Research on the Influence of Interactive Animation Based on Extended TAM Model on User Focus Immersion in Software Application

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Abstract

The work aims to study user's immersion in APPs by expanding the three dimensions of TAM based on the interactive animation theory and comparatively study the effects of different interactive animations in different APPs on the user immersion, thus obtaining the hypothesis theory model for user immersion in the dynamic design, so as to supplement the extended research of TAM in interaction design. Methods: The relevant theories of TAM and immersion model were used to comprehensively extend the research measures of interactive animation in APPs, and construct a new hypothesis theory model. Then, two kinds of typical interactive animation were used to conduct the immersion experiment on their dynamic effects. SPSS was mainly used in the experiment for the data statistics and analysis of the questionnaire composed of user research and experience measure. Finally, the hypothesis theory model herein was verified. Conclusion: The experimental results show that H1-H7 is positively correlated, and the hypothesis theory model is established. The experiment verifies that under certain conditions, the interactive animation designed based on the proposed hypothesis theory model can improve the user's immersion more effectively, and bring them better experiences in APP.

Keywords*: Interactive animation, Concentration and immersion, TAM model*

I. Introduction

From a technological perspective, with the advent of the 5G era, various applications will undergo revolutionary disruptions. Designers will study users' usage and experience from more angles and dimensions. Interactive animation was once popular and widely studied and used, but due to the constraints of information technology, interactive animation has not been widely used and studied in cell phone terminals. As cell phone is one of the most important terminals in the intelligent information era, interactive animation is bound to make a breakthrough in its applications on APPs, thus providing users with a more realistic, efficient, interesting, convenient and fast experience.

From the user's point of view, the time people spend using cell phones is increasing, and the immersion experience that cell phones bring to users through APPs (applications) is gradually differentiated. The immersion that APP brings to users is multifaceted. From the design level, the immersion of APP use is a high-level experience for users, which penetrates all aspects of design. The immersion of the interface cannot simply be equated with the immersion of that APP, and the significance of immersive interaction design is to help users use it more smoothly and efficiently and in a pleasant mood .

II. Building an immersion model in the dynamic design in APPs

The Technology Acceptance Model (TAM) is considered to be one of the most influential and commonly used theories of information control systems. TAM is used to describe the degree of acceptance of information by individuals, and the field it covers has evolved with the persistent efforts of a large number of researchers, but there is still little research in the field of interaction design that extends to the APP aspect. In this paper, we focus on this area to study the user's immersion model based on the animation effect design of APP as a specific antecedent of TAM to complement the research of TAM in interaction design.

The study of user immersion in the dynamic design of APP is developed based on previous theories. The Likert scale and experimental data are used to verify the hypothetical relationship model between dynamic design and immersion, as well as the interrelated and sequential influence of user satisfaction.

(1) The impact of dynamic design on perceived enjoyment

In recent years, TAM has been applied to the study of consumer environments with the addition of an "enjoyment" factor, which is related to the user's pleasure when using the system [5]. Scholars Moon and Kim extended TAM by applying the perceived enjoyment of the intrinsic motivation factor in the mindstream concept, indicating that enjoyment is an important factor that motivates users to use the system. Designers should consider both intrinsic and extrinsic motivational factors in user interface design, which can help improve the usability.

In the context of Internet applications, this hedonic component is described as "fun" or "enjoyment"[6]. Scholars Bruce H Thomas and Paul Calder have suggested that techniques borrowed from comics and computer animation can enhance the experience of interacting with computers, and have experimentally demonstrated that the judicious application of the "hedonic" component can make interfaces smoother and more enjoyable to use.

Based on these theoretical studies, this paper proposes the hypothesis H3: dynamic design has a positive impact on perceived enjoyability.

(2) Effect of perceived usefulness and ease of use on immersion

Interaction design not only focuses on how to make it simpler for users to identify products and operate them more easily, but also attaches importance to how to make users gain emotional pleasure and satisfaction, and this need for emotion is precisely what makes users pursue experience [8]. From the perspective of interaction design, Ou Xifan and Tan Hao proposed that interaction design based on the premise of usefulness, goodness, and desire to use helps users gain a better emotional experience, that is, immersion.

Based on these theoretical studies, this paper proposes hypotheses H4-H5: H4 is that perceived usefulness has a positive effect on immersion, and H5 is that perceived ease of use has a positive effect on immersion.

(3) The effect of perceived enjoyment on immersion

Immersion theory has been most widely applied in the context of gaming. People experience games when they are also experiencing the most perceived enjoyment. Koufaris applied flow theory to study online consumers' purchase behavior and asserted that the mobility experience consists of PE (Perceived enjoyment), attentional focus, and perceived control [10]. Lu, Zhou, and Wang studied IM (Instant Messaging) services offered in the Chinese market and identified that the mobility experience of these app users includes PE and attentional focus. Following the rapid development of computer games and mobile devices, Zaman, Anandarajan, and Dai also suggested that the mobility experience can be assessed through PE concentration [12]. Based on these theories, it can be seen that perceived enjoyment is known to have an impact on immersion. Therefore, this paper proposes hypothesis H6: perceived enjoyability has a positive impact on immersion.

(4) The impact of immersion on user satisfaction

When users are fully immersed in an app or in an occurrence, they have the feeling of forgetting time, which increases user satisfaction. L. Deng et al. proposed that immersion affects users' satisfaction and thus determines their persistence in using mobile Internet services . Therefore, this paper proposes hypothesis H7: immersion has a positive effect on user satisfaction.

(5) Theoretical hypothesis model

The study of the effect of dynamic design on immersion using the enhanced TAM model based on Material Design was conducted to establish the theoretical hypothesis model shown in Figure 1.

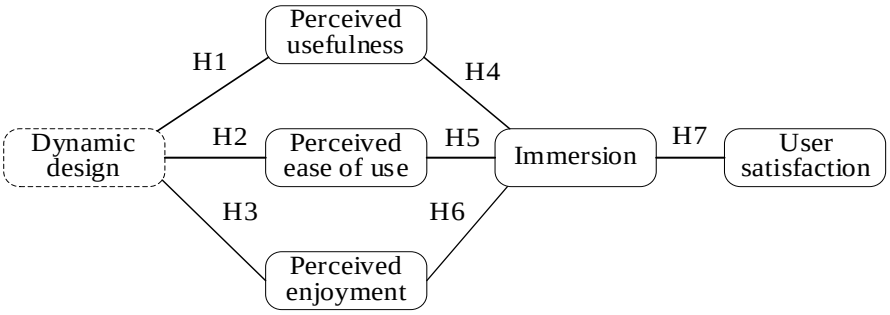

Fig 1: Theoretical hypothesis model

III. Measures of research concepts

The measures studied in this paper are synthesized based on the research measures proposed by scholars such as Dianne Cyr, Milena Head, Alex Ivanovc, van der Heijden Hans, Lavie Talia, and Tractinsky Noam, and then modified in the context of this paper's research area and investigation.

(1) Perceived usefulness

Perceived usefulness is the subjective perception that a user will be more productive when using a particular system. According to the research questions on perceived usefulness proposed by Dianne Cyr, MilenaHead, and Alex Ivanovc, the perceived usefulness is measured by four aspects in conjunction with this paper as shown in Table 1.

Tab 1: Perceived usefulness measures

Questions on the measure of perceived usefulness
The animation effect helped me to be more efficient
The animation effect made it easier to complete the tasks I wanted to complete
The animation effect helped me to be more efficient in my work
The animation effect made the task I wanted to accomplish more difficult

(2) Perceived ease of use

Perceived ease of use refers to the perception that a particular system will save the user trouble when using it. The higher the user's perceived ease of use, the more positive his or her attitudinal tendency to use it. Also the higher the user's perceived ease of use, the greater their perceived usefulness.

(3) Perceived enjoyment

Perceived enjoyment refers to the perception that the user feels happy or fun when using a particular system. In game apps, users will have a very obvious perceived enjoyment. In an app, the most important thing is to make the user feel enjoyable through the process of interaction.

(4) Immersion

Immersion is measured by people's judgment of their own emotions. When a user is using a particular system, he or she is using his or her skills completely, and there is a loss of spatial and temporal awareness. When the user's skill level is

balanced with the highest level of challenge, they achieve the immersion effect, which is usually referred to as "forgetfulness". The "forgetfulness" state is most likely to occur when a person performs a task or activity wholeheartedly for an intrinsic purpose. And the person must be in an active state to be most likely to be immersed.

(5) User satisfaction

User satisfaction is an evaluation of various aspects of a particular system made by users after they have used it. Satisfaction occurs with expectations. Users predict how they will feel before using the product, and then compare the actual feelings of use with the predicted feelings of use through actual experience. The result after this comparison is called user satisfaction.

Related theories have studied the antecedents of satisfaction from different aspects, with considerations ranging from psychological to physical. With the development of information technology, the ISS model (Information System Success Model) was first proposed by William H. DeLone and Ephraim R. McLean in 1992, based on previous studies on user satisfaction. The model provides a comprehensive explanation of user satisfaction and describes and illustrates the key to assessing the success of information systems. Domestic and international research based on the ISS model has also been increasing. These studies expand on the ISS model and generally introduce variables such as perceived usefulness, perceived ease of use, and expectations to expand the model.

According to the ISS model and the measurement questions of user satisfaction proposed by J. Cronin, M. Brady, and G. Hult, combined with this paper, four aspects were measured, as shown in Table 2.

Tab 2: User satisfaction measures

Questions on the measure of user satisfaction
This type of interaction was not difficult for me to use
This type of interaction meets my usage needs
I appreciate this interaction
I would like to use this product

IV. The impact of interactive dynamic design in APP on expanding TAM

The statistics of the independent samples of the general dynamic design and interactive dynamic designs for expanding TAM are shown in Table 3. In the case of interactive dynamic effects, the mean score of perceived usefulness was 11.80 with a standard deviation of 2.59. The mean score of perceived ease of use was 11.41 with a standard deviation of 2.34. The mean score of perceived enjoyment was 11.97 with a standard deviation of 2.19. In the case of general dynamic effects, the mean score of perceived usefulness was 10.87 with a standard deviation of 2.74. The mean score of perceived ease of use was 10.01 with a standard deviation of 1.31. The mean score of perceived enjoyment was 10.34 with a standard deviation of 1.81.

The results were further analyzed using an independent samples t-test and are shown in Table 4. The results show that the difference between the interactive and general dynamic effects was the greatest in perceived enjoyment ($T=4.795$, $p<0.00$); the second greatest in perceived ease of use ($T=4.161$, $p<0.00$); and the smallest in perceived usefulness ($T=2.119$, $p<0.05$).

Tab 3: Statistics of independent samples of general dynamic and interactive dynamic designs for expanding TAM

	Mean (E)	Standard deviation	Standard error mean
Interactive dynamic design - perceived usefulness	11.8081	0.26109	2.59779
General dynamic design - perceived usefulness	10.8793	0.35987	2.74071
Interactive dynamic design - perceived ease of use	11.4141	0.23593	2.34743
General dynamic design - perceived ease of use	10.0172	0.17303	1.31778
Interactive dynamic design - perceived enjoyment	11.9798	0.22056	2.19452
General dynamic design - perceived enjoyment	10.3448	0.23790	1.81177

Tab 4: T-test of independent samples of general dynamic and interactive dynamic designs for expanding TAM

	T-test for equality of means						
	T	Degree of freedom	Significance level P-value (two-tailed)	Mean deviation	Standard error	95% confidence interval for the deviation	
						Lower limit	Upper limit
Perceived usefulness	2.119	155	0.036	0.92877	0.43840	0.06277	1.79477
Perceived ease of use	4.161	155	0.000	1.39690	0.33574	0.73368	2.06012
Perceived enjoyment	4.795	155	0.000	1.63497	0.34097	0.96142	2.30852

V. The impact of interaction dynamic design of APPs on perceived ease of use

The linear regression analysis of hypothesis H2 is shown in Table 5. The regression equation was established with perceived ease of use as the dependent variable and interactive dynamic design as the independent variable. The results are illustrated in 3.4.3. The R^2 of interactive dynamic design on perceived ease of use reached 10.8%, and the p-values were less than 0.05. From the analysis of the above data, it can be seen that the interactive dynamic design positively affects the perceived ease of use, so the hypothesis H2 holds.

Tab 5: Linear regression analysis for hypothesis H2
aAnalysis of variance table for the regression model

Model	R	R^2	Estimated standard error	F	Significance P
1	0.328a	0.108	2.02	18.96**0.000	

a.Predictive variables: (constant), interactive dynamic design
b. Table of regression model coefficients

Model		Non-standardized coefficient		Standardized coefficient	T	Significance P
		B	Standard error	Beta		
1	(Constant)	6.956	0.926		7.511	0.000
	Interactive dynamic design	0.326	0.075	0.328	4.323	0.000

a. Dependent variable: perceived ease of use

VI. The impact of interaction dynamic design of APPs on perceived enjoyment

The linear regression analysis for hypothesis H3 is shown in Table 6.The regression equation was established with perceived enjoyment as the dependent variable and interactive dynamic design as the independent variable. The results are illustrated in 3.4.3. The R^2 of interactive dynamic design on perceived ease of use reached 14.3%, and the p-values were less than 0.05. From the analysis of the above data, it can be seen that the interactive dynamic design positively

affects the perceived enjoyment, so the hypothesis H3 holds.

Tab 6: Linear regression analysis for hypothesis H3
aAnalysis of variance table for the regression model

Model	R	R^2	Estimated standard error	F	Significance P
1	0.379a	0.143	2.04	25.92**	0.000

a.Predictive variables: (constant), interactive dynamic design
b Table of regression model coefficients

Model		Non-standardized coefficient		Standardized coefficient	T	Significance P
		B	Standard error	Beta		
1	(Constant)	6.680	0.937		7.132	0.000
	Interactive dynamic design	0.388	0.076	0.379	5.092	0.000

a.Dependent variable: perceived enjoyment

VII. The effect of perceived usefulness, ease of use, and enjoyment of APPs on immersion

The linear regression analysis for hypotheses H4, H5, and H6 is shown in Table 7. Regression equations were established with immersion as the dependent variable and perceived usefulness, perceived ease of use, and perceived enjoyment as the independent variables. The result was R^2=38.8%, and the p-values in the ANOVA table and coefficient table were less than 0.05, indicating that the three can effectively predict the immersion degree. From the above data analysis, it can be found that perceived usefulness, perceived ease of use, and perceived enjoyment performance positively affect the immersion degree. Therefore, hypotheses H4, H5, and H6 are valid.

Tab 7: Linear regression analysis for hypotheses H4, H5, and H6
aAnalysis of variance table for the regression model

Model	R	R^2	Estimated standard error	F	Significance P
1	0.623a	0.388	2.30	32.30**	0.000

a. Predictive variables: (constants), perceived usefulness, perceived ease of use, perceived enjoyment
b Table of regression model coefficients

Model		Non-standardized coefficient		Standardized coefficient	T	Significance P
		B	Standard error	Beta		
1	(Constant)	2.210	1.133		1.951	0.053
	Perceived usefulness	0.642	0.071	0.589	9.076	0.000
	Perceived ease of use	0.495	0.103	0.361	4.826	0.000
	Perceived enjoyment	0.495	0.099	0.373	5.011	0.000

a. Dependent variable: immersion

VIII. Correlation analysis of the immersion model

Correlation analysis is an analysis method in statistics that counts the correlation between two or more variables, and is used to measure whether the variables are closely related to each other as well as the correlation. Correlation analysis is not strictly dependent. In contrast to regression analysis, the variables in correlation analysis have equal status with each other and there is no causal relationship. In contrast, in regression analysis, there is a distinction between the independent and dependent variables and a definite relationship. Correlation analysis is generally used before regression analysis, and the coefficient that generally measures correlation analysis is Pearson correlation coefficient, which is the value of R.

R>0 indicates a positive correlation between the variables, and R<0 indicates a negative correlation between the variables. As can be seen from the table, the correlation coefficient values of interactive dynamic design with perceived usefulness, perceived ease of use, and perceived enjoyment in this study are all greater than 0 and p is less than 0.05, indicating that interactive dynamic design is significantly and positively correlated with perceived usefulness, perceived ease of use, and perceived enjoyment.

Tab 8 Correlation analysis of the immersion model

	Interactive dynamic design	Perceived usefulness	Perceived ease of use	Perceived enjoyment
Interactive dynamic design	1			
Perceived usefulness	0.16*:	1		
Perceived ease of use	0.33**	0.30**	1	
Perceived enjoyment	0.38*	0.34**	0.75**	1

*.The correlation is significant at a confidence level (double test) of 0.05

**. The correlation is significant at a confidence level (double test) of 0.01

	Immersion	Perceived usefulness	Perceived ease of use	Perceived enjoyment
Immersion	1			
Perceived usefulness	0.58*	1		
Perceived ease of use	0.36**	0.30**	1	
Perceived enjoyment	0.37**	0.34**	0.75**	1

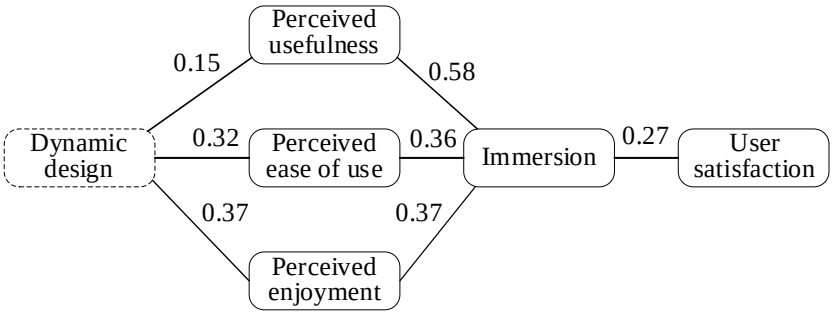

Fig 2: Test results of the theoretical model

The correlation analysis of the immersion model is shown in Table 8. The correlation coefficients of immersion, perceived usefulness, perceived ease of use, and perceived enjoyment of the interactive dynamic design in this study were all greater than 0, and p-value was less than 0.5. It indicates that the immersion in the interactive dynamic design is significantly and positively correlated with perceived usefulness, perceived ease of use, and perceived enjoyment. The results of the theoretical model are shown in Figure 2, and H1-H7 were positively correlated, so the theoretical hypothesis model is valid.

IX. Conclusion

The analysis of the questionnaire by SPSS verified that hypotheses H1-H7 in this hypothesis model are all valid. It verified the hypotheses H1 (dynamic design has a positive effect on perceived usefulness), H2 (dynamic design has a positive effect on perceived ease of use), H3 (dynamic design has a positive effect on perceived enjoyment), H4, H5, H6 (perceived usefulness, ease of use, and enjoyment have a positive effect on immersion), and H7 (immersion has a positive effect on user satisfaction). The final conclusion is that under certain conditions, dynamic design based on the principles of the hypothetical theoretical model constructed in this paper can improve users' concentration and relaxation.

Dynamic design can directly affect users' immersion, but the prerequisite is to study and accurately grasp the scope of dynamic design applications.

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