step in opacity layer mode. Next step, finding the pixels which are crossing over the pixel and pixel color are similar or closed, in this work called “pixel overlapping.” Last step, all of the pixel overlapping was invert into different colors such as white color, the main color

of pictorial band image, and darker color.

Next, the opacity layer mode is used to drop the opacity value on both QR code and pictorial band image. This technique is a basic concept for display both layout of QR code and pictorial community band image. In experimental, the researcher tried to setup the opacity value range between 45% to 75%. The suitable opacity values are range between 50% to 60%. Therefore, the default opacity value was set as 55% and allows the users to adjust it by themselves.

Figure 1 shows the example of hybrid marker in overlapping mode, and Figure 2 shows the example of hybrid marker in opacity layer mode. The opacity values were set to 55% and 100% for QR code and pictorial band image respectively.

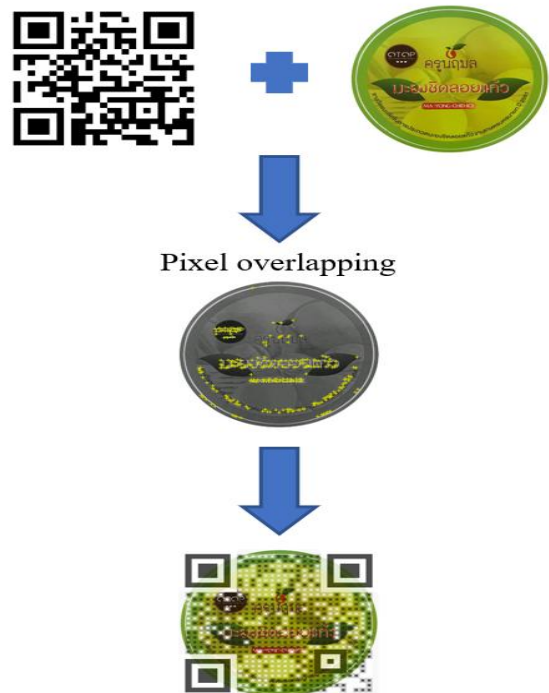


Fig. 1. The example of hybrid marker from color community brand image in overlapping mode.



Fig. 2. The example of hybrid marker from color community brand image in opacity layer mode.

Considering to pictorial brand image in gray scale or black and white picture, user can define the main color and combine or overlaying the QR code on pictorial brand image directly. The example of combination of QR code and community brand image illustrate as Figure 3.



Fig. 3. The example of hybrid marker from black and white community brand image.

D. Development of augmented reality content

The augmented reality contents or information were developed at the stage. There are several styles of contents such as image, uniform resource locator (URL), three-dimensional (3D) object, video format or open media in YouTube viewer. This developed system allows the user as entrepreneurs to choose their QR code, community brand image, and content for display information to consumers. In general, QR code can keep the hidden information as redirected URL. This research applied this benefit of redirected URL when the customers scan the hybrid marker without the mobile application. It will be asking for confirmation to automatic redirect to installation the mobile application or asking for viewing the augmented content directly on web browser from the content server which provides in this system. Figure 4 shows the simple flow of hybrid marker scanning and detecting the mobile application installation.

E. System implementation and evaluation

This developed system was installed on AR content server which provides in this work and implemented for users who are community product entrepreneur. These users have received training on how to use the system to test and use the system from the process of creating a QR Code, selecting the brand image and then creating it as a hybrid marker, selecting the content to be used and offer to consumers, and initial system implementation tests. Figure 4 and 5 show the sample contents that user choose to display for customers.

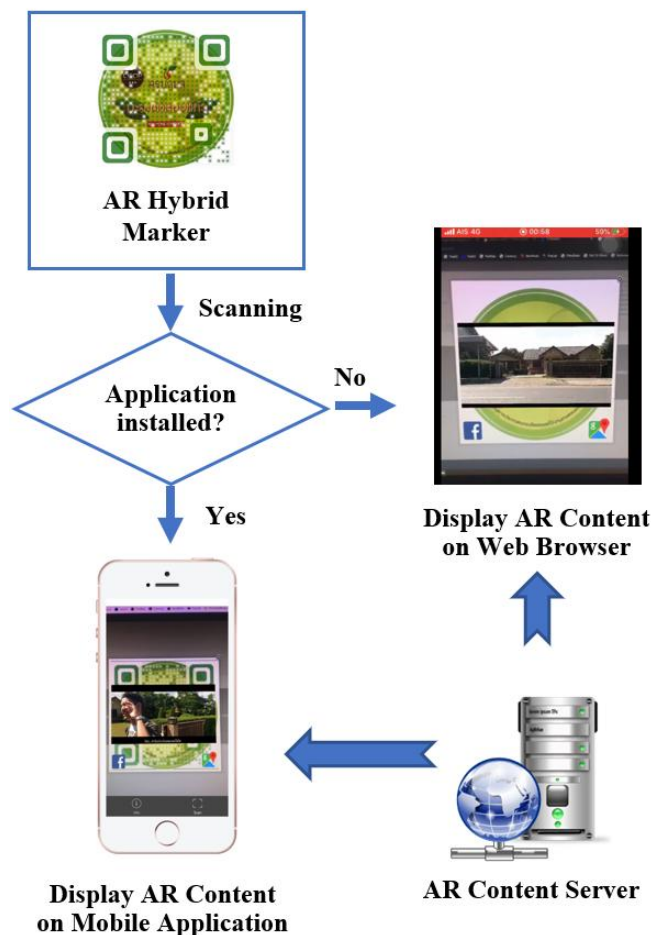


Fig. 4. The simple flow of hybrid marker scanning and detecting the mobile application installation.



Fig. 5. The hybrid marker and augmented reality content in style of video or YouTube.

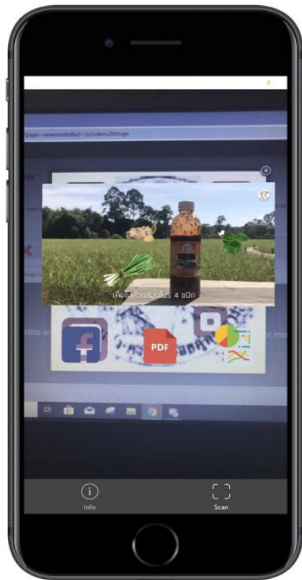


Fig. 6. The hybrid marker and augmented reality content in style of URL on web browser.

the AR hybrid markers and the mobile application were evaluated in the concept of black box testing by 30 entrepreneurs and five experts who expertise in information technology or marketing. The criteria topic for black box testing includes functional testing, compatibility testing, usability testing, performance testing, and stress testing. All tests were graded the score between one to five point in term of Likert scale [11] guidance. The scores were summarized and analyzed to mean, standard deviation (SD), and interquartile values [12].

III. RESULT AND DISCUSSION

The results of developing AR hybrid marker using pictorial QR code for community products were shown as follows.

A. The efficiency of hybrid marker and application

Based on black box testing, the result shows that all criteria topic evaluated by five experts has a mean value equal or higher 4.56 with SD value does not over 0.53. Besides, by 30 entrepreneurs, the mean value equal or higher 4.77 and SD value does not over 0.43 for all testing. The minimum mean of criteria topics is 4.56 for both experts and entrepreneur’s evaluation. The mean values of functional testing and performance testing are higher than another testing.

According to the mean value in total, it was 4.64 for the expert’s evaluation and value at 4.81 for the entrepreneur’s evaluation. Thus, the efficiency of overall black box testing in this work is the highest level. The black box testing results shown in Table I.

Table- I: The black box testing results of hybrid marker and application

Criteria topic of evaluation	Experts		Entrepreneurs	
	Mean	SD	Mean	SD
1. Functional Testing	4.78	0.44	4.83	0.38
2. Compatibility Testing	4.56	0.53	4.80	0.41
3. Usability Testing	4.56	0.53	4.80	0.41
4. Performance Testing	4.78	0.44	4.83	0.38
5. Stress Testing	4.56	0.53	4.77	0.43

Criteria topic of evaluation	Experts		Entrepreneurs	
	Mean	SD	Mean	SD
Total average	4.64	0.48	4.81	0.40

B. User acceptance of hybrid marker and application

In this experimental, the efficiency of hybrid marker and application were analyzed and evaluated for user acceptance in domain quartiles. This evaluation is consisting of first-quartile (Q1), median, third-quartile (Q3), interquartile range (IQR), and quartile deviation (QD). The results of all quartiles were shown as Table II.

Table- II: The results of user acceptance of hybrid marker and application

Criteria topic of evaluation	Mean	SD	Quartiles			IQR	QD
			Q1	Median	Q3		
Experts							
1. Functional Testing	4.78	0.44	5	5	5	0	0
2. Compatibility Testing	4.56	0.53	4	5	5	1	0.5
3. Usability Testing	4.56	0.53	4	5	5	1	0.5
4. Performance Testing	4.78	0.44	5	5	5	0	0
5. Stress Testing	4.56	0.53	4	5	5	1	0.5
Total average	4.64	0.48	4	5	5	1	0.5
Entrepreneurs							
1. Functional Testing	4.83	0.38	5	5	5	0	0
2. Compatibility Testing	4.80	0.41	5	5	5	0	0
3. Usability Testing	4.80	0.41	5	5	5	0	0
4. Performance Testing	4.83	0.38	5	5	5	0	0
5. Stress Testing	4.77	0.43	5	5	5	0	0
Total average	4.81	0.40	5	5	5	0	0

According to Table II, the IQR is the value of Q3 which is subtract by Q1. All IQR values do not over 1 and the QD is not over 0.5. Thus, the hybrid marker and the application are high consensus when evaluated by experts and entrepreneurs.

IV. CONCLUSION

This research presents the hybrid marker for augmented reality by mixing the QR code overlaying on the existing pictorial brand image of the community products. There are opacity layer mode and overlapping mode for generate the hybrid marker. The opacity layer is a simple technique to adjust opacity value of QR code by default it was set to 55%. The overlapping mode is applied by invert the color of pixel overlapping between QR code and pictorial brand image. The hybrid marker can be detected quickly and meaningful to consumers and respond to the augmented reality contents such as image, URL, 3D object, and videos or YouTube in the viewer. The community product entrepreneurs can manage their hybrid marker by mixing the picture of their product with QR code and provides the several type of augmented reality content by themselves. In case the consumers do not install the mobile application, this system will force asking the users to confirm for install this application on their smartphone or asking to view the augmented reality content from the AR content server directly which is provides in this system.



The efficiency of the hybrid marker and developed mobile applications are evaluated in black box testing by experts and entrepreneurs in terms of functional testing, compatibility testing, usability testing, performance testing, and stress testing. All tests were evaluated and analyzed to mean, SD, and quartiles. The minimum mean of criteria topics is 4.56 for both experts and entrepreneur's evaluation. Considering to the result of user acceptance for this system, the IQR values are not over 1 and QD values are not over 0.5. It can be said that the hybrid marker and developed mobile application for augmented reality has the efficiency in the highest level and improve the meaningful AR marker by mixing the pictorial brand image with QR code for the community products.

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REFERENCES

1. A. C. Hax, *The delta model: Reinventing your business strategy*, SpringerLink, 2010.
2. S. Mohapatra, *Business process automation*, New Delhi: PHI Private Lited, 2009.
3. R. Nilanjan, *Emerging Innovative Marketing Strategies in the Tourism Industry*, IGI Global, 2015.
4. S. Sumesh, *The Augmented Reality Marketing: A Merger of Marketing and Technology in Tourism*, IGI Global, 2016.
5. A. Tikanmäki and J. Röning, "Markers—Toward general purpose information representation," *Proceedings of the IROS2011 Workshop: Knowledge Representation for Autonomous Robots*, San Fransisco, CA, USA, 25 September 2011.
6. DENSO WAVE INCORPORATED. (2020, January 29). DENSO WAVE, the Inventor of QR Code. [Online]. Available: <https://www.qrcode.com/>
7. R. H. Le, M. Nguyen, H. Tran and W. K. Yeap, "Pictorial AR Tag with Hidden Multi-Level Bar-Code and Its Potential Applications," *Multimodal Technologies and Interaction*, vol. 1, no. 20, pp. 1-22, 2017.
8. M. R. Lynn, "Determination and quantification of content validity," *Nursing Research*, vol. 35, 1986, pp. 382–385.
9. S. Nuanmeesri, "Mobile application for the purpose of marketing, product distribution and location-based logistics for elderly farmers," *Applied Computing and Informatics*. Vol. 9, 2019.
10. S. Nuanmeesri, "Extended Study of Undergraduate Students' Usage of Mobile Application for Individual Differentiation Learning Support of Lecture-based General Education Subjects," *International Journal of Online and Biomedical Engineering*, vol. 13, no. 9, 2019, pp. 99–112.
11. R. Likert, *A Technique for the measurement of attitudes*. Archives of Psychology, New York University, 1932.
12. J. Han, M. Kamber, and J. Pei. *Data Mining: Concepts and techniques*, 3rd ed., Morgan Kaufmann, 2012.

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