Perceived Benefit, User Satisfaction And Ease of Use of Mobile Augmented Reality (MAR) Shopping Aid

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Abstract

This aim of this study is to examine the effectiveness of mobile shopping aid using mobile devices through augmented reality. Against the background of emerging trends in mobile shopping, the researchers offer a mobile shopping aid or tool developed on the web, technology that is heightened with a novel setting, namely the augmented reality technology. Essentially, augmented reality is a computing environment in which the real world (as experienced through the camera of a mobile phone in real time) is superposed with a synthetic user interface. To elicit opinions and feedback from potential users, a survey involving 60 students (20 boys and 40 girls) were recruited to collect data pertaining to three important measures, namely *ease of use*, *perceived benefit*, and *user satisfaction*. The data gathered were analysed, and the findings indicated that these three elements were significant in making online shopping more effective. Thus, these findings emphasize that these three factors have to be carefully factored in the design of such a novel mobile tool to help ensure shoppers become highly engaged and satisfied in online shopping.

Keywords:

Augmented reality, mobile devices, online shopping, user satisfaction.

INTRODUCTION

The proliferation of mobile devices, such as smart phones, has been spurred in unison with various services based on mobile platform. Lately, many mobile services, in particular online shopping, have catapulted to another level of novelty through the use of augmented reality technology in virtual products are displayed on the mobile screen, which can be interacted with ease (Kim, 2011). Augmented reality (AR) has been viewed as an excellent technique for providing human–computer interfaces to various applications (S. Prince. et al, 2002), which can naturally complement physical objects by providing an intuitive and a collaborative interface to a three-dimensional information space embedded within physical reality. Essentially, augmented reality is a new strain of computer technology that captures real objects in real time through the mobile camera. Artificial objects, such as a virtual pencil, will superimpose these real or 'live' objects to allow the user to manipulate real objects interactively. Moreover, multimedia elements, namely video, sound, or graphics, are included to further reinforce the sense of immersion and presence. In essence, augmented reality is quite different from the generic virtual reality because both real and synthesized objects (or worlds) can co-exist to provide an environment that is interactive, 'media-rich', and responsive, making information processing in any type of activities (e.g., learning, training, shopping, etc.) more discerning through reinforced, augmented views. Thus, augmented reality provides a better comprehension of the real world compared to the generic virtual world (Luckin & Fraser, 2011).

From the educational and social standpoints, augmented reality provides a number of benefits to help humans cope with various demanding tasks. Of late, augmented reality has been making inroad in various learning, training, and social spheres. For instance, in the medical field (Patel, 2012), augmented reality has been used to help train young doctors to perform intricate surgical procedures where the patient's inner organs are digitally synthesized into virtual organs that can be surgically 'dissected' using real time navigation. In education, augmented reality provides compelling learning experiences to help students gain

a better understanding through multiple perspectives. For example, history students can visit a virtual museum in which they can interact with historical artifacts using their fingers or hands (captured by the camera) as the interface. This kind of interaction evokes a greater sense of reality than ordinary multimedia presentations. More and more applications of augmented reality are emerging as mobile devices can now support this technology. These applications are beginning to appear in the military, engineering, entertainment, and commerce. Whilst, the role of user interface in electronic commerce was tested for print versus on-line catalogs or e-commerce (Griffith, Krampf, & Palmer, 2001), pointing that medium intensity and other components of the content–presentation interface employable on a web site to stimulate higher levels of consumer involvement with retailer offerings and a more positive consumer response than a content–presentation interface of direct on-line replication of published fabric.

E-commerce provides numerous functions that have benefitted many sections of our society. Business minutes are performed almost spontaneously, regardless of time and space. For instance, buying books online can be easily performed by giving way to the relevant web site. Book titles can then be quickly queried and, once relevant information is fed to the user, the user will make the determination as to whether to buy or not. Online advertisements have also been making their presence prominently. Almost all products, ranging from small items to large items, are advertised online through the web. Communication has become more efficient where prospective purchasers can easily get to a company' website to browse products that are on sale. Recently, most companies' websites are interactive, rich (in media), and informative (by delivering a range of communication channels). In an attempt to further improve online shopping; many researchers have begun to concentrate on using augmented reality. Through this novel technology, online shoppers can not merely see the objects of interest, merely they can virtually 'touch' the objects by gesturing their actual hand onto the displayed objects – unlike the experiences that they accept from other shopping tools. Their shopping experiences can be further enhanced through multimedia elements. Therefore, the interaction between the shoppers and products is done more interactively and compellingly (Squire, 2010). However, finding such an online mobile shopping assistant or aid is extremely expert and quite prohibitively expensive; but on a plus note, the long term benefits can outweigh higher initial setup cost (Chen & Chang, 2014). The concept of customer satisfaction is often regarded as unitary of the central issues in the Internet shop (Lee, Pi, Kwok, & Huynh, 2003). Client satisfaction is important in the operation of Internet shopping because satisfied customers tend to attain not only more purchases, but also repeat purchases (Szymanski & Hise, 2000). Latterly, the allocation of product-related information through augmented reality has become a focal point in research (P. V¨alkkynen, et. al, 2012). An eminent example exemplifying the power of augmented reality is Google's Project Glass, which conveys augmented information into everyday life. The rapid technological advancement makes a monumental addition of application possibilities while the costs for hardware, evolution and implementation decrement. Otherwise, augmented reality is also continuously gaining in importance for corporate users such as retailers. Also the opportunity of displaying online content at the Point of Sales, augmented reality can also be used in the opposite way to simulate conventional shopping experiences in e-commerce (Agarwal & Pradeep, 2013).

Like any other technological tools, the success of mobile augmented reality shopping tool is dependent on a number of interrelated factors, which have to be given due emphasis. To explain the factors and their relations, several researchers have formulated a few models such as Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989), Unified theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis,

2003), DeLone and McLean model (DL&ML) (DeLone, & McLean, 2003), and Educational Technology Model (ETM) (Almarashdeh, Sahari, Mat Zin, & Alsmadi, 2010). Invariably, some of the newer models were formulated based on older models, thus some having the same underlying constructs, such as system quality, service quality, course quality, learner satisfaction, LMS use, and perceived benefit (Mtebe, & Raisamo, 2014). In this paper, the constructs that were examined were learner satisfaction, LMS use, and perceived benefit given that the remaining constructs mainly deal with the technical aspects of the systems. According to Ives, Olson, and Baroudi (1983), user (learner) satisfaction, which measures learner's attitude towards the system, is "the extent to which users believe the information system available to them meets their information requirements." Thus, if the user perceives the system to be poor, the system is rendered inferior. In contrast, higher learner satisfaction of the system will lead to higher "intention to use", which in turn improves usage (Delone & Mclean, 2003). Based on these interrelations, satisfied learners will perceive the system to be beneficial to their learning and will most likely use the system more persistently. The construct LMS measures the extent to which learners use the LMS, which in effect serves as a barometer that shows the success (or failure) of such a system implementation (Delone & Mclean, 2003). With frequent use of the system, learners will be more likely to improve their knowledge and skills – the positive impact of which will resonate throughout the organization. According to same researchers, measuring the net benefit of the system entails the evaluation of the system along with the purpose of the system. On the practical way to measure the perceived net benefit is through eliciting learners' perception on the benefit of the system (Mtebe, & Raisamo, 2014). In unison, all these factors will have a serious impact of the selection and use of such a LMS. Furthermore, the use of such a system will also be influenced by several mediating, notably demographic factors, which need to be considered when implementing online learning for students.

Against the backdrop of this context, the researchers carried out the study with the specific purpose to study the impact of online mobile shopping aid through augmented reality on prospective buyers' preferences. To help guide the research, the researchers formulated three research questions as follows:

a) What is the participant's perceptions of the augmented reality, mobile shopping aid in terms of ease of use?
b) What are the participant's perceptions of the augmented reality, mobile shopping aid in terms of perceived benefit?
c) What are the participant's perceptions of the augmented reality, mobile shopping aid in terms of user satisfaction?

AUGMENTED REALITY ON MOBILE SHOPPING AID

Essentially, augmented reality is a subset of mixed reality as conceptualized by Milgram and Kishino (1994). Figure 1 below shows the Reality-Virtuality (RV) continuum: real environment at one pole and virtual environment on the opposite pole. Clearly, users who are actually absorbed in the virtual environment will have a bigger sense of 'being in the real environment' when their experiences are augmented through augmented reality.

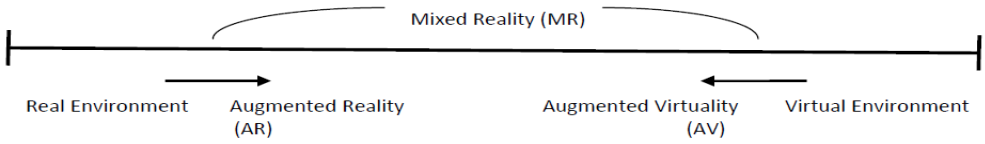

Figure 1. Representation of the Reality-Virtuality (RV) Continuum (re-drawn from Milgram et al., 1994)

Their vision, picking up, and touching are highly stimulated to perceive objects more deliberately, enabling their minds to make mental pictures of objects with ease. Interacting with the virtual objects become naturally easy through their hands. In essence, although the users consciously comprehend that objects seen on the screen are merely representations of actual objects, but the movements of the fingers (as captured from the camera) in manipulating the virtual objects seem 'real'. For instance, the user can focus the tablet camera (see Figure 2) on one page of a furniture magazine and automatically (and instantaneously) a virtual table pops out along the tablet screen. Having the virtual table appears on the screen allows the user to execute several roles such as viewing, rotating, moving, and other cases of manipulation in a lifelike way.

Figure 2. A snapshot of augmented reality in online furniture shopping

Obviously, augmented reality opens a new window of opportunity in many areas including online shopping. For instance, a prospective buyer can flip through a particular product magazine; at a certain page, the buyer using the mobile phone camera can zoom in on the target picture of a product detail. A few minutes later, a three dimensional object representing the particular merchandise item will appear on a company's network site. The user can start 'toying' with the product detail to consider its characteristics such as its colors, texture, dimensions, and (of course) price. Multimedia elements, such as video and audio, are also embedded to provide a more compelling representation of the product item. Hence, the buyer is fed with rich, timely information to help get safer conclusions.

Development tools

In this work, the researchers used a host of engineering sciences, namely Java, Eclipse, D'Fusion Software, and MySQL to develop the augmented reality Mobile Shopping Aid (AUGMENTED REALITY), which was implemented on Windows 8 platform. The first two technologies were employed to train the required user interface and augmented reality environment, whereas the third technology was employed to build up the database into which data are stored and recovered. Figure 3 depicts the principal elements of the mobile shopping aid.

Figure 3. The main components of the Mobile Shopping Aid

Fundamentally, the functions of AUGMENTED REALITY can be separate into two classes. The initiative includes the instructions and image printing. The second includes the product id, product info, and product preview. The manner in which the AUGMENTED REALITY is operated is by mapping information held in a magazine to the data in the database. Relevant information about producing items is based along the catalogue indices and product information listed on the back page. Each product detail is checked using a digital tagging representing the product id. Basically, buyers are able to explore the merchandise right from the magazine cover and then preview a product item with minimum effort in real time (see Figure 4). In addition, buyers can perform other parts that are linked to the particular product item such as seeking information on the manufacturers, date of manufacture, expiry date, and others (see Figure 5).

Figure 4: The product preview function

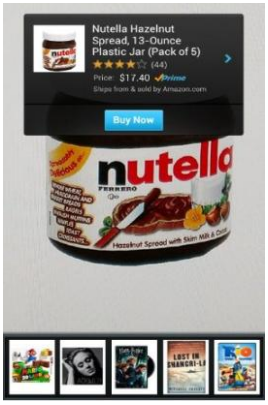

Figure 5: Product item information

RESEARCH METHOD

Participants

The research involved a survey in which a group of 60 students (20 boys and 40 girls) was recruited as survey participants. Their ages ranged from 18 to 24 years, and all of them were competent in online shopping, given that every one of them had at least one mobile device.

Procedures

In this study, two groups were formed where the first group (N = 30) used personal computers (without augmented reality) and the second group (N = 30) used mobile phones (with augmented reality) to perform a series of online shopping tasks. All the participants performed the online shopping tasks for half an hour in two computer labs at the same time. For the second group, the participants were instructed to position their phones at an approximate distance of 35 cm from the selected magazine. This was vital to ensure images scanned by the camera were of the right resolution (see Figure 6). After finishing the online shopping tasks, all the participants were administered with a questionnaire. This questionnaire helped the researchers to collect data pertaining to the AUGMENTED REALITY perceived usefulness, namely ease of use, shopping efficiency, memorability, and user satisfaction based on 4-point Likert scale (Nielsen, 1993).

Figure 6: The recommended distance between targeted images and hand phone

FINDINGS

Data collected were analyzed using the Statistical Package for Social Science (SPSS) version 20.0. The independent variable was the shopping mode (2 levels: non-augmented reality mode vs. augmented reality mode) and the dependent variables were ease of use, shopping efficiency, user satisfaction, and memorability. To determine main effects and interaction effects of these measures, a series of 2-Way Anova procedure were performed to detect any significant differences between these two shopping modes. The alpha significance level was set at 0.05 to detect any possible significant differences. Table 1 summarizes the means and standard deviations of the measured constructs (factors).

Table 1: The means and standard deviations of the measured constructs

Factors	Gender	Shopping mode			
		Non-Augmented Reality		Augmented Reality	
		Means	*SD*	Means	*SD*
Use	Boys	3.22	0.71	3.44	0.83
	Girls	2.90	0.97	3.90	0.67
	All	3.06	0.84	3.67	0.75
User	Boys	3.15	0.78	3.40	0.82

Satisfaction	Girls	3.10	0.82	3.50	0.77
	All	3.13	0.80	3.45	0.79
Perceived Benefit	Boys	3.28	0.75	3.55	0.80
	Girls	3.30	0.81	3.26	0.75
	All	3.29	0.78	3.41	0.77

For the measure of use, the overall mean scores (and standard deviations) of the non-augmented reality and augmented reality groups were 3.06 (*SD* = .84) and 3.67 (*SD*=.75), respectively. For the former shopping mode, the boys and girls attained mean scores of 3.22 (*SD* = .71) and 2.90 (*SD* = .97), respectively. For the latter shopping mode, the boys and girls attained mean scores of 3.44 (*SD* = .83) and 3.90 (*SD* = .67), respectively. For the measure of user satisfaction, the overall mean scores (and standard deviations) of the non-augmented reality and augmented reality groups were 3.13 (*SD* = .80) and 3.45 (*SD*=.79), respectively. For the former shopping mode, the boys and girls attained mean scores of 3.15 (*SD* = .78) and 3.10 (*SD* = .82), respectively. For the latter shopping mode, the boys and girls attained mean scores of 3.40 (*SD* = .82) and 3.50 (*SD* = .77), respectively. For the measure of perceived benefit, the overall mean scores (and standard deviations) of the non-augmented reality and augmented reality groups were 3.29 (*SD* = .78) and 3.41 (*SD*=.77), respectively. For the former shopping mode, the boys and girls attained mean scores of 3.28 (*SD* = .76) and 3.30 (*SD* = .81), respectively. For the latter shopping mode, the boys and girls attained mean scores of 3.55 (*SD* = .80) and 3.26 (*SD* = .75), respectively.

The first 2-way analysis of variance yielded a main effect for the shopping mode, F (1, 57) = 97.14, $p < .05$, such that the measure of use was significantly higher for augmented reality shopping mode. For the same measure, the main effect of gender was found to be non-significant, F (1, 57) = 1.89, $p > .05$. Likewise, no interaction effect was detected. The second analysis yielded a main effect for the shopping mode, F (1, 57) = 85.15, $p < .05$, such that the measure of user satisfaction was significantly higher for augmented reality shopping mode. For the same measure, the main effect of gender was found to be non-significant, F (1, 57) = 1.22, $p > .05$. Likewise, no interaction effect was detected for this measure. The third analysis yielded a main effect for the shopping mode, F (1, 57) = 74.14, $p < .05$, such that the measure of perceived benefit was significantly higher for augmented reality shopping mode. For the same measure, the main effect of gender was also found to significant, F (1, 57) = 43.24 $p < .05$. However, no interaction effect was detected for this measure.

DISCUSSION AND CONCLUSION

From the findings, there were significant differences in terms of the measured constructs between non-augmented reality shopping and mobile augmented reality shopping which favoured the latter mode of shopping. Among the four measures, the ease of use of the shopping experience recorded the highest significant difference between these two modes of shopping. Clearly, applying the augmented reality on the student's mobile phone made their shopping activities more convenient as queries about the product were done just touching the touch screen of the telephones. Moreover, closer scrutiny of the merchandise item of interest was done by gestural manipulation of the student's hand in front the phone camera. The combined interaction was not only convenient, but natural, thus generating a compelling experience for the users as they queried and examined the product items in such an environment that mimicked real life shopping behaviours.

Trailing not too far from this measure, the user satisfaction factor recorded the second highest significant difference between the two shopping modes. Both shopping modes

registered impressive scores, but the augmented reality shopping had the slight advantage. Again, the same argument applies here as user satisfaction is dependent on a number of factors, namely ease of use and perceived benefit. Apparently, user satisfaction is a construct derived from an amalgam of other constructs such as mentioned earlier, with each contributing an impact on user satisfaction as perceived by the user. This measure is an important construct as it represents the ability of users to retain a sense of 'good' feelings after immersing in an environment that is meaningful. In a sense, this measure reflects a high level of accomplishment of the user's psychological needs, which has been demonstrated to be attainable through augmented reality shopping. In addition, this sense of shopping euphoria experienced by the user provides some insights regarding the 'closure' of the shopping behaviour – the user becomes contented at the end of the shopping activity.

The third highest significant difference between the two shopping modes was observed for the measure of perceived benefit. This observation could be inferred from the high scores of the augmented reality shopping for the two other measures explained previously. With better responsive, interactive display of product item using the mobile phone, the whole process of conducting shopping activities was drastically improved. This immense improvement had a direct impact on the user's perception with regard to the perceived benefit – shopping was quick, product examination was interactive, and information was rich.

Overall, this study provides important, new insights regarding the use of novel technology – augmented reality, mobile shopping aid – for online shopping. This new technology, as anticipated, has been widely received in this study, suggesting a potential shift in users' preference in online shopping in the coming years. Though it is rather premature to stake a claim that PC-based online shopping will eventually be replaced by mobile online shopping, emerging evidence (such as seen in this study) clearly points toward the focal point of the future online shopping –shopping using mobile devices. It is therefore incumbent on software and application developers to continue to explore the many possibilities of augmented reality in enhancing future mobile online shopping experiences.

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