



**ACCEPTANCE AND RESPONSE ATTRIBUTE MODEL
TOWARDS AUGMENTED REALITY GAMES BASED ON HAND
GESTURE INTERACTION**



**MASTER OF SCIENCE IN INFORMATION AND
COMMUNICATION TECHNOLOGY**

2023



Faculty of Information and Communication Technology

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INTERACTION**

اونيور سيتي تیکنیکل ملیسیا ملاک
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Master of Science in Information and Communication Technology

2023

**ACCEPTANCE AND RESPONSE ATTRIBUTE MODEL TOWARDS
AUGMENTED REALITY GAMES BASED ON HAND GESTURE
INTERACTION**

FARAH FARHANA BINTI ROSZALI

**A thesis submitted
in fulfilment of the requirements for the degree of Master of Science
in Information and Communication Technology**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this thesis entitled “Acceptance and Response Attribute Model Towards Augmented Reality Games Based on Hand Gesture Interaction” is the result of my research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and, in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Information and Communication Technology.

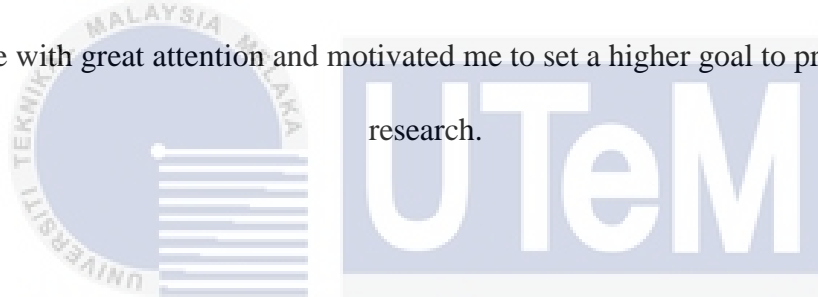
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DEDICATION

This research is dedicated to my family and friends who are never missed to give attention and love throughout my research journey.

This research was also dedicated to my supervisor, Ts. Dr. Ibrahim bin Ahmad who have guided me with great attention and motivated me to set a higher goal to produce better research.



Finally, I dedicated this research to all UTeM lecturers and staff who were involved in giving cooperation for this study.

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ABSTRACT

Nowadays, augmented reality is used in numerous fields such as health and safety training, education, entertainment, and computer games. The combination of real and virtual objects in a real environment allows the user to experience the real world with virtual objects superimposed upon or composited with the real world. Over the past few decades, the use of augmented reality has been brought to the gaming field. However, there were limited studies that emphasize hand motor-impaired users. In this study, the model has been developed to represent the acceptance and response of hand motor-impaired users towards an augmented reality game application. The model has been derived from the UTAUT2 model, especially for the user acceptance attribute. The purpose of this study is to design a prototype of an augmented reality game application and to develop a model who have an element for user acceptance and response towards hand motor-impaired users. The objectives of this research are (i) to identify the element and criteria of augmented reality game design that contribute to the enjoyable experience for hand motor-impaired users, (ii) to develop a model for Hand Motor-Impaired Users-Acceptance and Response (HMIU-AR Model), (iii) to validate the HMIU-AR Model and (iv) to design an augmented reality game based on HMIU-AR Model. The methodology of this study was done by combining the quantitative and qualitative data, there are divided into two parts where are Part 1, the design and development of augmented reality games, and Part 2, the research of acceptance and response of AR games toward hand motor-impaired users. Part 1, consists of four phases which are requirement analysis, design, implementation, and evaluation. While in Part 2, there are three phases which are the formation of the proposed model, formation of items for the questionnaire, and model validation of augmented reality game for hand motor-impaired users. The respondents of this study consist of 100 students to play and test the application and four respondents for the interview session. Based on the user acceptance questionnaire that has been used, the study found that the mean value obtained from all factors of user acceptance is positive, overall exceeding the 3.00 value. The mean of user and expert value on the augmented reality game applications also showed positive appraisal for all constructs with an overall mean value is 3.52 for users and 4.76 for experts. This study shows that the mobile games that have been developed have a positive impact on user acceptance of the use of games in their learning. Furthermore, the integration of augmented reality elements was also noticed to have a valuable impact on this study. Thus, augmented reality game designers need to pay close attention to the elements that are appropriate before designing an enjoyable game interface that is accessible to the target users.

MODEL ATRIBUT PENERIMAAN DAN TINDAKBALAS TERHADAP PERMAINAN REALITI TERIMBUH BERDASARKAN INTERAKSI ISYARAT TANGAN

ABSTRAK

Pada masa kini, realiti tambah digunakan dalam banyak bidang seperti latihan kesihatan dan keselamatan, pendidikan, hiburan dan permainan komputer. Gabungan objek sebenar dan maya dalam persekitaran sebenar membolehkan pengguna mengalami dunia nyata dengan objek maya yang ditumpangkan atau digabungkan dengan dunia nyata. Selama beberapa dekad yang lalu, penggunaan realiti terimbuah telah membawa ke bidang permainan. Walau bagaimanapun, terdapat kajian terhad yang menekankan pengguna gangguan motor tangan. Dalam kajian ini, kami akan mengembangkan model yang mewakili penerimaan dan tindak balas pengguna yang mengalami gangguan motor tangan terhadap aplikasi permainan realiti terimbuah. Model ini berasal dari model UTAUT2, terutama untuk atribut penerimaan pengguna. Tujuan kajian ini adalah untuk merancang prototaip aplikasi permainan realiti terimbuah dan mengembangkan model yang mengaitkan penerimaan dan respons pengguna terhadap pengguna yang mengalami gangguan motor tangan. Objektif untuk penyelidikan ini adalah untuk mengenal pasti elemen dan kriteria reka bentuk permainan realiti terimbuah yang menyumbang kepada pengalaman menggembirakan bagi pengguna yang mengalami masalah motor tangan, (ii) untuk mengembangkan model untuk Penerimaan dan Tindak Balas Pengguna yang Terjejas Motor Tangan (Model HMIU-AR) (iii) untuk mengesahkan Model HMIU-AR dan (iv) untuk merancang permainan realiti tambah berdasarkan Model HMIU-AR. Metodologi kajian ini dilakukan dengan menggabungkan data kuantitatif dan kualitatif, terdapat dua bahagian di mana Bahagian 1, reka bentuk dan pengembangan permainan realiti terimbuah dan Bahagian 2, penyelidikan penerimaan dan tindak balas permainan realiti terimbuah terhadap pengguna yang mengalami masalah motor tangan. Bahagian 1, terdiri dari empat fasa yang merupakan analisis, reka bentuk, pelaksanaan dan penilaian keperluan. Sementara di Bahagian 2, ada tiga fasa yang merupakan pembentukan model yang diusulkan, perkara formasi untuk soal selidik dan pengesahan model permainan realiti terimbuah untuk pengguna yang mengalami gangguan motor tangan. Sampel kajian ini terdiri daripada 100 pelajar universiti untuk menguji permohonan dan empat responden untuk sesi temu ramah. Berdasarkan soal selidik penerimaan pengguna yang telah digunakan, kajian mendapati bahawa nilai min yang diperoleh dari semua faktor penerimaan pengguna adalah positif, secara keseluruhan melebihi nilai 3.00. Penilaian pengguna dan pakar pada aplikasi permainan realiti terimbuah juga menunjukkan penilaian positif untuk semua konstruksi penilaian dengan nilai min keseluruhan adalah 3.52 untuk pengguna dan 4.76 untuk pakar. Kajian ini menunjukkan bahawa permainan realiti terimbuah yang telah dikembangkan mempunyai kesan positif terhadap penerimaan pengguna terhadap penggunaan permainan dalam pembelajaran mereka. Selanjutnya, penyatuan elemen realiti terimbuah juga diperhatikan memberi kesan yang berharga pada kajian ini. Oleh itu, pereka permainan realiti terimbuah perlu memperhatikan aspek ciri yang sesuai sebelum merancang antara muka permainan yang menyeronokkan yang dapat diakses oleh pengguna sasaran.

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LIST OF ABBREVIATIONS

AR	- Augmented Reality
ARG	- Augmented Reality Game
HCI	- Human-Computer Interaction
ICT	- Information and Communication Technology
MOE	- Ministry of Education
TAM	- Technology Acceptance Model
UTAUT2	- Unified Theory of Acceptance and Use of Technology 2
UTAUT-EG	- Unified Theory of Acceptance and Use of Technology Educational Game

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LIST OF PUBLICATIONS

1. Roszali, F.F, Ahmad, I., and Sarudin, N., 2020. Augmented Reality Game (ARG) Design Framework: Acceptance and Response of Hand Motor-Impaired Users. *Journal of Solid-State Technology*, 63(3).
2. Roszali, F.F, Ahmad, I., and Sarudin, N., 2019. The Existing of Supportive Technology Tools for Hand Motor-Impaired User: A Systematic Literature Review. *International Journal of Recent Technology and Engineering (IJRTE)*.



CHAPTER 1

INTRODUCTION

1.1 Introduction

Computer games were already applied in many areas as a medium for education, marketing, advertising, entertainment, and games for health (Küçüküran et al., 2022). There are more than 50 sites for serious or educational games and 10 of them are classified as serious games that have changed the world (Di Paola et al., 2019). Rapid development in computer technology has caused various genres of computer games to be developed such as military (Nystrom et al., 2018, Mao and Chen, 2020), education (Balzotti and Hansen, 2019, Steinmaurer et al., 2020), health (Ayed et al., 2019, Tubelo et al., 2019) and serious disease (Ferguson et al., 2020). Games are fun activities (Karakoç et al., 2022). Everyone has the right to play whatever game is available in any platform. This includes users who are problems controlling their hands normally.

People with physical and mobility impairments continue to struggle to attain independence in the performance of routine activities and tasks (Rashid et al., 2019). The loss of motor function can affect a person's quality of life significantly by leaving them partially or even completely dependent on others (Bai et al., 2010, Šumak et al., 2019). The motor-impaired users' particularly in the hands of the arm are said to be either lost or restricted in the muscle or movement control function. From the previous study, there are a lot of researches use augmented reality (AR) as an approach to give amusement experience or training process to the user. Restoring and augmenting human capabilities compensating for reduced motor functions and disabilities may be carried out by different approaches, all

of them finalised to return to the involved person some missing functions or capabilities (Pedrocchi et al., 2013).

In addition, integration of game with AR technology, methods and techniques used in the process of delivering educational content should involve not only the domain of cognitive; even in psycho motor must also be emphasized. Process control using hand gesture toward environmental games interface, which serve as a medium of learning is seen to have a significant impact in terms of cognitive and psycho motor. Single tapping as a gesture is the most used method to activate targets on touch screen devices (Zhong et al., 2015). Therefore, this study aimed to look at the patterns of hand control to the game interface design. Effects of users' acceptance and response against the characteristics of the game interface obtained has been analysed and subsequently design a framework appropriate game interface design will be backed up. At the initial stage of analysis, the characteristics of a game interface are obtained for designing and developing processes for testing and playing by target users. While in the real testing, users will interact with the game interface while playing the game. Using video footage from kinect camera recorded, hand gesture using free movement users will be determined and analysed. Based on the finding, a database related by AR controlling the users' hand movements and gesture recorded. Acceptance and response attribute framework for AR game based on users' hand gesture interaction is expected to be delivered which would be significant contribution as guidelines in implementing game to the motor-impaired users.

1.2 Problem Background

Motor-impairment is person who encounters with low or decreases the functionality of their limbs' movement. From the previous study, the most prevalent conditions include rheumatic diseases, stroke, Parkinson's disease, multiple sclerosis, cerebral palsy,

traumatic brain injury, and spinal injuries or disorders (Trewin and Keates, 2006, Cheat and Wongsaisuwan, 2018, Keates, 2018). This condition makes them feel down and pressure since their movement has limitation. They cannot do as previous activities since their motor-impaired has limited.

Nowadays, there are plenty of technologies and application that has been developed to help the user to improve and feel the excitement while doing exercises or during rehabilitation. In this study, AR game has been developed for user who has motor-impaired and will focus on the hand gestures. It will show their response and acceptance toward the game design and human computer interaction (HCI). Generally, the term HCI describes the interaction between human and computer for example the communication channels between humans and computers (Bachmann et al., 2018).

Heretofore, there has been a little further research and development (Chen et al., 2020) on AR game for motor-impaired user especially on the acceptance and response of the use of the technology as a medium for them to exercise and in the same time has a lot of fun.



1.3 Problem Statement

Based on background of the problem that has been discussed, the following is a problem statement that has been identified.

1.3.1 The Limitation of Augmented Reality Game for Hand Motor-Impaired User as Supportive Technology

There are many problems faced in determining the interface design aspects of a good game design especially in an Augmented Reality-based game. The designers of the game mostly must deal with the aspects in determining the level of a game according to the

number of enemies or the strategy of the game. However, they should consider the user who dealing with hand motor-impaired. This is because they have limitation to play game in term of hand gesture interaction. Most of the current tool are based manual depend on expertise experience and knowledge. The problem is lack of study on characteristic of augmented reality game application for hand motor-impaired user and the current learning is not user friendly and costly according to Chen et al. (2020). There should be a mechanism to assist the game designer that can be used as a guide. The characteristics of a good game design must be registered in order to help the game designers. From here a framework model can be produced with a viewing angle of the user adaptability in the use of hand gestures interaction. Moreover, the study deals with the interaction of a hand gesture towards the game interface design has produced not many ongoing. In helping the motor-impaired users who are growing up in the use of hand gesture interaction to the game produced, it is seen very, very helpful. This is because the user will try to use gaming environment that resulted in solving a given problem.

1.3.2 The Limitation of Study About Acceptance and Response of User Toward Augmented Reality Game

Augmented reality game is the new application that need more and further research regarding the acceptance and response toward user experiences. To identify the potential of new technologies, it is essential to examine user acceptance (Obeidy et al., 2017). The contribution game towards motor-impaired user need to give more attention since they still have desire to play the game. Evaluation acceptance should include the criteria and element that relatable with the user. User acceptance of technology has been an important field of study for over two decades now (Chuttur, 2009). But, the study regarding user acceptance toward augmented reality game for user who have hand motor-impaired

problem still lack and need to discover their acceptance with this technology. In addition, the previous study used an augmented reality game for rehabilitation but there were no data about user acceptance while using this application (Held et al., 2020). Besides that, in this study required to find the response of user toward this application. From the previous study, there are a few research regarding user response towards augmented reality or game such as (Park et al., 2020). But the focus is for rehabilitation to disable user. However, the lack of information and study the response of user with this application need for further research and explore. Therefore, this study needs to investigate the acceptance and response for hand motor-impaired while engaging augmented reality game.

1.4 Research objectives

The purpose of this study is to develop an attribute model of acceptance and response to the interaction of users with hand-motor impairment problems. The main elements and criteria for the augmented reality games will be identified before the game will be develop.

Based on the purpose of this study, the following are the objectives to be achieved:

1. To identify the element and criteria of augmented reality game design that contribute to experience for hand motor-impaired users.
2. To develop a model for Hand Motor-Impaired Users - Acceptance and Response (HMIU-AR Model).
 - a. Identify the related theory to form a HMIU-AR Model
 - b. Analyse the element and criteria to develop HMIU-AR Model
3. To validate the HMIU-AR Model.
 - a. Validation I: Qualitative validate from expert.
 - b. Validation II: Quantitative validate from expert.
 - c. Validation III: Validate from playtest.

1.5 Research question

This research intends to answer a numbers of specific research questions as follows:

RQ1: What are the element and criteria of augmented reality game that contribute enjoyable to user?

RQ2: How to develop the element of Hand Motor-Impaired User-Acceptance and Response (HMIU-AR Model)?

RQ3: How the element of HMIU-AR Model can be validated?

RQ4: How to design of the augmented reality game based on element of HMIU-AR Model?

1.6 Theoretical framework

In this research a theoretical framework was developed consists of four phases which are analysis, design and development, implementation, and evaluation. Figure 1.1 shows the theoretical framework for this research.

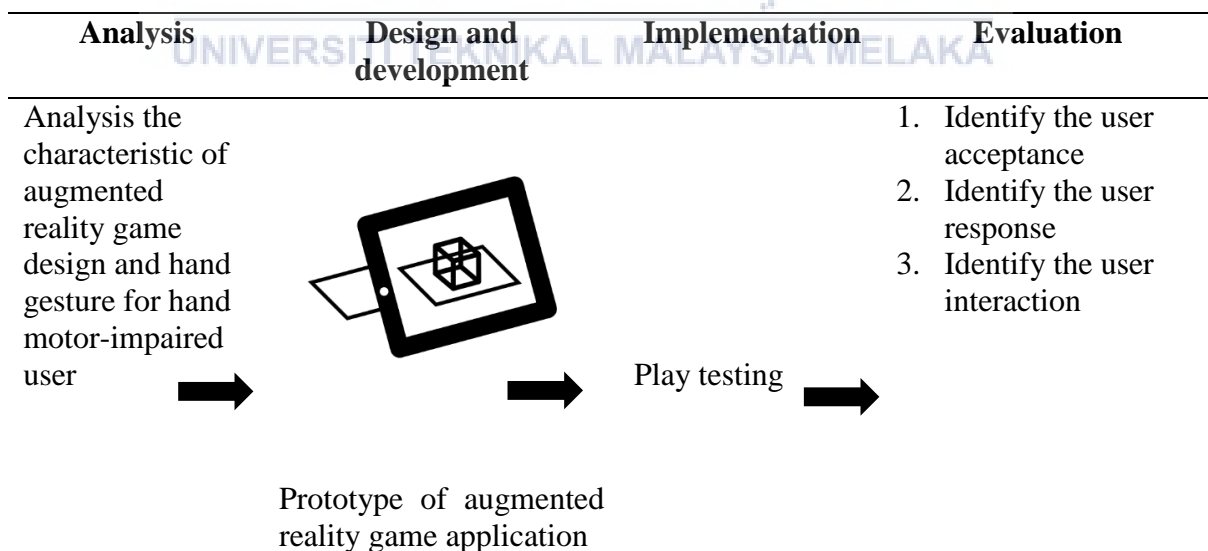


Figure 1.1: The theoretical framework of research