Preliminary Emotional User Experience Model for Mobile Augmented Reality Application Design: A *Kansei* Engineering Approach

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Abstract—The user experience, often known as UX, is the key factor in determining a product success and increase user's acquisition. However, this field of research lacks conceptual and practical models to follow when designing pervasive technologies such as mobile augmented reality (MAR). To convey a pleasant UX, it is necessary to identify the contributing factor and the components that influence the enhancement of the MAR design. The findings of the study indicated that emotions are the main factor that drives the user's perception and hence, their choice and pleasure. This paper presents a preliminary model for designing an emotional UX mobile augmented reality application with the use of *Kansei* engineering approach. Ultimately, this model will provide insight into the design fundamentals that influence the user experiences. The outcomes of this study will assist researchers and designers in shaping the emotional user experience design.

Keywords—augmented reality, design model, emotional UX, *Kansei* Engineering, user experience

1   Introduction

User experience (UX) design is the practice of designing products with users in mind in order to provide meaningful, relevant, and engaging experiences to the intended users. In today's rapidly evolving technological landscape, where a variety of application options exist, addressing the application's usability alone is insufficient, as specified in ISO 9241-11 [1]. Consumer demands change throughout time, shifting from a simply functional to an emotionally satisfying level as time and technology evolve [2]. Similarly, [3] argued that application design should addresses the whole UX rather than the concept of usability alone. This is where the emotions come into play to provide pleasurable experience when users interact with the applications and interfaces. Recent advancements in immersive technology, such as mobile augmented reality (MAR), has

altered the way people interact with devices and information, hence provide new opportunities for investigating how to design in immersive environments. MAR is an enhanced reality where the user's actual environment is seamlessly incorporated into digital contents through the superimposition of objects in an immersive environment, allowing better communication and engagement.

However, the user may experience various design challenges while using such immersive technologies [4]–[6]. As it becomes more prevalent in real-world circumstances, there is an increasing need to comprehend the nuances of MAR interface design to satisfy the augmented reality (AR) users [7]. To deliver a positive UX design, designers must address the user challenges by comprehending the factors and components of MAR design. Despite the increasing prevalence of this persuasive technology, however there is a lack of conceptual and practical model to be followed when designing the MAR applications for UX. So what are the essential design components for designing an emotional UX MAR application?

In order to provide a favourable UX and to increase the total depth of the UX for MAR, designers must grasp the design elements and end-user emotional needs. To satisfy the user is to please them because user satisfaction is strongly influenced by their emotions and pleasurable experiences [8]–[10]. But how to conceptualize the user's emotions into product design? *Kansei* Engineering (KE) is the option. In emotional design research, there is a user-oriented technique known as KE that is able to tackle the human affect by translating their emotions into design elements [11]. For that purpose, this study proposes an initial model that highlight the essential component of MAR emotional UX design with the incorporation of KE. This work emphasis the needs of emotional UX model that helps the designers to design for experience rather than focusing on the usability alone. The model was developed based on literatures and preliminary findings. The findings suggested several key components of UX and MAR. This model is intended to provide guidelines on how to design AR applications for mobile devices such as smartphones or tablets.

This study is motivated by the advanced technological research and trends in UX and AR. Since the past literatures demonstrated that UX is a phenomenon that contributes to the success of digital products [8], [12], [13], therefore investigating the potential of emotional UX in the field of AR technology is warranted.

2   Related works

2.1   Emotional user experience

Emotions have a tremendous impact on user experience (UX). The term "emotional UX", which has gained a lot of attention these days, implies the emotions or feelings that users experience or go through when they use a product [14], which may be impacted by the design of that product [4], [5], [15]. During the past two decades, there has been a dramatic increase in discussion on the significance of emotions in the design field. Thus, emotional design emerged as the effort to promote positive emotions [8]. In product design, emotional design is an approach that leverages human feelings to

create products that make people happy and make them feel a part of it, resulting in a positive user experience [9]. Emotional design is intended to deliberately elicits an emotional reaction from its users.

Human emotions are driven by various factors such as products or things, environment, circumstances, and places. In the context of design, certain design choices could allow users to form certain emotional connections, hence altering their level of satisfaction. Once this connection is established, the feeling may be repeatedly elicited, forging a solid and enduring relationship between users and the product over time. In this regard, the design decisions of a product are crucial as it will affect the intended user's response and perception.

In his book, [16] has argued that most of today's design are missing the pleasurable component, as shown at the apex of the pyramid in Figure 1. According to [16], besides paying attention to the system's functionally, reliability, and usability, the system must also fulfill the pleasurable aspect to win the users, which in his opinion is to foster pleasurable emotions. Pleasurable aspect, as part of emotional element has been shown to positively correlate with human perception and attention, making its inclusion in system design crucial [16]–[18]. This is also supported by [10], [19], who assert that designing is more than just creating something that adheres to usability principles; it must also connect with the audience and have an emotional impact.
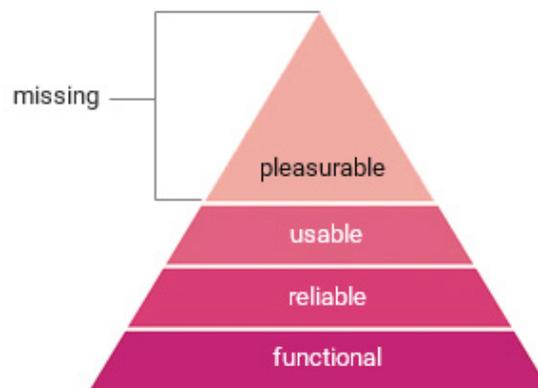

Fig. 1. The needs for pleasurable design [16]

2.2 Importance of emotions in user experience

According to [20], products that are designed based on user's emotional needs may have a significant impact on the overall user experience since emotions consciously and subconsciously influence decision making and interests. There are two main types of emotional response which are positive and negative [9]. Positive emotions will certainly promote good experience while negative emotions will lead to poor experience. Negative experiences induce negative perceptions against the product, which impact how people perceive and accept it, resulting in product avoidance. If the product design does not meet the user requirements, they will not stay and will search for alternatives. A

number of studies have shown the significance of emotions as factor of product success [21], increase product adoption [22], [23], and enhance customer satisfaction [8]. Emotion is fundamental to human experience [24]. People's reactions to things are often expressed via emotions, either positively or negatively, which makes the emotional design research important. Overall, offering a favorable and engaging UX has become a key objective in the design of interactive systems, because according to [8], [22], [25], positive emotion enhances interaction and perception. Thus, the goal of emotional design is to shift away from concentrating just on usability or functionality but towards designing an experience that exceed the user's expectations.

2.3 Emotional UX and mobile augmented reality

MAR is a palm-based experience that allow users to effortlessly explore the virtual world of technology by following the on-screen cues and instructions. MAR is designed to mirror the real world by seamlessly blend digital information with the physical surrounding [26]. MAR technology has the ability to provide users with immediate responses coupled with on the go contents that stimulate interaction, thus enhancing their user experience (UX). The augmented reality is an experience where designers enhance parts of users' physical world with computer-generated input [7]. AR has impacted people's activities around the globe, as a result of its widespread implementation in various sectors such as education [27], [28], healthcare [29], [30], transportation [31], [32], retail [33], [34], and entertainment [35], [36]. It has been observed in the study [34] that with the use of AR, customers can evaluate products better and studies by [27], [29] reported that AR has improved student understanding and facilitated the learning activities.

As discussed by scholars, AR most important characteristics are presence, immediacy, and immersive [37], [38], where presence refers to the feeling of being present in the virtual world, while immediacy refers to receiving immediate response as a result of interacting with an AR application, and immersive is where the digital contents are presented on top of the real world. These three important AR features aid users to comprehend information presented on the MAR user interface (UI) while interacting with the MAR applications, making the process of interaction flow naturally, which accordingly improves their experience. However, what are the design components of MAR applications?

To ensure the success and acceptability of MAR apps, user research should be carried out as part of the design process. This will contribute to a better comprehension of user and design requirements and assist designers in determining the best design dimensions. Humans, as the ones who interface with screens are constantly governed by their emotions, which dictate their choice to continue or discontinue using a product. Thus, improving the user's emotional experience is crucial for increasing app engagement and user retention. In line with this, it is essential to consider the user's emotions when designing MAR applications so as to enhance their whole experience. Therefore, a specific model that focus on the design of MAR emotional UX is needed to form a baseline and serve as a guideline for designing the emotional UX MAR applications in

order to investigate how the design elements may influence the users' emotions, thereby enhancing their satisfaction and pleasurable experience.

Table 1 presents the current AR models that cater to AR application design, satisfaction, or user experience. However, none of the models addressed the relationship between user emotion and AR design elements. Despite the fact that a model presented by [26] focused on UX, the model was intended only for overall AR system development, comparable to a model presented by [41]. While there are models that concentrated on user engagement, the model proposed by [42] emphasized on identifying the game elements that foster user engagement, while [39] focused solely on the engagement factors for hearing impact users. Other UX models were merely concerned on user acceptance and adoption [33], [40]. After all, UX model that address the relationship between AR design elements and the users' emotion are non-existent, and needs further research [34], [43]. For this reason, it's important to explore the user's emotions, and investigate how they are influenced by MAR design elements in order to design a pleasant user experience.

Table 1. Existing Augmented Reality Models

Model Context	Aspects Discussed	Research Focus	Source
Model for AR application design and development for user experience	Design and Implementation of UX model for AR Systems	Overall MAR system development	[26]
Conceptual model of MAR for hearing impaired museum visitors' engagement	Design and development of AR application that focus on museum visitor's engagement.	Focus on the engagement types	[39]
Conceptual model for AR adoption in retail industry	Factors Affecting AR adoption in retail industry	Identifying factors of adoption	[33]
Conceptual model for AR user acceptance	Encourage user experience, satisfaction and willingness in E-commerce purchase through AR	Acceptance model	[40]
Conceptual model for AR application development with enjoyable aspect	MAR for cultural heritage towards enjoyable informal learning	MAR development (hardware, software)	[41]
Conceptual model for user engagement in MAR games	MAR games user engagement	Focus on games element	[42]

2.4 *Kansei* Engineering and emotional design

Emotions affected by the user's emotional states, personality, situational or contextual factors [44], [45]. Consequently, emotional design for a particular context will elicit associated feelings that flow naturally across the user experience. In order to comprehend how emotions influence digital products, designing for emotions requires a contextual analysis, which entails assessing the emotions in a specific context of use. In emotional design field, *Kansei* Engineering (KE), a Japanese-origin term, has been recognized as a technique that able to elicit the user's emotions and transform them into product design [46]. *Kansei*, a synonym for emotion, its method begins with determining what emotions customers experience and how to address their requirements. KE

has been applied in various industrial domains such as Mazda, Sharp and Wacoal [47], as well as in computing domains for user interface design strategy through emotion discovery [48]. By employing KE to anticipate users' responses, product designers may produce designs that are more closely aligned with users' expectations, enhancing their emotional experiences.

3 Methodology

This study involves three subsequent steps, adapted from [49]. The steps as illustrated in Table 2 was carried out in order to achieve the objective of developing an emotional user experience model for mobile augmented reality application design. The literature survey included a review of numerous issues associated with user experience, augmented reality, emotions, and *Kansei* Engineering in order to determine the most prominent components of emotional user experience design. It is then followed by the formation of relationships among those components in order to construct a model, as summarized in Table 2 and further described below.

Table 2. The Model Development Steps

Step	Activity	Objective
1	Review of literature	Model Development
2	Identify essential components of the research	
3	Determine relationship among the components	

3.1 Step 1 – Review of literature

The first step involved searching for relevant literatures through seven electronic databases which are ScienceDirect, IEEEXplore, ACM Digital Library, SpringerLink, Emerald Insight, Taylor and Francis, and Scopus. The online databases were selected from the list of online databases subscribed by the university library and accessible to the researchers. The articles published in academic journals and international conferences by these seven databases are recognized as reliable and worthy for discussion. In this step, the authors thoroughly screen and review the articles collected from the mentioned databases for content eligibility. Articles were selected for inclusion based on their relevance to the research topic, with consideration given to publications that addressed the context of affect, *kansei*, or emotion, emotional design, user experience, emotional user experience, augmented reality, and mobile augmented reality.

3.2 Step 2 – Identify essential components of the research

This step involved of a comprehensive review of the selected publications as identified in Step 1 in order to determine the key components that are pertinent to this study. The literature review involved an in-depth investigation of the topic around UX and

AR and debates revolving around the value of emotions in UX, UX in mobile applications, UX elements, UX in the context of MAR, MAR types, MAR elements, as well as emotional research linked to *Kansei* Engineering. The findings of this step are discussed in Section IV.

3.3   Step 3 – Determine relationship among the components

From Step 1 and 2, it is learned that emotion plays a vital role in determining the human pleasurable experience [16], [17], [19], [50]. It is also learned that, when done well, emotional design may elicit emotions that will drive people to respond positively. However, it is necessary to identify what kind of design will elicit positive emotions? Therefore, each design component, as identified in step 2, needs to be associated with emotion to discover how it will influence the user's emotion. Since each design component will elicit distinct emotional response [51], it is vital to analyze the correlation between AR design components and user emotions in order to determine the design cues that are suitable for each component which might contribute to a positive emotion. Therefore, the emotion-design relationship must be formed. Each relation serves as a basis for measuring the strength of the correlation and assessing its significance, which can be achieved with the use of the *Kansei* Engineering method. Having these relationships among the components resulted in the formation of a model as presented in Figure 2 under Section IV. This step also involve validation from five experts (AR, UI/UX design, and mobile app design experts) as detailed in [52]. This step is important not only for establishing the correlation dependencies, but also for imposing the boundaries of the research context [49].

4   Findings and discussion

Based on the research conducted, five key components pertinent to the scope of the investigation were identified by the study's findings, three of which are the design components known as user interface (UI) design, interaction design, and content design, which are to be designed within a particular AR system context in order to determine their influence on the user's emotional experience. The summary of the findings of this study is presented in Table 3.

Table 3. The Key Components of Mobile Augmented Reality for User Experiences

Model Components	Definitions	Augmented Reality	User Experience
User interface	UI refers to the area of the screen devoted to facilitate the user's activities with the system, such as viewing, accessing, and manipulating the contents presented on the interface.	[7], [53], [54]	[20], [55]–[57]
Interaction	Real-time feedback resulting from MAR activity that fosters engagement.	[5], [25], [43]	[58]–[60]
Content	Virtual content design to provide understanding of the immersive environment and to support engagement or activities	[26], [61], [62]	-
Context	The environment in which AR technology being designed will function or be incorporated.	[63]–[66]	-
Emotions	The feelings or perspectives of an individual that are formed by their personal experiences.	-	[1], [17], [67], [68]

Based on the findings of the literature, a preliminary model to guide the design of emotional user experience of AR-based mobile applications was developed, namely ARMAD, a short for Augmented Reality Mobile Application Design; a model for designing a mobile augmented reality application incorporating emotions for positive user experience. The model comprises of five components, as discussed above; UI design, interaction design, content design, as well as context and emotion. This model suggests that MAR should be designed within a specific AR context, with the incorporation of all the proposed design components; UI design, interaction design, and content design, in order to elicit the pleasurable emotional user experience.
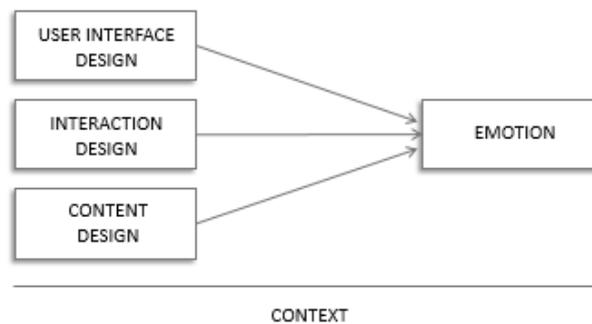
Fig. 2. Augmented Reality Mobile Application Design (ARMAD) Model

For better understanding, the findings of this study also proposed the design fundamental pertaining to the AR context for each proposed component in the ARMAD model above, as outlined in Table 4.

Table 4. The Design Elements Fundamentals of MAR

MAR Components	AR Context	Design Fundamentals
User Interface Design	Presence	- Suitable visual cues to support the feeling of being presence in the virtual world - Interface-environment harmony and compatibility
Interaction Design	Immediacy	- Rich and lively interaction to support the immediate feedback when interacting with the system
Content Design	Immersion	- The structure and organization of virtual information and comprehensibility to facilitate understanding while in an immersive environment

This emotional research on user experience is important given that humans prefer to reflect on their experiences. The *Kansei*, which is represented in the model by the "emotion" component, involves eliciting the users' emotions via their engagement with MAR sample products, then conceptualizing those emotions before determining the ideal design solutions for the actual MAR applications. Therefore, it can be concluded that, complementing emotion in UX and MAR design has path towards pleasurable design. This model will serve as a guideline for practitioners and researchers in shaping the way to design for user experience.

5 Conclusions and future work

This paper proposed a preliminary model for designing an emotional user experience of mobile augmented reality application. The findings indicated that, aside from emotion, four other components have been identified as key components to form the model which are UI, interaction, content, and context. By incorporating contextually relevant *kansei* / emotions into the MAR design, this model is expected to provide users with pleasurable experiences in the mobile application context. Undoubtedly, user research is very important in the design process, and one approach to do it is by comprehending their affect or emotions, as suggested by the model.

This research contributes to a new understanding of the potential use of *kansei* / emotions in defining design elements towards enhancing the user experience of AR mobile applications. Understanding user's emotions are crucial as they influence the user's acceptance, pleasure and most importantly, set a baseline on how to design for pleasurable UX.

In future, based on this preliminary model, MAR prototype will be developed by incorporating the design components and guidelines as proposed in the model. The key objective of the research is to design an emotional MAR that cater to human emotions in order to improve their experience. Therefore, the user-centered approach using KE will be incorporated since human factors play an important role in designing. In terms of the research design, the self-reporting quantitative approach will be employed. Results from the study design will be used to validate the initial model, which entailed user assessment using semantic differential scale on a variety of prototype specimens, in order to establish the design cues for each individual component.

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