ISSN 2278-3091
Volume 8, No.1.4, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse1081.42019.pdf
https://doi.org/10.30534/ijatcse/2019/1081.42019

Emotions Detection of User eXperience (UX) for Mobile Augmented Reality (MAR) Applications

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ABSTRACT

Mobile Augmented Reality (MAR) is becoming a major interactive technology for cross-domain and destination applications. The number of using MAR apps around the world in excess of 2.2 billion by 2019. Despite the recent advances in MAR technology and tools, the User eXperience (UX) design perspective has not been seriously taken into consideration. In this paper, an MAR application production scheme using UX is practically investigated. Particularly, “GlassOn" app which provides visual information on how the user looks like with various types of glasses, is utilized in accordance with the user’s emotion raised by the interaction. To verify the effectiveness of this scheme, an evaluation experiment was conducted with 10 participants. The numerical values that indicate the rates of each emotion were taken from Microsoft Azure Face API. Meanwhile, a questionnaire survey was conducted to collect each participant’s perception of each pair of glasses as subjective evaluation. The comparison between subjective evaluation and the numerical results shows that the more the emotion of surprise is raised rather than happiness, the higher the user’s purchase rate. It is revealed that UX is useful to inspire the user’s purchase desire for glasses online.

Key words: Mobile Augmented Reality (MAR), User eXperience (UX), Emotions Detection, Emotion API, Mobile Device

1. INTRODUCTION

Augmented Reality (AR) enhances the real world by superimposing digital data on top of it. When the AR experience is delivered on mobile devices, it is called Mobile Augmented Reality (MAR). MAR applications have gained much intention from both academia and industry in recent years. In particular, as mobile devices increasingly involve people’s daily lives, such as education, entertainment, navigation, and in other fields, it is difficult to evaluate interactive mobile applications by only their functions and usability, due to the involvement of human perception. In such a situation, UX has become a crucial requirement for the evaluation of MAR applications. The difference between positive and negative experiences can make a huge impact on the user’s sensory perception of MAR applications. Eventually, the quality of the applications can be then improved once the user’s feedback of his/her experience is taken into consideration. In fact, user satisfaction and emotional impact are considered as the main factors of User eXperience (UX). In literature, UX of MAR applications has been being studied for recent years. However, [1] indicated that contemporary works mostly focus on the usability of the evaluation of MAR applications without considering the user’s emotion raised by the service. In this study, emotional engagement was considered as a key factor in achieving sustainable use of mobile applications. The main goal is to evaluate the UX of an MAR application and explore the limitations of the MAR application from the user's perspective, and to provide a reference basis for technology developers.

The structure of this paper is as follows: See section 2 for related work. Meanwhile, methodology are stated in section 3. Section 4 evaluates the experiment through data acquisition and results. Eventually, the discussion and conclusions are respectively presented in section 5 and 6.

2. RELATED WORK

According to [2], MAR has emerged to mainstream technology. It is defined as "an AR in which a mobile device (smartphone or tablet) is used to display and interact with virtual content, and the virtual content is overlaid on a real-time camera feed in the real world". User experience is considered as a subjective and universal concept that defines the experience of a technology product. In addition, according to the [3] standard, [4] the user experience is “a person’s insight and response, the result of the use or intended use of the system, product or service”.

Some researchers have investigated the field of MAR UX. [5] proposed and explained how to use a projector-based AR to solve problems and/or new solutions that help enhance their user experience. [6] embodied a suevey of users’ perceptions of MAR advertising application perceptions. Understand

what respondents think about using MAR application awareness. [7] A baseline was set up to assess the overall pros and cons of the service when using the service. Through the MAR service, you can fully understand the potential end user's expectations for the user experience. They believe that MAR has the potential to empower people and promote understanding of the world around them and related information. [1] elaborated on the lack of MAR UX research mainly because of the recent nature of MAR as a mainstream technology. [8] proposed that major advancements in the development of MAR happened during the last decade. Despite the large number of MAR presenters and related research, the AR research community lacks an understanding of the user experience of mobile augmented reality services, especially in terms of emotional factors in user experience. Such understanding, however, [9] have explored that it is important to successfully develop widely accepted services to provide users with a pleasant and exciting experience.

3. METHODOLOGY

3.1 Research Design

First, we believe that a certain emotion of the user can directly reflect the user experience and thus affect consumer behavior. Therefore, we designed this experiment to study UX in this experiment by adjusting MAR technology and using the "GlassOn" application. Thereby, the users' reaction to each selected product is obtained. According to their reaction or emotional changes, it is easy to find out their preference for the glasses choice when they show their interest.

By guiding users to use the mobile application of virtual glasses' images, their visual information will be obtained and then analyzed in order to objectively extract the hidden emotions from the human's interaction. Meanwhile, the subjective evaluation in terms of participant's perception is collected by using a questionnaire. The conclusion is then obtained by comparing the experimental results with the subjective evaluation.

3.2 Application Selection

Sometimes, it is very difficult for customers to make decisions about whether to buy goods online. The main reason is that they cannot directly try them out. For example, if you buy glasses online, you won't get a good "user experience" if you can't try them beforehand. Therefore, in order to investigate the impact of the user experience on the MAR application, the GlassOn Mobile App was selected. It is a mobile device application that transforms a device screen into a virtual mirror by real-time streaming. Additionally, it covers virtual glasses with AR technology and directly tries on glasses through mobile devices. Therefore, users can make more accurate decisions based on the experience effect and emotional output, thus reducing the return rate of goods.
In this study, the Video Editor Expert is used to intercept images from video. By using the software, participants are filmed at an average rate of one lens per second for each pair of glasses. This software intercepts the image time evenly, and the emotions of the participants are recorded objectively, which makes the experimental results more reliable.

3.3 Participants or Respondents

There are 10 well-educated participants in this experiment, including 5 undergraduate students, 5 graduate students. Thus, they can easily understand the concept of mobile augmented reality and its functionality. Among them, there are 3 females and 7 males. It should be noted that to gain the most authentic emotional output value, the selected participants have never used GlassOn application before.

3.4 Questionnaire Session Procedure

After trying various glasses on the application, the participants are asked to complete a questionnaire to obtain their preference level for each pair of glasses. Such the results are considered as subjective evaluation indicators.

3.5 Analysis Method Selection

In order to extract the human emotion to the numerical values, a Microsoft API – called Microsoft Azure Face API, is used. As shown in Figure 1, the confidence of a set of emotions on each face in the image, such as anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise, is considered the output of this API. As we all know, these emotions are cross-cultural and have a general connection with specific facial expressions. Since the system conducts the method of facial expression analysis, however, humans have the ability to hide emotions; it is necessary to keep the experimental environment as independent as possible so that participants can express emotions more naturally.

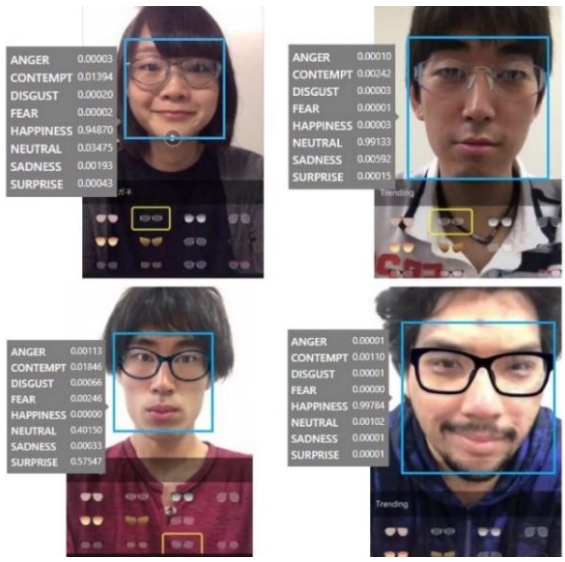

Figure 1: Subjects' numerical values of each emotion using Microsoft Azure Face API while trying various types of glasses.

4. EVALUATION

4.1 Data acquisition

First, ensure consistency in data collection:

- Keep the experimental environment consistent and not be changed and ensure sufficient illumination during the experiment;
- To ensure the natural human reaction, participants are asked to do an experiment in a quiet and undisturbed room;
- The mobile phone used in the experiment is set to “Flight Patterns”, to avoid interrupting video recording.

At the same time, each participant read the notes of the experiment to understand the purpose and the procedure of the experiment. Participants experience the "GlassOn" application on the iPhone, whereas, the recording function is also turned on to record the emotional changes of the participants. Each participant experiences 10 types of glasses in turn, within 10 seconds for each type of glasses. After completing the experiment, participants are asked to fill out a questionnaire - "which glasses would you willing to buy?" The perception for glasses is established based on the user’s preference. In order to obtain a user’s emotional information, a video editing software is used to capture iPhone’s screenshot with the sampling frequency of one screenshot per second. Eventually, they are uploaded to the Microsoft Azure Face API producing, in total, 8 emotional values and record data.

4.2 Results

Based on the API scores for each type of 10 glasses, as the example of user 1 shown in Figure 2. Observe the emotional reaction type denoted by X, of each participant. As shown in User 1's API score, most of the emotions are reflected by the Happiness Value, then X is Happiness. The maximum value of each emotion for each type of glasses is considered as maxX (eg. MaxS=MaxSurprise), and its distribution is shown in Figure 3. And the MX is a sort of maxX from large to small. Meanwhile, we compare the UserPerception (UP) of each glass as shown in Table 1, whose emotions can be represented by Happiness value and Surprise value.

In the experiment, we found that except for the neutral, the Happiness value and the Surprise value are the main emotional expressions, and the other emotions are almost no more than 0.1, we ignore it for the time being. Lastly, we calculate the correlation in Figure 4 and come up with a conclusion. The emotion of users 1, 3, and 6 can be described by “happiness”. Meanwhile, the dominant emotion of users 7, 8, and 9 is “surprise”. Table 2 shows the Correlation and the average value of maxHappiness and user subjective evaluation. And Table 3 shows the Surprise value under the same rule.

5. DISCUSSION

According to the above experimental results, positive emotions, such as surprise and happiness, can be considered as the purchasing motivation of users. It is also found that the higher value of surprise in comparison with happiness, the higher purchase rate from the user. In addition, more than half of the participants said that using the MAR application before purchasing, will eliminate the unnecessary products’ concern, and procide users with a ture visualization of the product, making online shopping more convenient. Importantly, MAR-based shopping apps allows users to increase their confidence in deciding whether the products should be bought or not. Being able to see product demonstrations during the shopping process, try out products and access more complete information, further support changing shopping behaviors that are increasingly focused on the retail environment by reducing purchase uncertainty. For retailers, they can trigger online sales and brand awareness by improving the customer experience, which can stimulate customer flow and increase user stickiness. In addition, embedding AR objects in mobile applications requires appropriate design considerations, such as identifying user needs, providing natural interactions, and enabling users to interact with applications through realistic avatars.

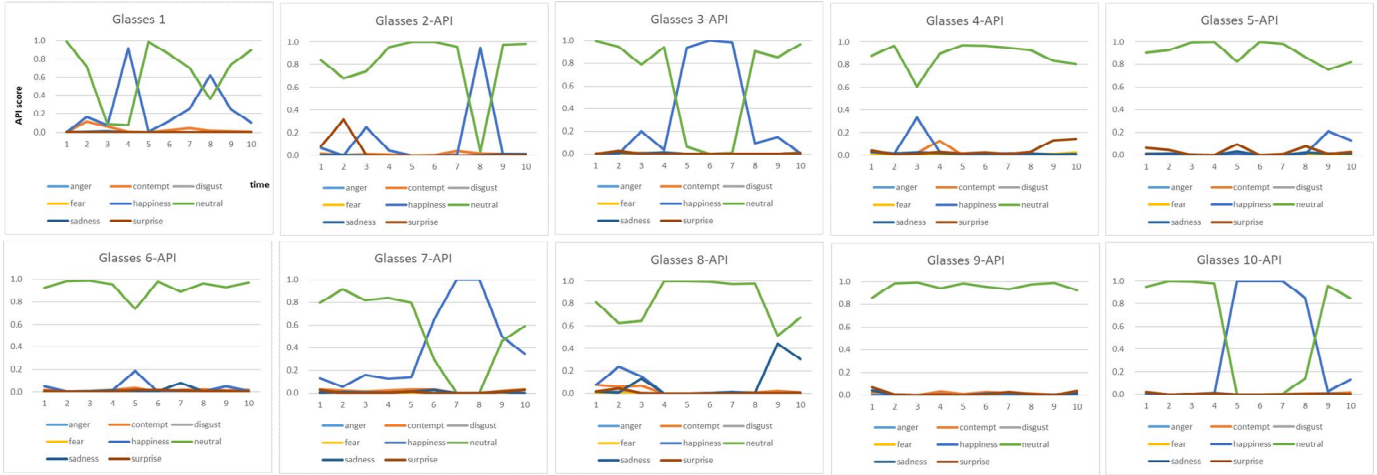

Figure 2: API scores for each type of 10 glasses of user 1.

Table 1: Results between subjective evaluation and the numerical results for the emotion happiness and surprise.

	Happiness Value									Surprise Value								
	user1			user3			user6			user7			user8			user9		
	MaxH	MS	UP	MaxH	MS	UP	MaxH	MS	UP	MaxS	MS	UP	MaxS	MS	UP	MaxS	MS	UP
G1	0.91395	5	7	0.46180	1	9	0.54748	7	7	0.00605	10	9	0.09468	7	10	0.00213	10	10
G2	0.94870	4	1	0.03226	5	5	0.99983	1	1	0.00995	9	10	0.01366	10	6	0.01629	8	7
G3	1.00000	1	3	0.15233	4	8	0.05813	10	3	0.02315	7	8	0.06787	9	7	0.01991	7	6
G4	0.32745	6	10	0.29353	2	10	0.29233	9	10	0.01167	8	6	0.16337	6	8	0.00614	9	8
G5	0.21122	8	4	0.03160	6	7	0.29636	8	4	0.03842	6	7	0.07635	8	9	0.02198	6	9
G6	0.18719	9	8	0.02533	7	2	0.74460	5	8	0.33436	5	3	0.24781	1	4	0.02424	5	3
G7	0.99999	2	2	0.15468	3	1	0.99887	2	2	0.44351	4	4	0.18058	5	5	0.08727	3	5
G8	0.23457	7	5	0.01078	8	4	0.80047	3	5	0.48666	3	5	0.19477	4	3	0.13523	2	4
G9	0.00099	10	9	0.00511	9	6	0.78508	4	9	0.57547	1	2	0.24518	2	1	0.02433	4	1
G10	0.99998	3	6	0.00084	10	3	0.56323	6	6	0.52045	2	1	0.22521	3	2	0.16964	1	2

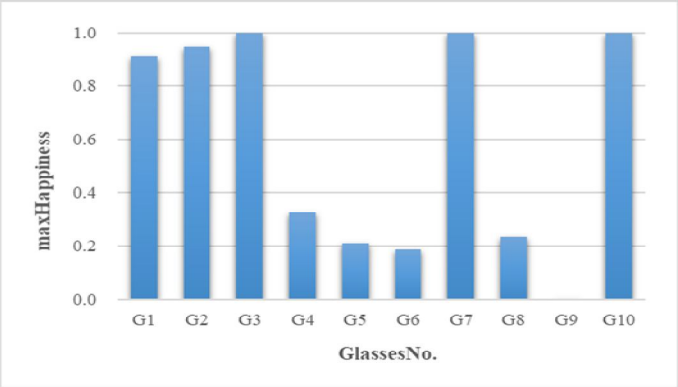

Figure 3: Maximum value of Happiness for each type of glasses of user 1.

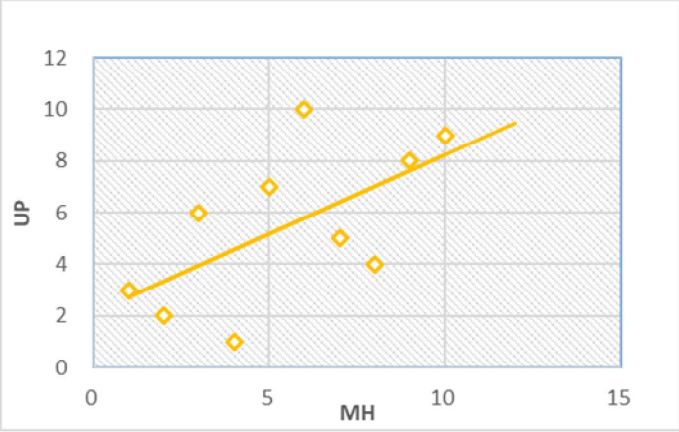

Figure 4: Correlation between the rank of MaxHappiness (MH)

Table 2: Correlation and the average value of maxHappiness and user subjective evaluation (DORR maxH is the correlation of maxHappiness value).

	user1	user3	user6	AVERAGE
DORR maxH	0.61212	0.50303	0.3697	0.49495

Table 3: Correlation and the average value of maxSurprise and user subjective evaluation (DORR maxS is the correlation of maxSurprise value).

	user7	user8	user9	AVERAGE
DORR maxS	0.89091	0.72121	0.84242	0.81818

It is quite difficult to get the emotional rate of some participants in this experiment because the data analysis method in this study is based on the changes in facial expressions. As we have shown in this study, the ability of people to hide emotions depends on their personality. In future work, different types of applications can be used to try different methods to do more test on more participants, so that we can acquire more comprehensive user experience results.

6. CONCLUSIONS

This study proposes an MAR application production scheme by using UX and verifies the effectiveness of the proposed scheme. The assessment was based on a case study with the application GlassOn: an online glasses shopping trial-wear program that provides visual information about how users see various types of glasses. And investigates user emotions that

were triggered by interaction and conducts evaluation experiments on participants. In the experiment, while the Microsoft API provides the numerical values of each emotion, questionnaires are used to collect the subjective evaluations of each participant in terms of their perception of each glass. The comparison between numerical values and subjective evaluation shows that emotional participation and user experience are closely related.

Our research results show that attractiveness will become mainstream because of the relatively high user satisfaction and the surprise value of the product to the user, which will become an important factor affecting user consumption. Despite some shortcomings, their use is bound to be positively correlated with a variety of retail consequences. Overall, participants believe that MAR technology has a value-added impact on marketing, and that almost all respondents will use these applications. The combination of MAR and retail industry is bound to become the trend of the retail industry in the future.

REFERENCES

1. Amir Dirin, Teemu H. Laine, **User Experience in Mobile Augmented Reality: Emotions, Challenges, Opportunities and Best Practices**, Computers 2018, 7, 33. https://doi.org/10.3390/computers7020033
2. Laine, Teemu, **Mobile Educational Augmented Reality Games: A Systematic Literature Review and Two Case Studies**, Computers, vol. 7, no. 1, Mar. 2018, p. 19. https://doi.org/10.3390/computers7010019
3. I. DIS, "9241-210: 2010. **Ergonomics of human system interaction-Part 210: "Human-centred design for interactive systems**, International Standardization Organization (ISO). Switzerland, 2009.
4. Shafaq Irshad, Dayang Rohaya Bt Awang Rambli, **User Experience of Mobile Augmented Reality: A Review of Studies**, 2014 3rd International Conference on User Science and Engineering (i-USEr). https://doi.org/10.1109/IUSER.2014.7002689
5. Thitirat. Siriborvornratanakul, **Enhancing User Experiences of Mobile-based Augmented Reality via Spatial Augmented Reality: Designs and Architectures of Projector-Camera Devices**, Volume 2018, p. 17. https://doi.org/10.1155/2018/8194726
6. Shafaq Irshad, Dayang Rohaya Bt Awang, **User Perception on Mobile Augmented Reality as a Marketing Tool**, 2016 3rd International Conference On Computer And Information Sciences (ICCOINS). https://doi.org/10.1109/ICCOINS.2016.7783198
7. D. Chatzopoulos, C. Bermejo, Z. Huang, and P. Hui, **Mobile augmented reality survey: From where we are to where we go**, IEEE Access, 2017. https://doi.org/10.1109/ACCESS.2017.2698164
8. Clemens Arth, Raphael Grasset, Lukas Gruber, Tobias Langlotz, Alessandro Mulloni, Daniel Wagner, **The History of Mobile Augmented Reality**, Comput. Graph. Vis. 2015, 2, 1–40.
9. Thomas Olsson, Else Lagerstam, Tuula Ka¨rkka¨inen, Kaisa Va¨a¨na¨nen, Vainio-Mattila, **Expected user experience of mobile augmented reality services: a user study in the context of shopping centres**, Pers Ubiquit Comput (2013) 17:287–304. https://doi.org/10.1007/s00779-011-0494-x