

# Development and Evaluation of i-Brochure: A Mobile Augmented Reality Application

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**Abstract**—Brochure is a typical promotional tool that has been used by most higher learning institutions to disseminate information to their prospective international students. However, some drawbacks of brochure include; information consisting of only text and images, non-interactive and if updated, the brochure will be obsolete. With the advent of mobile technology, Mobile Augmented Reality has been introduced to facilitate human in their daily lives. This paper discusses the development and evaluation of a Mobile Augmented Reality interactive brochure application. The aim of this application is to provide interactive information beyond that of a typical brochure in promoting higher learning institutions amongst the international students. By using the Mobile Augmented Reality application, the students will be able to access information in the form of virtual contents which cannot be acquired from a typical paper brochure. The results of user evaluation towards the use of the application indicated that they agreed with all the measurements which include Usefulness, Ease of use, Functionality and effectiveness, Outcome/future use and Satisfaction.

**Index Terms**—Advertising; i-Brochure; Higher Institution; Mobile Augmented Reality.

## I. INTRODUCTION

In the educational field, Malaysia has attracted nearly 80,000 international students in 2010, coming from about 100 countries. This is attributed to its high quality of education, low fees, peaceful multicultural society, using English as a medium of instruction and the political stability. As such, Malaysia has set another target that is to attract 150,000 international students to come and study in Malaysia [1]. In promoting a Higher Learning Institution (HLI), the typical media that are normally being utilized include websites and brochures. These media are utilized to disseminate as much information as possible to the prospective students. In the case of the brochure, it is the most widely used approach. However, some drawbacks of brochure include information consisting of only text and picture that are static, non-interactive and if updated, the brochure will be obsolete. According to Zins and Elias [2], very limited research has been conducted to involve modern technologies to the existing brochures. Commercial technologies that have been introduced into this area have had limited success. Since mobile phones are getting more powerful in terms of hardware and capabilities, they can be used to benefit human through the introduction of new mobile applications.

One of the missions of Universiti Utara Malaysia (UUM) is

to provide the international students with complete information about the university by using brochure as one of the promotional media. However, based on the authors' observation, the information provided by the existing brochure is limited to the programs that are being offered by the respective colleges. In order to further understand the situation, a preliminary study has been conducted amongst the international students of UUM pertaining to the information that is of utmost important to them prior to coming to UUM. The study was conducted amongst 50 international students who were selected based on the convenient sampling technique. The results indicated that the respondents were not able to get complete information related to the academic programs, academic facilities, student accommodation and places at the university from the existing UUM brochures. The study also indicated that only 22% of the students were satisfied with the information that they acquired from the brochure and 94% believed that the brochure can be further enhanced.

In addressing this issue, this paper presents the interactive brochure (i-Brochure), an application based on Mobile Augmented Reality (MAR) which aims to facilitate and provide necessary information to the prospective international students. Through this application, they are able to view more information about UUM through interactive displays provided through the use of the i-Brochure application.

The remaining part of this paper is organized as follow: Review of literature is given in Section II. In Section III, we present the development of the i-Brochure application. Then in Section IV, we describe the evaluation of the i-Brochure application. Section V and VI present the results and discussion and finally, we conclude in Section VII.

## II. REVIEW OF LITERATURE

Augmented Reality (AR) is considered a variation of Virtual Reality [3]. In AR, the user can see the real world, with virtual objects superimposed upon or composited with the real world [4]. Additionally, AR generates a coalition which brings closer the virtual elements and real elements simultaneously on the screen with additional multimedia elements such as audio, video, and graphics based on the real world perception [5]. In other words, AR technology is not new and is concerned mainly with connecting the virtual objects in the actual world. A plethora of researches have been conducted to

study the utilization of AR technology in many areas which include; medical [6], [7], military [8], [9], manufacturing [10], [11], entertainment [12], [13], advertising [14], [15], education and training [16], [17].

#### A. AR in Advertising and Marketing

AR has been widely used in various forms in advertising and marketing. Several established and well-known companies around the world such as McDonald, Coca-Cola, Nike and Kellogg to name a few have adopted this technology as a tool in their marketing. AR as a modern way of advertisement is believed to be a perfect option to support in achieving the aims of advertising. This section discusses several studies on the application of AR in advertising.

Connolly and colleagues [18] studied information retention related to advertising among people by using standard 2D printed media and AR. The findings demonstrated that both methods are effective in providing visual components or products and generate interest in the product. Additionally, the results implied that the 2D printed media is much more effective in offering the required factual information. Thus, a possible explanation to this is that for the augmented reality advertisement, participants only viewed video recordings of the augmented reality advertisement.

Kolb [19] reviewed a study by Acentric on the effectiveness of Augmented Reality in advertising. An advertisement based on AR technology was created and published in the 2011 May issue of CAR magazine regarding a new Mercedes-Benz model. An evaluation among 79 respondents who were instructed to use the online AR advertisement revealed that 63% of the respondents checked out and view the AR advertisement on the website. It was also revealed that 86% of the respondents were interested in viewing the online advertisement remembered the Mercedes-Benz.

Another study conducted by advertising and marketing consultants [20] investigated parents' validation of AR advertisement which involves children's gadget. The sample of the study included two groups of 100 parents to compare between two types of advertising media; 2D printed and AR in order to know the best places to buy toys for their kids. Having watched the 2D printed advertisement, 45% of the sample considered buying toys, while 74% considered buying toys after viewing the AR advertisement. As a consequence, the highest price for the purchased games after viewing the AR advertisement was £7.99, whereas the highest price related to those who viewed the 2D printed advertisement was only £5.99. However, in terms of time spent on each type of the advertisement, AR advertisement viewers spent more time, 1 minute and 23 seconds, viewing the products. In contrast, the 2D printed advertisement viewers spent only 12 seconds. It was concluded that the more interesting the advertising media is, the more engagement on the part of the viewers and a higher possibility of the willingness to purchase a product even at a higher price. These findings indicate that the AR advertisement is effective in influencing the customer's decision in buying products.

Kim and Kim [21] studied on the implementation of AR for Smartphone advertisements. They developed the markerless AR Smartphone application aimed at conveying information

on advertisements to users. However, their study did not involve user evaluation on the application.

Wiwatwattana and colleagues [22] developed an iOS AR application as a sales marketing instrument to dramatically enhance the brand experience for ice dessert. The application enables the customers to select the ice flavours and toppings which are augmented over the real cone/cup by the customers themselves. The customers can see what they have ordered in real-time on the mobile screen and later received their order at the parlor.

Löchtfeld and colleagues [23] investigated two concepts for AR advertising for paper-based leaflets. They argued that leaflets are still one of the most important advertising mechanisms for retailers since leaflets create a higher emotional connection and with that more positive memory for brands and retailers. They presented GuerrillAR, an application for augmenting single pages with advertising content and PageAR, an application that supports users browsing through multi-paged advertising leaflets.

Even though many researches have been conducted to study the utilization of AR in advertising, most of them focus on the commercial products. There is a paucity of research on the utilization of Augmented Reality for the purpose of promoting Higher Learning Institutions (HLIs). Moreover, conceptual model or framework in developing an effective Augmented Reality HLIs promotional tool is still scarce. As such, this paper presents an initial effort toward the development and evaluation of an AR tool for the purpose of promoting HLIs.

### III. DEVELOPMENT OF THE I-BROCHURE APPLICATION

The development of the i-Brochure application was based on the spiral approach. The Spiral model which is represented by a spiral passing through four quadrants was adapted from Barry Boehm [24] represents the four phases of development namely; i) Planning, ii) Risk Analysis, iii) Engineering, and iv) Evaluation as shown in Figure 1. Each phase of the Spiral model involves sub-phases or rules and results where each phase result was passed to the next phase and so on and the phases were repeated until a proper application has been achieved.



Figure 1: Spiral Model

### A. Planning

This phase involves requirement gathering activity which involves the gathering of all the required information for the content of the i-Brochure application. All the information required by the application was gathered based on the following steps. Firstly, all the information pertaining to the international students and the extent of their requirements for the application was identified through the use of a user requirement questionnaire. Secondly, photos and videos to be used in the application were collected, and then the size and quality were modified in order to suit the Smartphone screen and later saved as the MP4 file format. Thirdly, the audio files were gathered, then converted to 128 kbps bit rate and saved as the MP3 file format. Fourthly, a paper MAR brochure was designed and produced to act as a medium in order to allow interaction with the i-Brochure application as shown in Figure 2. The contents required for the i-Brochure application consist of videos, images, text, and icons.



Figure 2: The paper MAR Brochure

### B. Risk Analysis

A formal process has been undertaken to identify the risks and alternative courses of action in developing the application. The risks that have been identified include; the accessibility of the i-Brochure application and also the retrieval of the virtual contents. It was decided that the i-Brochure application could be accessed by any prospective students anytime regardless of their location as long as they have the MAR brochure. It was also decided that the prospective students are able to retrieve the virtual contents of the MAR brochure through the use of a readily available viewer or browser.

### C. Engineering

Metaio Creator 3.5.3 has been used to develop the i-Brochure application. The Metaio Creator Integrated Development Environment enhanced with Android and iOS

development tools were used as a plug-in tool to develop the i-Brochure application. Meanwhile, the virtual contents which mainly comprised of video and audio were created and edited using the Adobe premiere Pro CS6, Format Factory V2.60, Adobe Sound Booth and Audacity. Adobe Photoshop and Format Factory V2.60 were used to create and edit the required images, photos, and QR codes. Finally, the MAR brochure was designed in the Adobe Photoshop. The virtual contents of the i-Brochure application have been uploaded on to the Metaio cloud hosting to allow users to access them from their Android or iOS Smartphone. Figure 3 illustrates the work stages within the Metaio Creator software.



Figure 3: Work stages within the Metaio Creator software

### D. Evaluation

In this phase, the i-Brochure application that has been produced in the previous phase was then installed in an Android Smartphone for testing. During the testing phase, several errors pertaining to the videos, images, and functionalities were noted for the purpose of improving and enhancing the application.

## IV. EVALUATION OF I-BROCHURE APPLICATION

The evaluation of the i-Brochure application comprised of expert and user evaluations.

### A. Expert Evaluation

The expert evaluation was conducted to determine the robustness of the i-Brochure application user interfaces and functionalities. The rationale was to detect error in the application before presenting it to the end users. Evaluation by experts was employed to validate in terms of usability before being introduced to the end users. The experts were categorized into two groups. The first group was the content experts consisting of two officers from the Center for Academic Affairs, UUM. They were selected based on their knowledge and experience in matters related to the promotion of UUM among prospective international students. They have checked and validated the content of the i-Brochure application as well as the MAR brochure. The second group was the User Interface experts consisting of two lecturers from the School of Computing and School of Multimedia Technology and Communication, UUM. They were selected based on their knowledge and experience related to the user interface design and layout for mobile application.

### B. User Evaluation

User evaluation was conducted to determine the users' perception on the usability aspect of the i-Brochure application. The evaluation was based on the modified and improved i-Brochure application. A set of questionnaire was used as the instrument for the evaluation.

The questionnaire covers measurements which include; usefulness, ease of use, functionality and effectiveness, satisfaction, and outcome/future use. Usefulness measures the level a person believes about using a specific application would raise up the user's performance level [25]. Ease of use describes the degree of easiness for a particular application by being free of heavy effort [26]. Functionality and effectiveness measure user's perception of the function and effectiveness of the application [27]. Satisfaction measures the level of satisfaction of the user with the whole application and contents [28]. Finally, outcome /future use represents the degree of a person is expecting to use this application [29]. A 5-point Likert scale anchored by "Strongly Disagree" (1) and Strongly Agree (5) was used as shown in Table 1 [30].

Table 1  
Five-Point Likert scale format

	Strongly	Disagree	Neutral	Agree	Strongly
Score	1	2	3	4	5
Category	Disagree		Neutral	Agree	

User evaluation of the i-Brochure application was conducted amongst 50 international students of UUM (respondents). The respondents consist of 26 male and 24 female. In terms of education background, 27 of them have a master degree and 23 have Ph.D. In terms of age, 2 of the respondents were between the ages of 21-25 years, 17 were between the ages of 26-30 years, 17 were between the ages of 31-36 years, 7 were between the age of 36-40 and 7 were over 40 years.

## V. RESULTS

The results of expert and user evaluations are discussed in the following sections.

### A. Expert Evaluation

Table 2 shows the tasks that have been done by the experts and the results of the evaluation. During the evaluation, the i-Brochure application was able to recognize all the markers in the MAR brochure and displayed the appropriate virtual contents. All feedbacks and recommendations from the experts were documented and earlier version of the application was modified accordingly.

Table 2  
Results of Evaluation Among Experts

Task	Comment
View help	OK
View videos	OK
Show location information	OK
Show university information	OK
Show historical information	OK
Hide information box	OK
Scan QR code using Smartphone camera	There is a delay.
Download and run videos via cloud	OK
View information	OK
Share videos on Twitter and Facebook	OK

### B. User Evaluation

For user evaluation, reliability analysis and descriptive statistics were used. SPSS version 18 for Windows 7 was

used for all the analyses. The reliability was addressed for the user evaluation questionnaire. The Cronbach alpha values were calculated to determine the inter-item reliability which assesses the degree of internal consistency between multiple measurements of a dimension and are shown in Table 3. Since all the dimensions have Cronbach alpha values of greater than 0.7, thus, all of them satisfy the internal reliability criterion as recommended by [31].

Table 3  
Reliability of the Measurements

Measurement	Number of items	Cronbach Alpha
Usefulness	6	0.782
Ease Of Use	6	0.786
Functionality and effectiveness	6	0.794
Satisfaction	4	0.865
Outcome/Future Use	5	0.787

Evaluation from users' perspective is important in obtaining the users' opinion towards the usability of the i-Brochure application. The descriptive statistics for all the measurements and items are presented in Table 4. Eight items with means of more than 4.5 are bolded which indicate that most of the users strongly agreed on these items and just agreed on the rest of the items that are related to the i-Brochure application. However, there is only one item which is marked with \* has a mean of 3.98.

## VI. DISCUSSION

Since all the dimensions have Cronbach alpha values of greater than 0.7, thus, all of them satisfy the internal reliability criterion as recommended by Nunnally and Bernstein [31]. Table 4 indicated that eight items (in bold) have means of more than 4.5 which indicate that the users strongly agreed on these items. Outcome/future use has four items, Usefulness has three items and Satisfaction has one item with means of more than 4.5. Meanwhile, users just agreed on eighteen of the items that are related to i-Brochure. Only one item has a mean value of less than 4. The most logical explanation to this is that the information provided by the i-Brochure application can be retrieved after scanning the appropriate QR code. Since this application has been developed for online purposes, the contents have to be retrieved from the Metaio cloud hosting. The retrieval of the contents also depends on the internet connection speed. Overall, the users agreed on the Usefulness (4.48), Ease of use (4.29), Functionality and effectiveness (4.10), Satisfaction (4.53) and Outcome/Future Use (4.37) of the i-Brochure application.

## VII. CONCLUSION

Research in the utilization of MAR technology with a paper-based brochure for the purpose of promoting higher learning institutions is still scarce. As such, this paper has looked into the possibility of introducing a new approach of HLIs promotion through the use of the MAR technology. We have elaborated on the development of the i-Brochure application which is targeted to the prospective international students who are interested in continuing their studies in the HLIs. The

application is intended to be a supplement to the existing paper-based brochure, a commonly used tool by the HLI in promoting the institutions and all the programs offered by the institutions. Since most students are using Smartphone nowadays, the idea of developing the application coincides with the needs of the international students to acquire more information pertaining to any particular HLIs. Students require something that is straightforward, easy to use, interactive, trendy, easily available anywhere and anytime tool. The i-Brochure application is able to provide the prospective international students with comprehensive information about the institution which is not available via the conventional brochure.

This research also presented the results of user evaluation related to the usability of the application. The results indicated that the users agreed on all the measurements which include Usefulness, Ease of use, Functionality and effectiveness, Outcome/future use and Satisfaction. From the results, the following key strengths are apparent in terms of searching for information related to the HLIs. The users think that the use of the i-Brochure application would enable them to accomplish tasks more quickly, increase their information search productivity, enhance their effectiveness on information search, and complete their information search quickly and effectively. The users also enjoyed using the i-Brochure and they would use it regularly.

In sum, this paper enhances our understanding of the usage of the Mobile Augmented Reality in promoting the HLIs. Prospective students might interact with the promotional tool provided by the HLIs in order to determine the effectiveness of the promotional strategy. HLIs may benefit from the findings of this study particularly when deciding on the appropriate promotional tool according to the prospective students' preferences. It is hoped that the findings of this study will encourage more prospective international students to use the i-Brochure application in order to understand more about a particular institution prior to their arrival to the institution. At the same time, this will help the institution to introduce a new promotional strategy which is more creative, innovative, informative, usable and up-to-date among the international students. This will help the institution to be more recognized at the international level through the use of more interactive and trendy marketing and promotional tool.

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Table 4  
Descriptive Statistics for All Items

Measurements and Items	Mean	SD
<b>Usefulness</b>	4.4800	
1. Using the i-Brochure would enable me to accomplish tasks more quickly.	4.5200	.54361
2. Using the i-Brochure would improve my information search performance.	4.4400	.61146
3. Using the i-Brochure in my information search would increase my productivity.	4.6200	.49031
4. Using the i-Brochure would enhance my effectiveness on the information search.	4.5200	.54361
5. Using the i-Brochure would make it easier to do my tasks.	4.4600	.76158
6. I enjoyed using the i-Brochure.	4.3600	.52528
<b>Ease of use</b>	4.2900	
1. Learning to use the i-Brochure would be easy for me.	4.4800	.64650
2. I would find it easy to get the i-Brochure to do what I want it to do.	4.3600	.66271
3. It is easy for me to become skillful when I use the i-Brochure.	4.1400	.80837
4. I would find the i-Brochure to be flexible to interact with.	4.1400	.72871
5. I would find the i-Brochure is easy to use.	4.3600	.77618
6. I found it easy to work in i-Brochure.	4.2600	.80331
<b>Functionality and effectiveness</b>	4.1000	
1. Information was presented in a meaningful way.	4.1200	.52060
2. I could achieve what I wanted in the i-Brochure	4.0200	.62237
3. I found it easy to access all the functionality of the i-Brochure	4.1200	.59385
4. The i-Brochure is easy to use	4.2000	.72843
5. The i-Brochure shows the information step by step	3.9800*	.71400
6. The i-Brochure presented in useful format	4.1800	.59556
<b>Satisfaction</b>	4.3700	
1. I was satisfied with this type of i-Brochure	4.3600	.77618
2. I was satisfied with the overall learning effectiveness.	4.2600	.80331
3. I enjoyed using the i-Brochure	4.5000	.61445
4. I found the i-Brochure contents meet my needs	4.3800	.66670
<b>Outcome/future use</b>	4.5300	
1. I was able to complete my information search quickly using the i-Brochure	4.5400	.70595
2. I could effectively complete my information search using the i-Brochure	4.5200	.54361
3. I was able to efficiently complete the information search using the i-Brochure	4.4400	.61146
4. Based on current experience with using this i-Brochure, I think I would use it regularly.	4.6200	.49031
5. I believe I could become productive using the i-Brochure	4.5200	.54361

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