Enhancing Customers' Knowledge and Decision Making using Augmented Reality

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Abstract: Augmented reality has seen massive success in recent years as it provides an opportunity for a seamless and rich user interaction with the real world. Recent studies have shown augmented and virtual reality can play a significant role in the future of retail. Innovations can help customers make good choices and can improve their confidence and satisfaction in their purchasing decisions. It also reduces the physical interaction between customers and store especially during lockdowns (i.e. during pandemics such as COVID-19). This paper presents ARiel, an augmented reality application for mobile commerce (m-commerce), enabling customers to turn catalogued items into 3D animated models. It was developed using Google's ARCore platform. Customers can try on products such as jewellery or watches using their mobile phones without being physically present in the retail shop. Data about their purchasing decisions are logged in a database. We describe the process of designing and implementing ARiel and the outcome of an evaluation using Nielsen's ten usability heuristics. We also outline our plan for future work.

Keywords: Augmented reality, m-commerce, usability heuristics

1. INTRODUCTION

E-commerce market will see a shift in purchasing power through the next decade due to internet penetration, especially on mobile devices (Statista, 2019). There are many websites such as TradeMe, Amazon, eBay and Alibaba providing the various ranges of products with details, images, and reviews to help customers with their purchasing decisions. Reviewing the product's images and consumer reviews in blogs, twitter and wikis are common (Tirunillai & Tellis, 2012). The customers can, therefore, presume the feeling of product possession before making a purchase. Due to the extensive use of smartphones, consumer online-posting has become a vital factor in product marketing (Chen et al., 2011; Singh et al., 2018). The electronic word of mouth, rating, reviews, forums and communities can shape consumer trust, which is essential for a business to successfully promote the products (Hajli et al., 2014). However, fake reviews can be formulated to gain competitive advantage by the competitors (Singh et al., 2018). Despite many product details, images and consumer reviews provided on the Internet, we believe there is still a need for the customers to try the products by themselves.

There has been a significant interest in Virtual Reality (VR) and Augmented Reality (AR) technologies in recent years. Both VR and AR can be utilized in many application domains such as health care, business, education, and amusement (Alkhamisi & Monowar, 2013). AR can help the user experience (UX) in three fundamental ways (Li & Fessenden, 2016):

1) By decreasing the interaction cost to perform a task:

The user can remain in the current environment and have relevant data displayed there, without doing any special action. In contrast, with a non-AR user interface (UI), the user needs to take an explicit action to access the information, which could require extra effort on the user's part. The lack of commands in AR interfaces makes the interaction efficient and requires little user effort.

2) By reducing the user's cognitive load:
In the absence of an AR system, the user would have to remember not only how to use the smartphone or the desktop to find the information they need, but also go through the process of finding it. With an AR system, the useful part of the information is displayed automatically, and the user does not need to add extra information to working memory or spend the effort to *save* it on paper or elsewhere.
3) *By combining multiple sources of information and minimising attention switches*:
With AR systems, the relevant information is displayed in an overlay on top of the object itself, so the user will not need to divide their attention. Many complex tasks (e.g., surgery, writing a report) do involve putting together multiple sources of information; some of them will benefit from AR.

There has been some research on VR and AR shopping assistant applications, such as Virtual Fitting Rooms (VFRs) which uses Natural Interaction (NI) technology with Microsoft Kinect and Asus Xtion as an environment for NI applications (Pachoulakis & Kostas, 2012). Pachoulakis and Kostas concluded that the VFRs allowed the customers to try-on apparel and mix-and-match accessories without being physically present in the retail shop and reduced much of the guesswork involved in shopping, which resulted in an enhanced shopping experience. Although this approach is interesting, most consumers could not try the VFRs platforms, because it required Microsoft Kinect or Asus Xtion which, people may not generally have access to. Waterlander et al. (2015) researched and implemented the Virtual Supermarket. People could experience and interact with the VR supermarket to purchase virtual ford products. Waterlander et al. claimed that shopping patterns in the Virtual Supermarket were comparable to shopping in real life. Other development using AR has been applied on the mobile application to support shoppers to find healthy food products in a grocery store aisle, reducing the amount of time to find desired healthy food products, e.g. (Ahn et al., 2015).

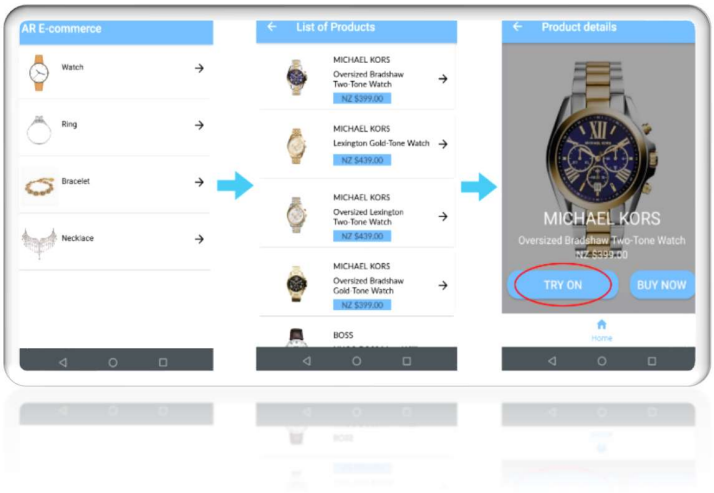

Figure 1. Screenshots of Ariel's product information pages

Research on the global online retail market indicates that the market value has demonstrated consistent growth for many years, and it is expected to reach $26 trillion in 2020 and $29 trillion in 2023 respectively (eMarketer, 2019). Despite VR and AR technologies gaining a lot of traction among consumers and businesses, these immersive technologies are growing at different rates (eMarketer, 2019). It is anticipated that 51.8 million people in the US will use VR and 77.7 million will use AR at least once per month in 2020.

The introduction of Apple's ARKit and Google's ARCore in 2017 signalled the tech industry's confidence in the ongoing support of AR experiences (eMarketer, 2019). Google has introduced the ARCore platform for building augmented reality experience, which enables android phones to sense the AR environment (Google, 2019). With ARCore, the android phones can detect the real-world environment and place virtual objects on a flat surface or augmented image (i.e. a specific 2D image). Recent studies have shown the effectiveness of this platform in increasing user engagement with an interface. For example, Alvaro-Tordesillas, Crespo-Aller, and Barba (2019) used ARCore to design and develop a mobile application (ArtAlive) for the generation of augmented reality

experiences on museum sculptural objects. They reported that after the use of ArtAlive, the level of involvement with the exhibitions exceeded the typical audio-guide or printed brochure. Zhang, Yao, Zhu and Hu (2019) proposed an assistive navigation system for visually impaired people that took advantage of ARCore, path planning, and human-machine interaction to provide fluent and continuous guidance in avoiding obstacles and risky places.

Current research shows that there are opportunities to develop e-commerce applications in mobile devices (m-commerce), leveraging the AR technology, to improve the online shopping experience. However, there is little work done on evaluating the usability of AR interfaces. We designed and developed a prototype for an m-commerce application that allows users to select and view the products' details similar to other online shopping applications. We then provided the users with an option to try-on products to visualise how the products would look like using a 3-D model. The research question we investigate in this paper is whether our augmented reality m-commerce application can meet Nielsen's top ten usability heuristics.

2. DESIGNING ARIEL: AN AR JEWELLERY M-COMMERCE APPLICATION

ARiel is a m-commerce application with augmented reality "try-on" feature, which aims to enhance the users' shopping experience by allowing them to try the 3-D products using their mobile phone. It has two main components: e-commerce android application and marker-based AR feature. ARiel's UI design was based on Jakob Nielsen's ten usability heuristics principles (Nielsen, 1994), described further in Section 3.

2.1 M-commerce Android Application

The e-commerce Android application part of ARiel consists of three pages, which are product category, product list, and product detail page. The users have to select the desired product before trying it with AR try-on feature. Its look-and-feel is similar to general applications in the Android market.

2.2 Marker-based AR Application

The AR application part of ARiel is a marker-based AR, which anchors AR contents (3-D objects) to a specific visual marker. There are two pages here, the guide page outlining the steps on how to print the marker and use AR camera, and the AR camera page. The AR feature requires the user to print a marker and attach the marker to fingers or wrist. They will then have to see the marker through the mobile phone's camera. The 3-D object of the products will be placed on top of the marker. The application also provides other products for the users to try on via this screen (see Figure 2).

We chose ARCore as a software development kit for the AR try-on feature, as one can simultaneously implement the AR try-on feature and the e-commerce mobile application without dependencies between each other. We, therefore, demonstrated that any current android applications in the market have the feasibility to use AR technology in their applications.

3. USABILITY EVALUATION

Jakob Nielsen proposed 10 general principles for interaction design (Nielsen, 1994), that have been extensively used for designing user interfaces over the last 25 years. They are referred to as "heuristics", as they are "broad rules of thumb and not specific usability guidelines". We used these usability heuristics to evaluate ARiel's UI:

1. *Visibility of system status*: According to the first heuristic, the system should always keep users informed about what is going on, through appropriate feedback within a reasonable time.
   ARiel users are informed about the current application's states.
2. *Match between system and the real world*: The system should speak the users' language, with words, phrases and concepts familiar to the user.
   All icons and messages in ARiel are meaningful and concise. The users can find them in everyday life, such as the camera icon and labels on the page's titles.

3. *User control and freedom*: Users often choose system functions by mistake and will need a clearly marked "emergency exit" to quickly leave the unwanted state.
   The back and home buttons are provided for emergency exit.
4. *Consistency and standards*: Users should not have to wonder if different words, situations, or actions mean the same thing.
   The position of buttons of all activities in the application are consistent and follow the same pattern of other commonly used products in the Android market.
5. *Error prevention*: Careful design can prevent a problem from occurring in the first place. Either eliminate error-prone conditions (ideally) or check for them and present users with a confirmation option before they commit to the action.
   ARiel would aim to stop users from making errors and warning messages are displayed at the appropriate times.
6. *Recognition rather than recall*: Minimise the user's cognitive load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another.
   The selected product will be highlighted in the app when it is displayed on the product list of AR try-on screen.
7. *Flexibility and efficiency of use*: Accelerators may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users.
   The system guide will be provided to the users who have no experience of using AR camera, which can be easily be skipped. Shortcuts are also provided for expert users.
8. *Aesthetic and minimalist design*: Dialogues should not contain irrelevant information. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
   The use of colour, shape, and typography in the application has been developed under the concept of material design aimed to provide minimum information displayed in each screen throughout the application.

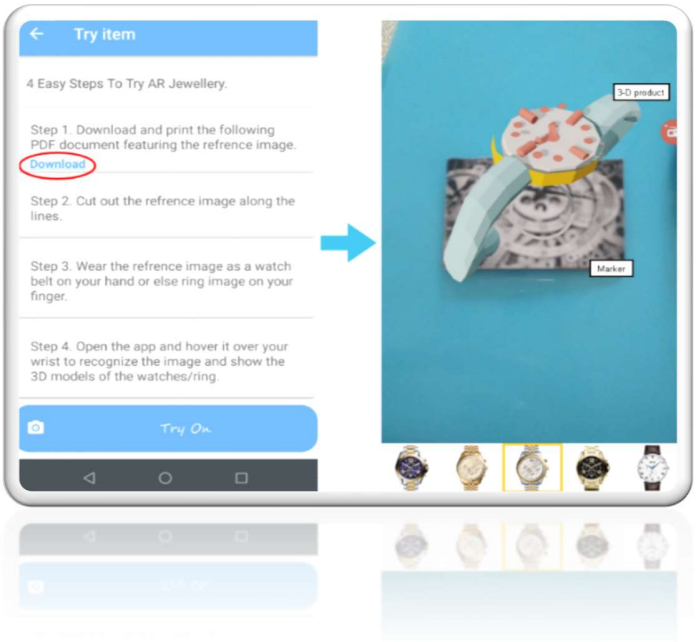

Figure 2. Screenshots of ARiel's product information page

9. *Help users recognise, diagnose, and recover from errors*: Error messages should be expressed in plain language with no source code, precisely indicate the problem, and constructively suggest a solution for the user.

ARiel's error and warning messages are easy to understand for both novice and expert users. It shows users how to fix the problem, so they can carry out interacting with the interface.

10. *Help and documentation*: Although it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, displayed when necessary, list concrete steps, and not be too large.
    ARiel provides a single-page user guide, written in simple plain language, to educate the users on how to use AR try-on feature.

The usual approach to designing a mobile application that makes use of the phone camera is to turn on the camera at the beginning when the application starts. The users will then operate the application via the given menu on the camera screen. The main disadvantage of this approach is that mobile devices have limited screen size, making it difficult for e-commerce applications to provide all product information along with menus in a single camera screen. Our proposed approach is more practical for the existing online e-commerce applications in the Android market, as the AR try-on module can be developed separately, and then be integrated into the existing application. The retailers can slowly introduce and educate the current users about this new feature.

4. Conclusions And Future Work

In this project, we designed and developed an AR try-on feature to enhance the consumers' shopping experience. Due to COVID-19 restrictions and the major challenges around user studies, we were not able to conduct an in-person evaluation to study participants' user experience and whether our app enhances their knowledge and decision making. We, therefore. used a well-known usability framework to validate the design of the interface.

AR interfaces provide great opportunities for improving user experience. The future of retail is profoundly informed by understanding what is different and what is similar in real and virtual worlds and how immersive technologies can affect both. Innovations can help customers make good choices, experience fewer time constraints or even increase confidence and fulfilment in their decisions. Retailers, however, can gain the advantage of emerging technologies to increase the engagement of their customers and simplify their lives. Our future plan is to conduct an evaluation study to examine the effectiveness of ARiel on improving customers' shopping experience and knowledge and the number of purchasing decisions made as a result of using the AR feature. The information overlaid over the physical world in AR interfaces can initially be overwhelming, but we believe it can help the customers with their purchasing decisions in the long run.

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