SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT

YUZAWANI BINTI YUSOFF

Bachelor of Computer Science

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : YUZAWANI BINTI YUSOFF

Date Of Birth : 15 December 1995

Title : Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment

Academic Session : Semester 2 Session 2018/2019

I declare that this thesis is classified as:

☐	CONFIDENTIAL	(Contains confidential information under the Official Secret Act 1997)*
☐	RESTRICTED	(Contains restricted information as specified by the organization where research was done)*
☑	OPEN ACCESS	I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_____	_____
(Student's Signature)	(Supervisor's Signature)
_____	_____
951215-11-5168	Noraniza Binti Samat
Date: 29/5/2019	Date: 29/5/2019

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Science (Graphics and Multimedia Technology) with Honors.

_____

(Supervisor's Signature)

Full Name : NORANIZA BINTI SAMAT

Position : LECTURER

Date : 29 MAY 2019

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : YUZAWANI BINTI YUSOFF

ID Number : CD16088

Date : 29 MAY 2019

SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT

YUZAWANI BINTI YUSOFF

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Computer Science (Graphics And Multimedia Technology) with Honors

Faculty of Computer Systems & Software Engineering
UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

All praise to the Almighty Allah S.W.T for His blessing which has given me strength, patience and wisdom and ability during the final year project developing period. Sincere thanks to the Allah for giving me the opportunity to complete this project on time. Firstly, I would like to express my deepest appreciation to all those who provides me the possibility to complete the PSM report. A special gratitude I would like to give to my supervisor Miss Noraniza Binti Samat for her insightful comments, outstanding advice and suggestions, spend time and helped me to coordinate my project especially in writing this report. In addition, I also want to give my sincere appreciation to the Faculty of Computer Systems & Software Engineering which always supporting all the students who are taking the PSM. Besides that, I would like to thank my family and friends that always give fully support and good advices.

ABSTRAK

Carpal tunnel syndrome (CTS) adalah keadaan perubatan kerana mampatan saraf median ketika bergerak melalui pergelangan tangan di terowong carpal. Terowong carpal adalah laluan sempit di pergelangan tangan, yang terbuka ke tangan. Ia dikelilingi oleh tulang pergelangan tangan di bawah dan ligamen carpal melintang di bahagian atas. Saraf median bergerak melalui terowong carpal dan memberi perasaan kepada ibu jari, telunjuk, jari tengah dan separuh jari cincin. Banyak urat atau otot juga melalui terowong karpal ini dan jika ada pembengkakan berlaku, saraf median yang besar dapat mampatan dengan mudah, menyebabkan CTS. Pemulihan untuk CTS mempunyai dua iaitu fizikal terapi dan pembedahan. Permainan ini untuk rawatan pemulihan sindrom carpal tunnel (CTS) untuk membantu dan memberi manfaat kepada pesakit dengan Sindrom Tunnel Carpal. Permainan ini dibangunkan dengan pergerakan fisioterapi berikut untuk permainan dan semua elemen dan keperluan dalam permainan ini dari pemulihan perubatan supaya ia lebih berkesan kepada pengguna. Permainan ini membuat pesakit berasa seronok untuk melakukan senaman. Metodologi ADDIE dipilih kerana ia menyediakan struktur yang sistematik semasa permainan ini sedang berkembang. Model ini mempunyai lima fasa untuk membangunkan iaitu analisis, reka bentuk, pembangunan, dan sistem pelaksanaan dan penilaian. Permainan serius untuk rawatan pemulihan sindrom carpal tunnel (CTS) terdiri daripada dua utama utama termasuk permainan dan mengenai CTS. Permainan untuk pesakit CTS berkembang dengan pergerakan fisioterapi berikut dan ia terdiri daripada dua pergerakan yang merupakan gerakan aktif gerakan dan pergelangan tangan dan setiap pergerakan mempunyai dua peringkat, untuk setiap peringkat mempunyai corak perbezaan permainan untuk pengguna selesai.Di samping itu, mengenai CTS terdiri daripada maklumat mengenai CTS, gejala CTS, rawatan dan latihan untuk rujukan pengguna. Permainan ini untuk Rawatan Rehat Pemulihan Carpal Tunnel (CTS) telah diuji oleh pesakit dan Encik Azeri sebagai pemulihan perubatan di Pusat Kesihatan Pelajar, UMP Gambang telah menguji keberkesanan permainan ini kepada pesakit. Ujian ini membantu untuk mencapai matlamat permainan ini. Permainan ini membantu dan memberi manfaat kepada pesakit sindrom carpal tunnel supaya kesakitan dapat dikurangkan dan CTS dihindari. Mengikut ujian itu membantu pesakit melegakan kesakitan mereka dengan bermain permainan CTS dan memberi mereka maklumat lebih lanjut mengenai CTS.

ABSTRACT

Carpal Tunnel Syndrome (CTS) is a medical condition due to median nerve compression when traveling through the carpal tunnel's wrist. The carpal tunnel is a narrow passage in the bracelet that opens in the hand. It is surrounded by the below wrist bones and the transverse carpal ligament above. The middle nerve runs through the carpal tunnel and gives the thumb, forefinger, middle finger and half of the ring finger. Many tendons also pass through this carpal tunnel and the large median nerve can be easily compressed if swelling occurs, causing carpal tunnel syndrome. Physical therapy and surgery are two wishes for rehabilitation for CTS. Serious games for carpal tunnel syndrome (CTS) rehabilitation treatment develop for help and benefits the patient with Carpal Tunnel Syndrome. This game develop by following physiotherapy movement for the game and all the element and requirement in this game from medical rehab so that it more effective to user. This game make patient feel fun to do the exercise. The ADDIE methodology model is chosen because it provides a systematic structure while this game is developing. This model has five phases to develop which are the analysis, design, development, and implementation and evaluation system. Serious games for carpal tunnel syndrome (CTS) rehabilitation treatment consist of two main major including game and about CTS. Game for CTS patient develop by following physiotherapy movement and it consist of two movement which is active range of motion and wrist extension and each movement have two level, for each level have difference pattern of game for user to complete. In addition, about CTS consist of information about CTS, symptoms of CTS, treatment and exercise for user to refer. Serious games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment has been test by patients and Mr. Azeri as a medical rehab at Pusat Kesihatan Pelajar, UMP Gambang test the effectiveness this game to the patient. This test helps to achieve this game's goal. This game helps and benefits the carpal tunnel syndrome patient so that pain can be reduced and CTS avoided. According to the testing it help patient to relief their pain by play CTS game and give them more information about CTS.

TABLE OF CONTENTS

TABLE	LIST OF TABLES	PAGE

FIGURE **LIST OF FIGURES** **PAGE**

LIST OF ABBREVIATIONS

SBPWM	Simple Boost Pulse Width Modulation
ZSI	Z source inverter

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Carpal Tunnel Syndrome (CTS) is a medical condition due to median nerve compression when traveling through the carpal tunnel's wrist. The carpal tunnel is a narrow passage in the bracelet that opens in the hand. It is surrounded by the below wrist bones and the above carpal ligament. The median nerve crosses the carpal tunnel and gives a feeling to the thumb, forefinger, centre and half of the ring finger. Many tendons also pass through this carpal tunnel and the large median nerve can be easily compressed if any swelling occurs, causing carpal tunnel syndrome.

Using a phone or tablet can cause damage and pain, including tingling and numbness in your hands and wrists. Starting with 500 students, an international study found that 54 percent of intensive users using devices longer than three hours a day showed signs of CTS. CTS is a common disease occurring in 2.7% of the general population. Women are more common than men, and the average age of CTS patients is 40 - 50 years (HealthDay News, 2017).

Physical therapy and surgery are two wishes for rehabilitation for CTS. Physical therapy has resulted in better results in the short term. Those who received treatment had less pain and a better function than those who had surgery.

Therefore, this thesis will focus on how the symptoms of carpal tunnel syndrome and treatment for rehabilitation could help and benefit the patient with CTS.

1.2 PROBLEM STATEMENT

There were many mobile games in these days of advanced technology that offer state-of - the-art technology that could promise user satisfaction. Malaysians spend over three hours on their smartphones every day, according to the smartphone user. As regards use, 40 percent of users spent time on social networking and chatting, 36 percent on entertainment and 15 percent on utility apps, it shows that they spend too much on their smartphones (The star online, 2016).

People who spend a lot of time on their smartphones can cause CTS because scrolling, taping and swiping affects their hands, painful wrist and disorder of their hands.

Table 1.1: The Project Problem Statement Carpal Tunnel Syndrome Game

No.	Problem	Description	Effect
1.	Social isolation.	Malaysians spend more than three hours every day on their smartphones.	• Painful wrist and hand disorder.
2.	Constant distraction.	CTS is a condition that causes tingling, numbness and other symptoms in your hand and your arm.	• Performance in daily routine.
3.	Tingling or numbness	Usually the thumb and index, middle or ring fingers are affected	• Drop objects • Shake out • Sensation like an electric shock

1.3 OBJECTIVES

The objective of this study is to develop a game application for patients to practice physical therapy treatment that can often relieve pain and numbness and restore normal use of the hand, wrist and arm without surgery. The objectives of achieving this objective are as follows.

I. To study the types of Carpal Tunnel Syndrome and rehabilitation therapy.

II. To design and develop a serious game for help and benefits the patient with Carpal Tunnel Syndrome.

III. To evaluate serious game effectiveness Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment for Carpal Tunnel Syndrome patient.

1.4 SCOPE

Scopes of developing Carpal Tunnel Syndrome game.

Table1.2: Project Scopes of Developing Carpal Tunnel Syndrome Game

User	The target user for this games are Carpal Tunnel Syndrome patient and anyone who using smartphone.
Technology	● Accelerometer Smartphone ● Game app for Android
Tools	● Unity ● Accelerometer ● Adobe Photoshop
CTS Therapy Movement	Carpal Tunnel Syndrome exercise movement : ● Front and back ● Left and right

1.5 THESIS ORGANIZATION

This thesis consist of five chapter.

Chapter 1:

This section is the introduction to this project. In this chapter, the problem statement was identified and stated to achieve the project objectives. The project scope has also been identified.

Chapter 2:

This section is intended to explain the literature review of this project. The existing system developed is reviewed and explained. The system comparison was also stated.

Chapter 3:

This chapter discussed the project methodology and framework in which the overall project process and framework was discussed. This chapter also explain the hardware and software requirements of the project.

Chapter 4:

This chapter discussed the implementation and test the components in which the overall development and implementation of the project was discussed. This chapter also discussed the project testing.

Chapter 5:

This chapter is the final part of the project, which explain the completion of the project and the future improvement that can be achieved.

CHAPTER 2

LITRETURE REVIEW

2.1 INTRODUCTION

In this chapter, there had four subtopics which first section will discuss on Carpal tunnel syndrome (CTS) consist of Symptoms of Carpal Tunnel Syndrome and rehabilitation treatment for carpal tunnel syndrome. Second section, serious games, the type of serious game and the benefits of serious games. The third section deals with the review of three existing systems, which were developed and referenced similarly to the game. Finally, comparison of three existing systems will be discuss.

2.2 CARPAL TUNNEL SYNDROME (CTS)

Carpal tunnel syndrome occurs when the tunnel is narrowed or tissues swelling around the flexor tendons, putting pressure on the median nerve. These tissues are called the synovium. Normally, the synovium lubricates the tendons, making it easier to move your fingers. It takes up space in the carpal tunnel when the synovium swells and, over time, crowds the nerve. This abnormal nerve pressure can lead to pain, numbness, tingling, and hand weakness (Charles D. Jennings & Katherine Faust, 2016).

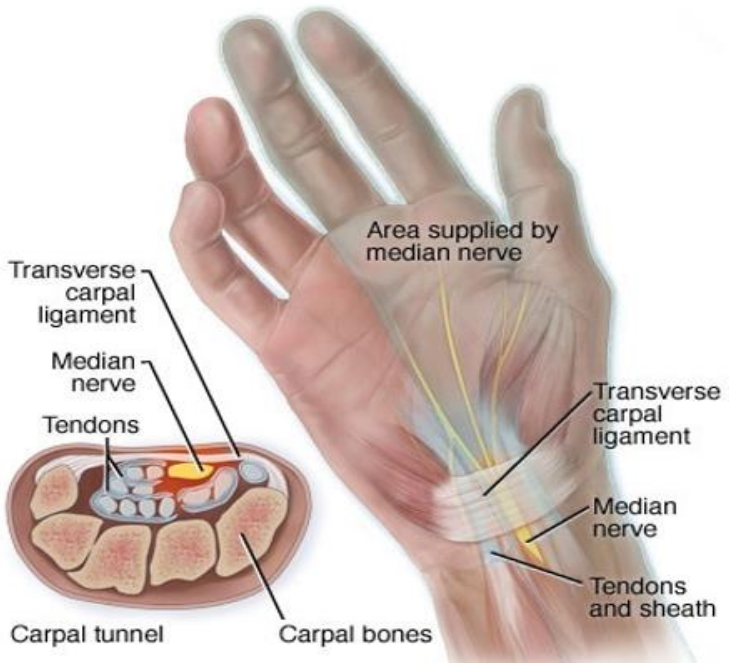


Figure 2.1: Carpal Tunnel Syndrome Therapy Anatomy

Figure 2.1 shows on carpal tunnel, it consists of tendons, ligaments and bones, a passage from the wrist to the hand. The median nerve passes through the tunnel and gives the thumb, index finger, and centre finger and thumb side of the ring finger a sensation.

2.2.1 Symptoms of Carpal Tunnel Syndrome

Typically, CTS slowly begins with feelings of burning, tingling, and numbness in the wrist and hand. The thumb, index and middle fingers are the areas most affected. In the first place, symptoms may occur more often at night. Many CTS sufferers do not connect a daytime activity that could cause CTS with the delayed symptoms. Many people also sleep with their wrist bent, which can cause more pain and symptoms in the night. As the CTS gets worse, the tingling can also be felt during the day, along with pain moving from the wrist to arm or fingers. Pain on the palm side of the hand is usually felt more.

The weakness of the hands that gets worse over time is another symptom of CTS. Some people with CTS having trouble grasping an object, making a fist or holding something small. The fingers may even feel swollen even if they are not. This feeling usually happens more often over time.

If left untreated, those with CTS may experience a loss of feeling in some fingers and permanent thumb weakness. In fact, thumb muscles can waste time. Eventually, patients with CTS may find it difficult to tell the difference between hot and cold temperatures by touch. Symptoms of Carpal Tunnel Syndrome may include:

I. Feel pain in the palm of the hand, such as numbness, tingling, burning and pain, mainly in the thumb and index, middle and ring fingers, especially close to the thumb and first 2 fingers.

II. Tingling or pain that can travel up the forearm to the shoulder.

III. Weakness and tediousness in the hand can make it difficult to perform good movements

IV. Dropping things can be due to the numbness in the hand or the weakness of the pinching muscles of the thumb, which are also controlled by the median nerve.

2.2.2 Therapy and Rehabilitation treatment for Carpal Tunnel Syndrome

Physical therapy helps to reduce the severity of symptoms and may eliminate the need for surgery to restore patients to an active and functional lifestyle. Physical therapy helps patients recover their wrist strength after CTS surgery.

Conservative early-stage care of CTS is recommended as a first step. Physical therapy can be effective in reducing symptoms and helping to carry out normal activities.

Physical therapy helps to reduce symptoms without operation to allow the patient to be as active and functional as possible. If CTS is severe or if your symptoms persist, the patient may refer a doctor for surgical consultation.

If necessary, surgery is carried out to release the tissue band that causes pressure on the median nerve. After surgery, physical therapy treatment is important to help restore wrist strength and learn to modify habits that may have caused CTS symptoms (J Occup Rehabil, 2011). There are few movement that help CTS Patient.

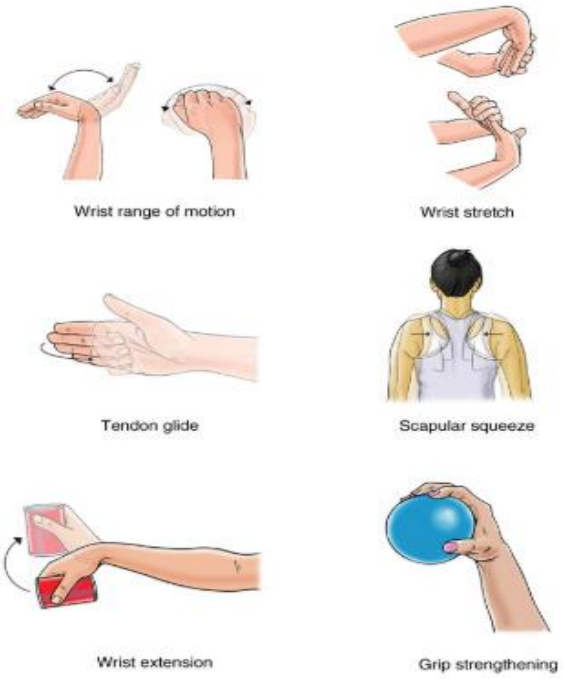


Figure 2.2: Carpal Tunnel Rehabilitation Exercise (Pachoulakis & Tsilidi, 2016).

Figure 2.2 shows on Carpal Tunnel rehabilitation exercise, there a few movement will help patient do exercise such as wrist range of motion, wrist stretch and wrist extension

2.3 SERIOUS GAME

A serious game or a computer game that was designed for the main purpose beyond pure entertainment. Serious games are used in a wide range of professional situations, such as education, training, recruitment, knowledge management, business, town planning, engineering, health care and policy. The development of a serious CTS game meets the requirement to help users perform the therapy in a fun way and reduce pain. The types of serious games are divided into a few categories: education, conviction and health. Symptoms

of Carpal Tunnel Syndromepurpose of this game categories is to help people recover from health problems. There are two types which fall into this category:

1. Exergaming

   The aim of this game is to help the player exercise.

2. Games for health

   These categories help the player with physical pain, psychological problems and so on.

Serious rehabilitation games aim to improve the cognitive and motor skills of patients during the rehabilitation process by facilitating the exercises and More fun to use simulation and virtual reality (VR) environments compared to traditional methods. There is an existing medical treatment system

Figure 2.3: Rehabilitation Games Gabarello

Figure 2.3 shows on Gabarello is one of serious game for neurological disorders and injuries such as a stroke, a spinal cord injury, children's locomotive ability can be affected. In

treatment patients rehabilitation process includes gait training, where it is recommended that each movement is trained in a task-specific program. This game is a playable prototype of a physiotherapeutic serious game which combines the robot-assisted gait therapy with virtual reality. Including the virtual reality game increases patient's motivation and joy while training and allows therapists to include video assistance, immediate feedback and real-time interactive experience (Barbara Plovie, 2014).

2.4 REVIEW OF EXISTING SYSTEMS

2.4.1 The Roller Ball

The Roller Ball game is developed in Unity3D and uses CTS-specific physiotherapy exercises to guide a ball along a bridge through a 3D scene while avoiding moving obstacles or breaking the bridge. The Leap Motion sensor is a hardware platform for the rehabilitation of CTS patients with serious games.

The Roller Ball game developed by Unity3D to explore the sensor's possibilities and limitations and concluded that the sensor's accuracy of tracking is sufficient to detect and track certain bracelet postures required by physiotherapy exercises to alleviate CTS symptoms. Limitations in the application of the sensor for the intended purpose occur naturally in CTS-specific exercises where the wrist-hand posture causes part of the hand.

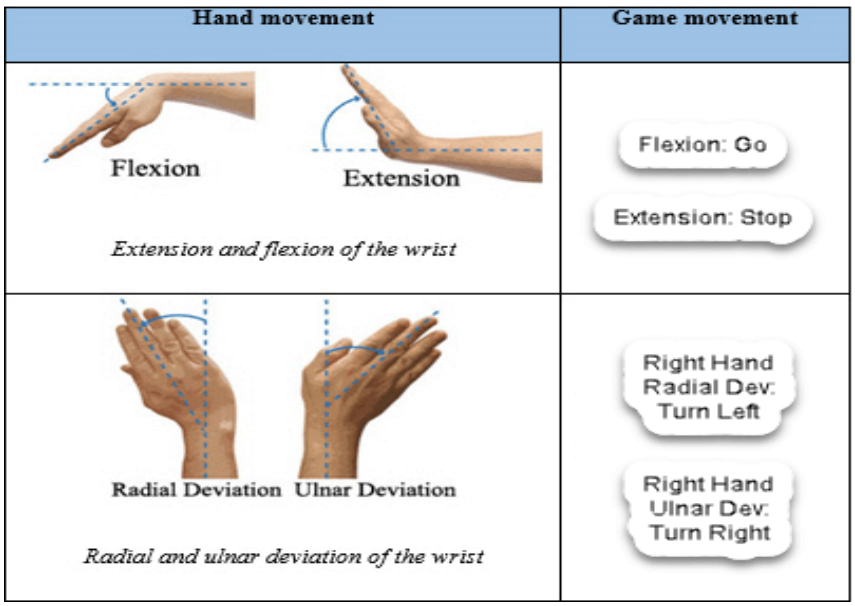


Figure 2.4: Four Wrist Physiotherapy Exercises (Pachoulakis & Tsilidi, 2016).

Figure 2.4 shows on four wrist physiotherapy exercises commonly used to treat Carpal Tunnel Syndrome are shown in the left column. Each exercise is detected as a gesture in the game and mapped to an action on the ball as shown in the column to the right.

The game scene supports the CTS physiotherapy repetitive exercises. CTS-oriented rehabilitation appears to be the Leap Motion controller, a small peripheral USB device commonly placed on the upside table. The device uses two monochromatic IR cameras and three infrasound LEDs to detect movement in an approximately hemispheric area centred on the sensor with a radius of about one meter.

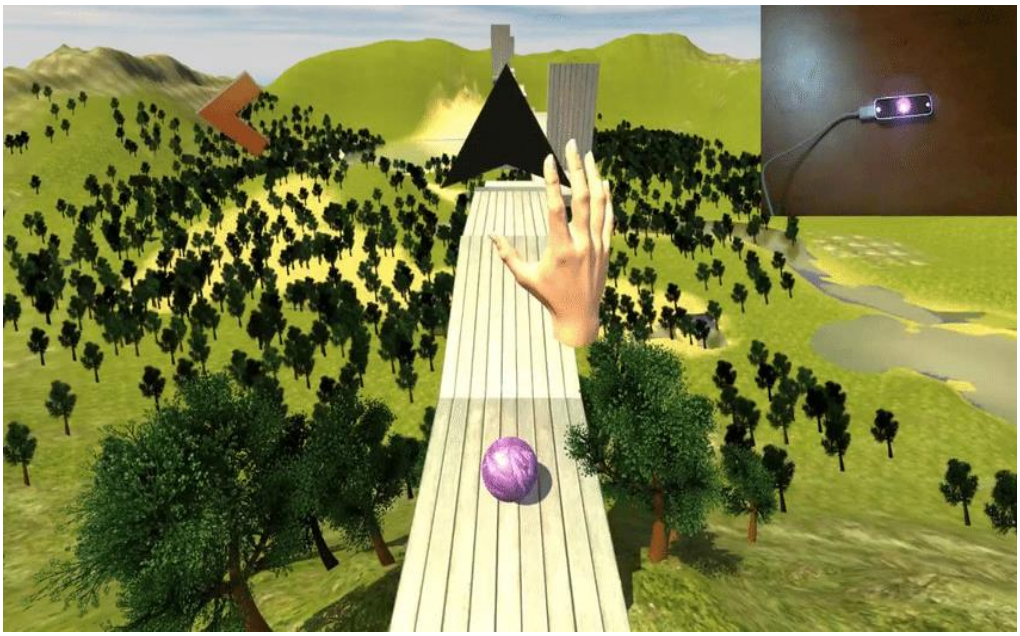


Figure 2.5: Control a Ball across a Bridge (Pachoulakis & Tsilidi, 2016).

Figure 2.5 shows on how the player need to guide a ball across a continuously reconfigurable bridge, while avoiding a number of moving obstacles.

Exercise Carpal Tunnel

The Carpal Tunnel app teaches the user simple, safe and adequate exercises using interactive tools such as images, videos, exercise register calendars to track symptoms and exercise frequency and type of activity. The user can then export it to show it to the doctor. This app is only available on the App Store for iOS devices (BuiltByDoctors, 2016).

Exercise is very important in preventing carpal tunnels and in treating symptoms if the condition already exists. In some cases, effective exercise can prevent the disorder and eliminate the need for surgery. Exercise is often recommended in combination combination with with splinting and daily modification of repetitive wrist faction in carpal tunnels. Exercises for CTS strive to stretch the forearm muscles, reduce tension on tendons in the carpal tunnel region and strengthen affected muscles.

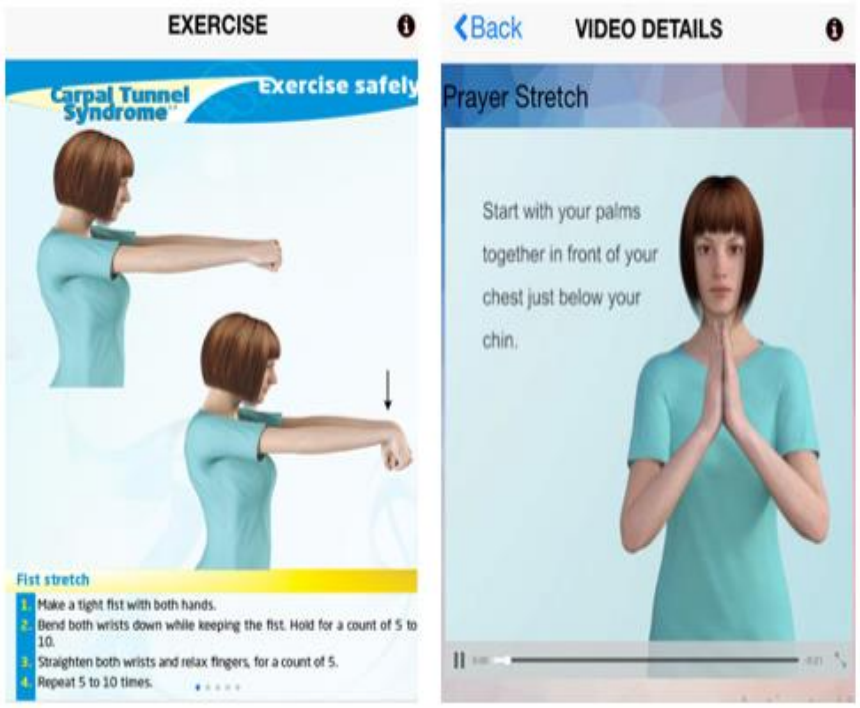


Figure 2.6: Safety Exercise for Carpal Tunnel Syndrome

Figure 2.6 show on step by step to how to do exercise and movement correctly by following the instructions and video detail.

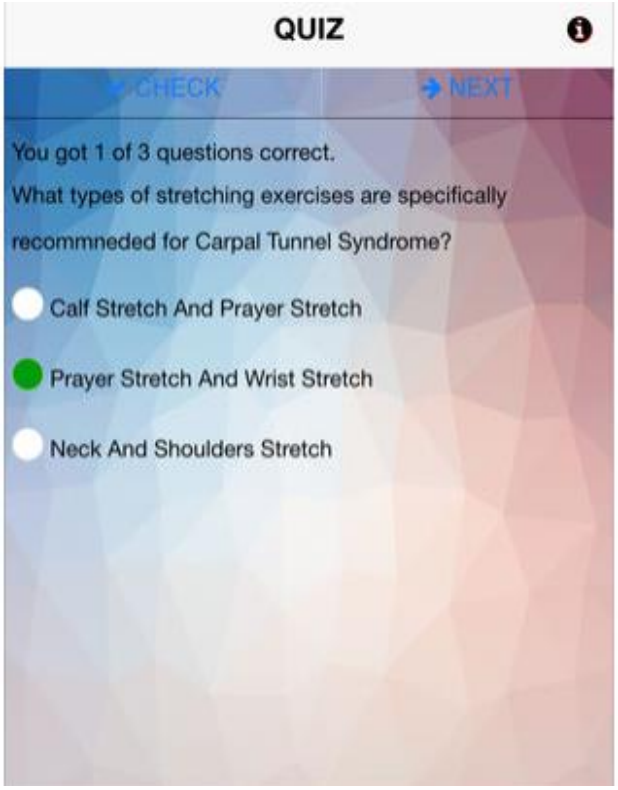


Figure 2.7: Quiz and Information about CTS

Figure 2.7 shows quiz and information about medical term both of that able to play and so that user will get more knowledge regarding CTS in interesting ways.

2.4.2 Exercise Carpal Tunnel

The Carpal Tunnel app teaches the user simple, safe and adequate exercises using interactive tools such as images, videos, exercise register calendars to track symptoms and exercise frequency and type of activity. The user can then export it to show it to the doctor. This app is only available on the App Store for iOS devices (BuiltByDoctors, 2016).

Exercise is very important in preventing carpal tunnels and in treating symptoms if the condition already exists. In some cases, effective exercise can prevent the disorder and eliminate the need for surgery. Exercise is often recommended in combination combination with with splinting and daily modification of repetitive wrist faction in carpal tunnels.

Exercises for CTS strive to stretch the forearm muscles, reduce tension on tendons in the carpal tunnel region and strengthen affected muscles.

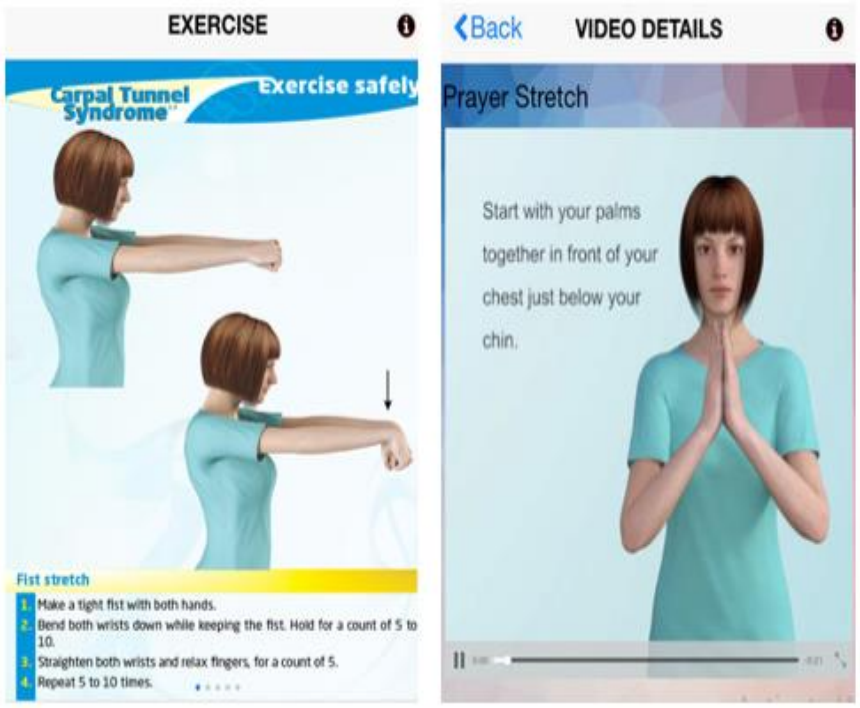


Figure 2.8: Safety Exercise for Carpal Tunnel Syndrome

Figure 2.8 show on step by step to how to do exercise and movement correctly by following the instructions and video detail.

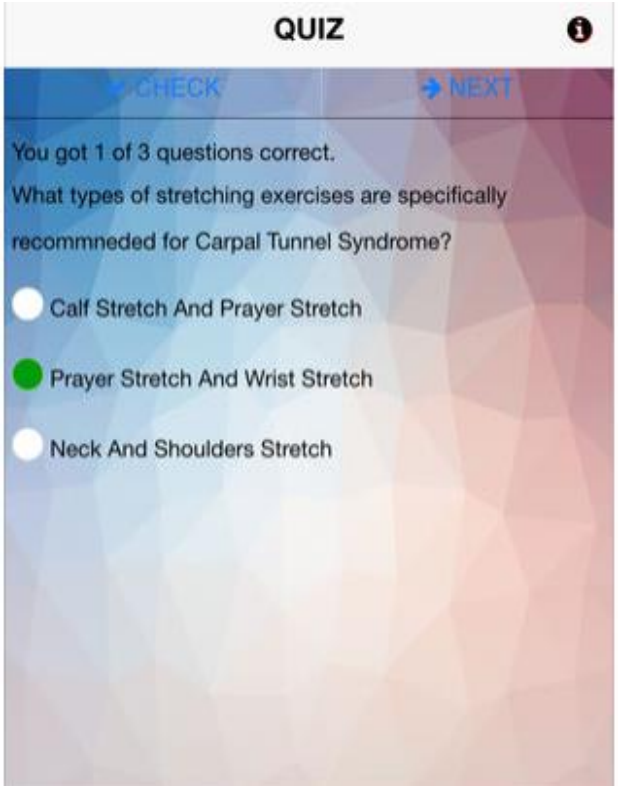


Figure 2.9: Quiz and Information about CTS

Figure 2.9 shows quiz and information about medical term both of that able to play and so that user will get more knowledge regarding CTS in interesting ways

This app consists of causes, symptoms and CTS treatment. It consists of animated user - friendly exercises that help prevent stiffness in the user's wrist. It's easy to understand and perform these exercises. These exercises are shown in detail so that users can easily understand them and perform them.

As we know that exercise for CTS have two condition first before operation and after operation so that tis app help both patient can use this App to reduce their CTS also help them to be as active and functional as possible, and resume their normal work, home, and leisure activities (Canny Technologies,2011).

2.4.3 Carpal Tunnel Syndrome

This app consists of causes, symptoms and CTS treatment. It consists of animated user - friendly exercises that help prevent stiffness in the user's wrist. It's easy to understand and perform these exercises. These exercises are shown in detail so that users can easily understand them and perform them.

As we know that exercise for CTS have two condition first before operation and after operation so that this app help patient and to reduce their CTS also help them to be as active and functional as possible, and resume their normal work, home, and leisure activities (Canny Technologies, 2011).

Figure 2.10: Type of Exercise CTS

Figure 2.10 shows three type of exercise for CTS wish is stretching exercise, strengthening exercise and active exercise and for active exercise have a few exercise same goes to other type. User also can choose exercise before and after operation for user so that patient can choose to do exercise depend on their condition.

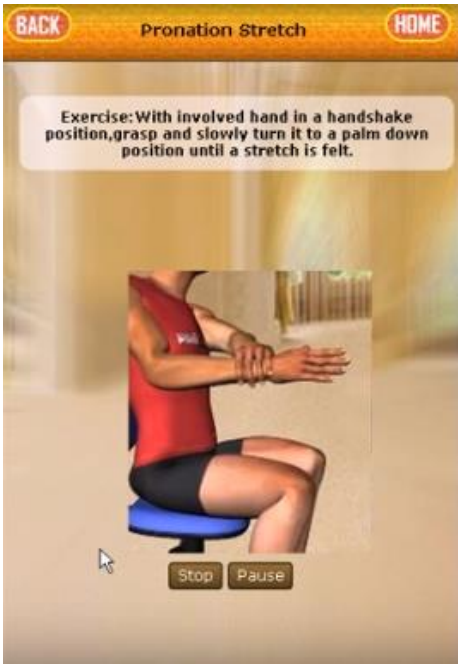


Figure 2.11: Video Tutorial for Each Type Exercise CTS

Figure 2.11 shows video tutorial and step to help user to do a correct position by following the instruction given.

2.5 COMPARISON BETWEEN EXISTING SYSTEMS

Review of Carpal Tunnel Syndrome application are shown in Table 2.1.

Table 2.1: Comparison between CTS Applications

Application	**The Roller Ball**	**Exercise Carpal Tunnel**	**Carpal tunnel Syndrome**	**Propose System**
Features	Fun ways for patient to do exercise to reduce to reduce pain and to avoid Carpal Tunnel Syndrome	To demonstrate step by stem doing a correct exercise by following the instruction	It consists of causes, symptoms, CTS treatment, animated user - friendly exercises that help prevent stiffness.	Serious Game for CTS rehabilitation treatment, doing a correct exercise by following Physiotherapy for early-stage of CTS and post-CTS surgery with fun way and motivated patient to do exercise.
Price	Free	Buy	Free	Free
Platform	Web	iOS Universal	Android	Android
Developer	Loannis Pachoulakis	BuiltByDoctors	Canny Technologies	Yuzawani Yusoff

2.5.1 Analysis Comparison between Existing Systems

Currently, based on the Review of CTS application, there are three serious games created for CTS to help the user to help reduce the severity of symptoms and possibly

eliminate the need for surgery to help patients return to an active and functional lifestyle. Physical therapy also helps post-CTS surgery patients to restore wrist strength.

First, The Roller Ball game use Motion sensor technology for the creation of CTS-oriented serious games it also consist of four wrist physiotherapy exercises. This game also expensive to compare another game or app because user need to buy the Leap Motion sensor for play this game.

Second, exercise Carpal Tunnel use interactive tools such as images, videos, calendar with exercise register. User can test its knowledge using way through a little and fun quiz. Able for IPhone user only and patient need to buy this app if they want to use it.

Third, Carpal tunnel Syndrome Consists of animated user friendly exercises which help to prevent stiffness in wrist join. User can choose exercise base on their condition for example before operation or after operation so that they can get a correct exercise. It free to download and use this system.

Lastly, there are no serious games created yet for CTS that free to use and fun ways and motivated patient to do exercise to reduce to reduce pain and to avoid CTS by following a correct physical therapy movement by using Accelerometer Smartphone technology. Because of that, creating the CTS games is the best ways to help the user to reduce pain and to avoid CTS.

2.5.1 Advantage and Disadvantage Existing System

Advantage and disadvantage existing system of CTS application are shown in Table 2.2.

Table 2.2: Advantage and Disadvantage Applications

SYSTEM	ADVANTAGE	DISADVANTAGE
The Roller Ball	• Motion sensor for the creation of CTS-oriented serious games. • Consist of four wrist physiotherapy exercises. • Using Leap Motion sensor technology	• Expensive patient needs to buy the Leap Motion sensor and hard to use. • This game also does not have inform about carpal tunnel syndrome.
Exercise Carpal Tunnel	• Interactive tools such as images, videos, calendar with exercise. • User can test its knowledge using way through a little and fun quiz.	• Able for IPhone user only and patient need to buy this app if they want to use it. • Doesn't offer a way to create an account and no app description.
Carpal tunnel Syndrome	• Animated user friendly exercises. Exercises are easy to understand and perform. • User also can choose exercise.	• Carpal tunnel Syndrome app is not interesting.

2.6 SUMMARY

In a nutshell, based on the review, there are no serious games for Carpal Tunnel Syndrome provide a fun game with correct movement and help patient to do exercise by using game. The main aim of this project is to create Carpal Tunnel Syndrome games that able to make user interesting to play this game beside they can reduce pain and avoid Carpal Tunnel symptom. This game is the best ways to help the user to reduce pain and avoid Carpal Tunnel symptom by following a correct physical therapy movement using Accelerometer Smartphone technology.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will consist of the methodology used and design elements of Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment. The ADDIE methodology model is chosen because it provides a systematic structure while this game is developing. This model has five phases to develop which are the analysis, design, development, and implementation and evaluation system.

3.2 METHODOLOGY USED

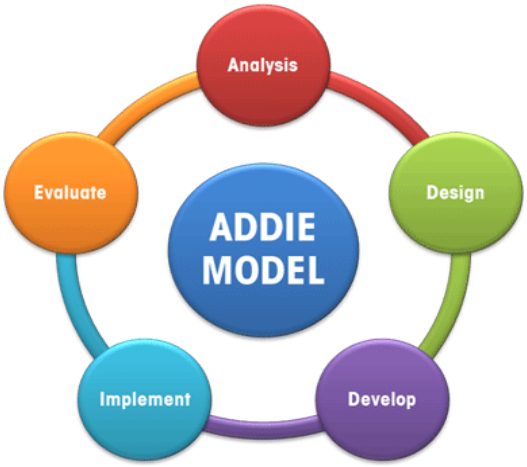


Figure 3.1: ADDIE Model.

Figure 3.1 shows on the ADDIE model which consist of five phases which are Analysis, Design, Development, Implementation, and Evaluation. ADDIE model is one of the most common models used in the instructional design field a guide to producing an effective design.

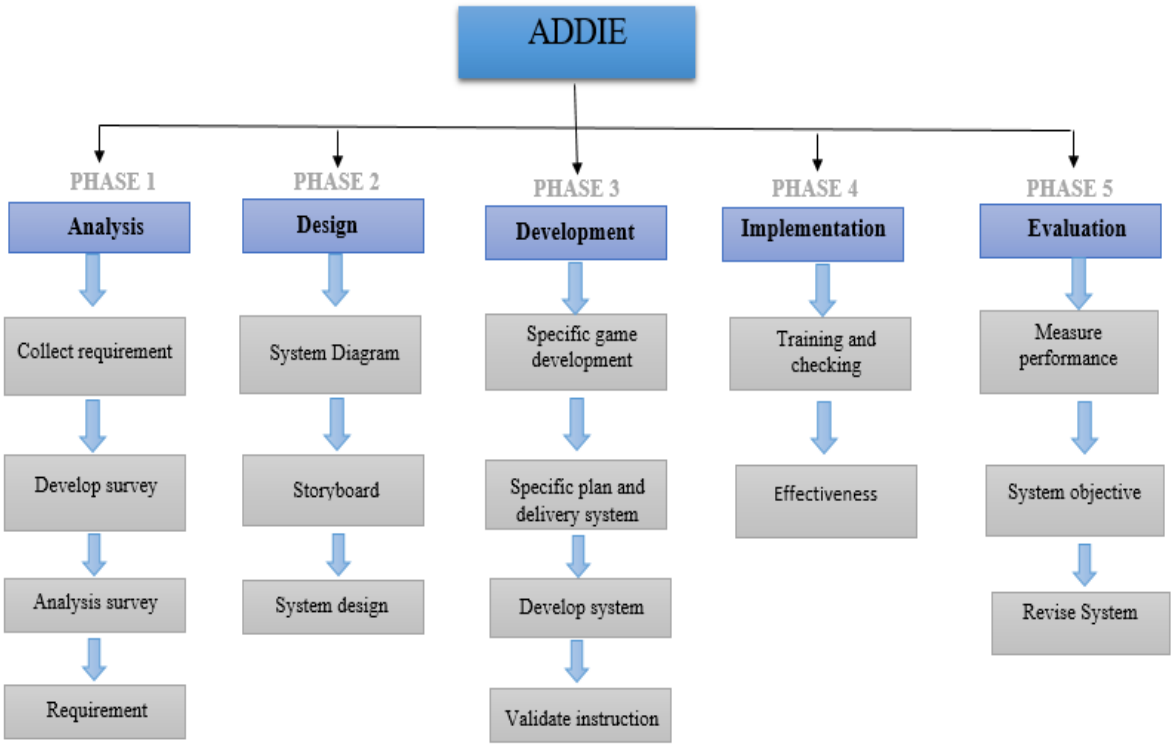


Figure 3.2: Work Breakdown Structure ADDIE Model

Figure 3.2 shows work breakdown structure for ADDIE Model which consist of five phases which are Analysis, Design, Development, Implementation, and Evaluation.

In addition, this systematic process is represented in the acronym ADDIE, which represents the important components of the teaching design process, which are analysis, design, development, implementation and evaluation. Each phase in ADDIE model is related to and interacts with each other (Aldoobie, 2015).

3.2.1 Analysis

In the analysis phase, all requirements are clarified, instructional goals and objectives are established and all requirements are established before this game is developed, such as collect data requirement, analysis data and meet physiotherapy and others requirements.

An interview has been conducted with Mr. Azeri as a medical rehab at Pusat Kesihatan Pelajar, UMP Gambang. Question and answer given during interview with physiotherapy as below.

1. Signs and symptoms CTS?

Signs and symptoms CTS is feel numbness, tingling, and pain in your thumb and the first three fingers of your hand. Moreover pain burning that travels up your arm wrist pain at night and weakness in your muscles hand.

2. Mostly male or female?

Most females compared to males and pregnant women may also have CTS.

3. Range age?

Late 40 and above because CTS may develop from an early age, but people don't take it seriously.

4. Occupation/profession that might have CTS?

Mostly people who use their hand to do work like a programmer and teacher.

5. What need to do if hand in pain?

If you feel pain at night put ice and soak your hand do exercise to reduce the pain and meet doctor to get treatment.

6. Holding the smartphone and using computer or laptop for long periods can cause hand and wrist fatigue?

Yes, both computer and smartphone might cause CTS because it will make hand feel numbness and tingling.

7. How we want to know, we had CTS?

Feel the symptoms as below

- numbness, tingling, and pain in your thumb and the first three fingers of your hand
- pain and burning that travels up your arm
- wrist pain at night that interferes with sleep
- weakness in the muscles of the hand

8. How to recover?

It depend on our condition it is need surgery or no need surgery

9. Movement?

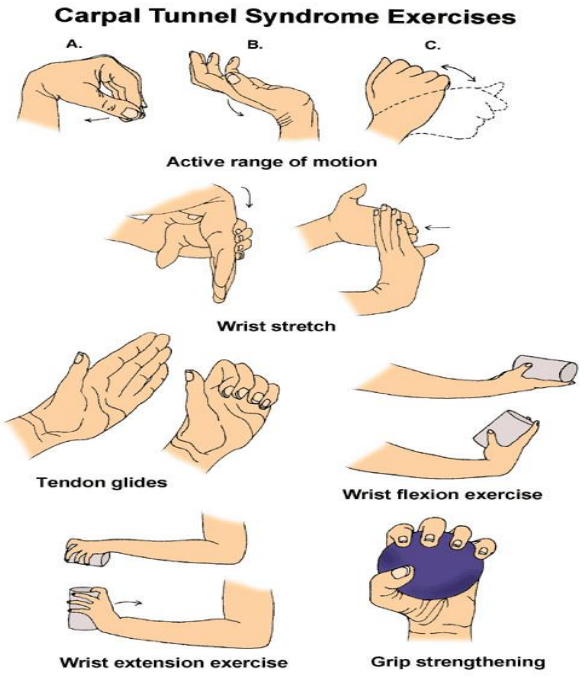


Figure 3.3: Movement for exercise

Figure 3.3 Exercise that patient can do for reduce their pain.

10. Did you think that Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment will help you reduce the pain?

Yes by following physiotherapy movement and time to play game

3.2.2 Design

This stage determines all objectives, tools for measuring performance, different tests, analysis of subjects, planning and resources. In the design phase, the focus is on system design how the application looks through the use of storyboards and system design before development begins.

3.2.1.1 Flowchart

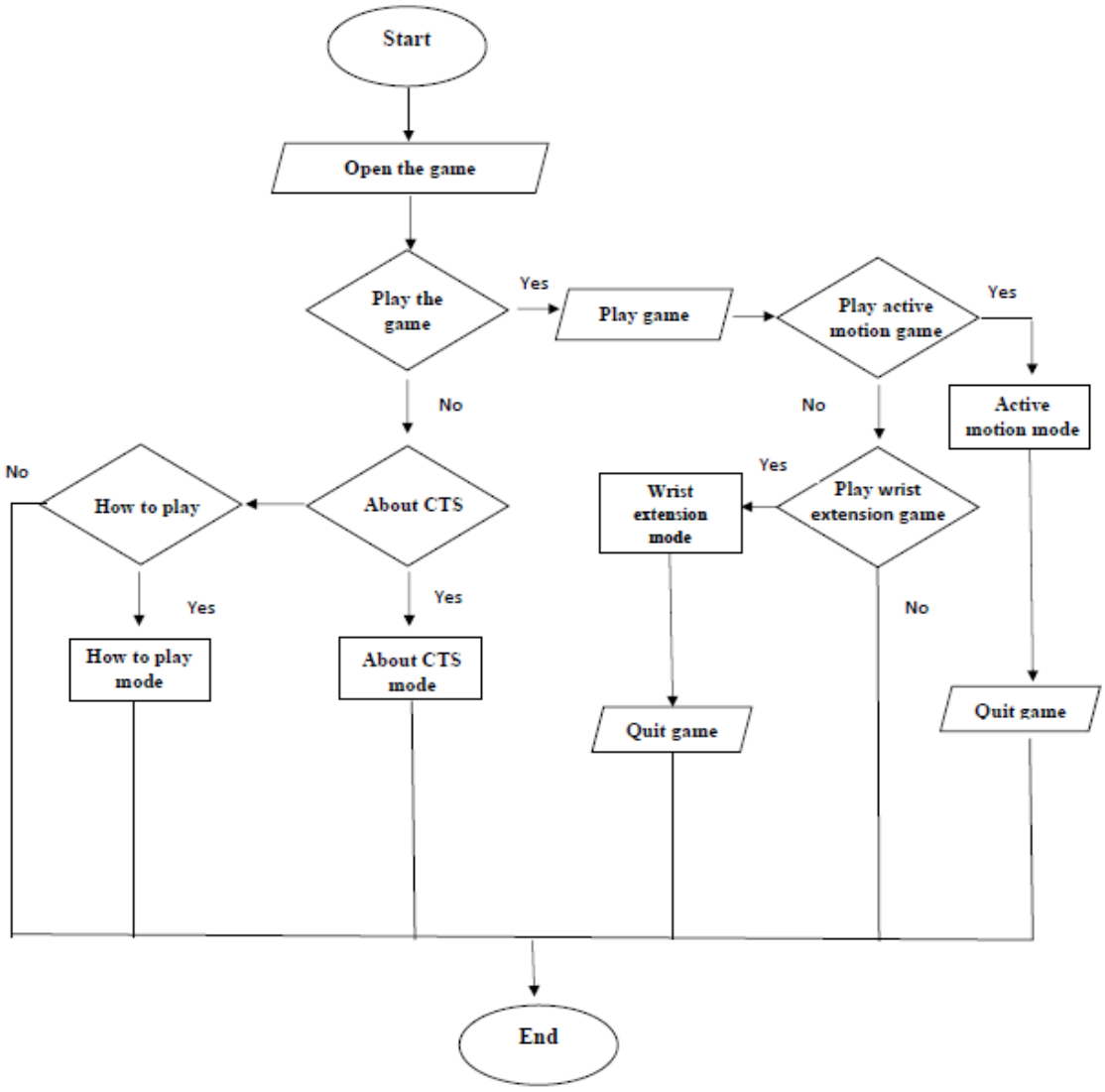


Figure 3.4: Flowchart

Figure 3.4 shows flowchart for overall Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment.

3.2.1.2 Context Diagram

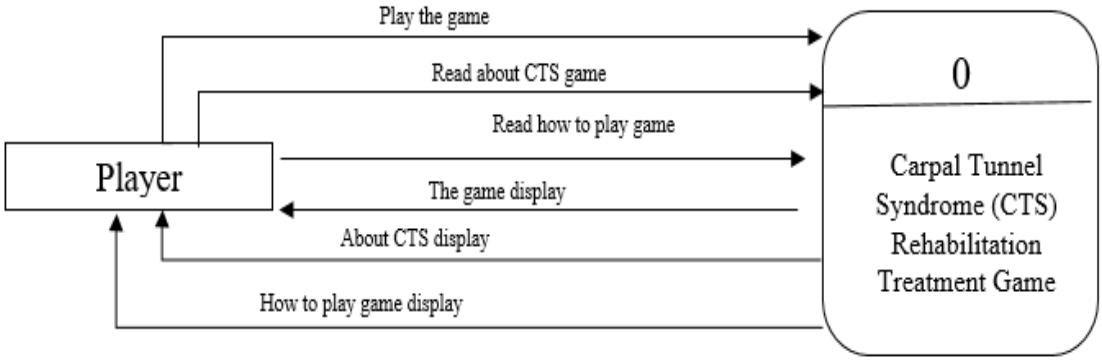


Figure 3.5: Context Diagram

3.2.1.3 Use Case Diagram

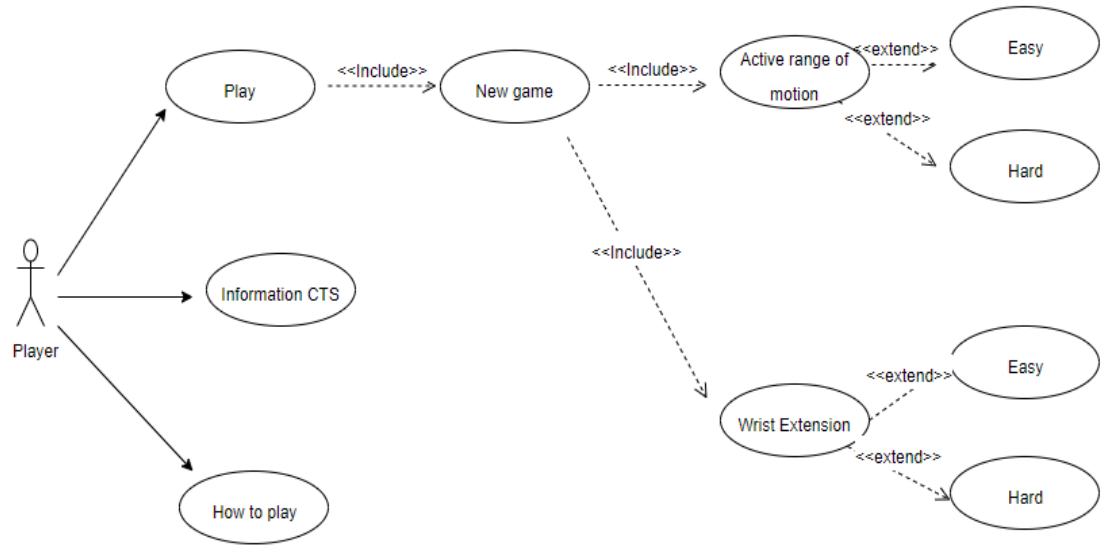


Figure 3.6: Use Case Diagram

Figure 3.6 shows the use case diagram for Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment, as you can see when player open the game there consist of 3 button which is Play button, Information CTS button and How to play button that available for player to choose. If player choose to play there is two option game active range of motion and wrist extension and it also can choose other they want easy of hard every game have

difference movement. Next, second button is Information CTS there contain information about CTS like how to causes, symptom, treatment and etc. Third button is how to play, this interface will give instruction to player how to play this game.

3.2.1.4 Content Diagram

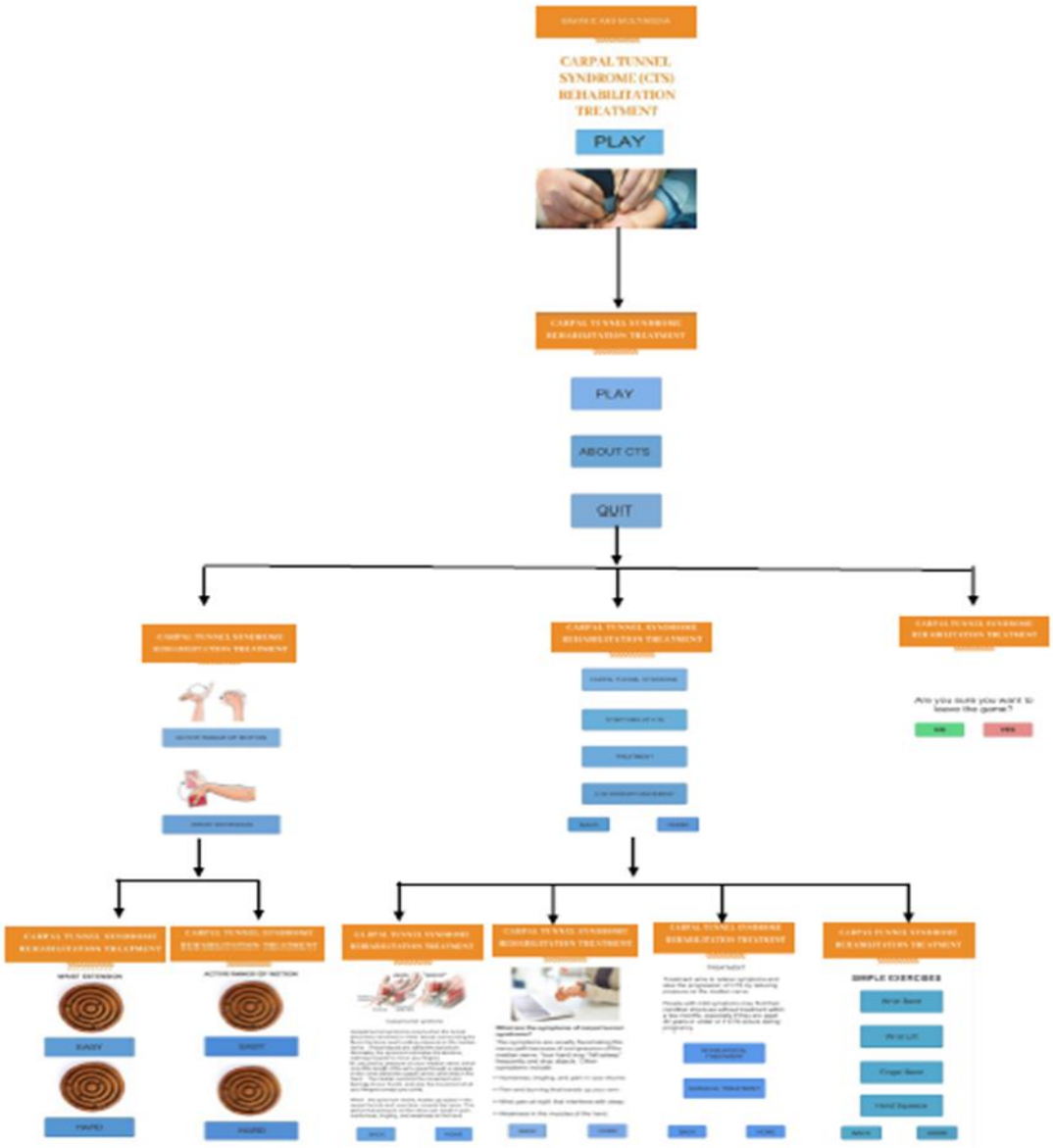


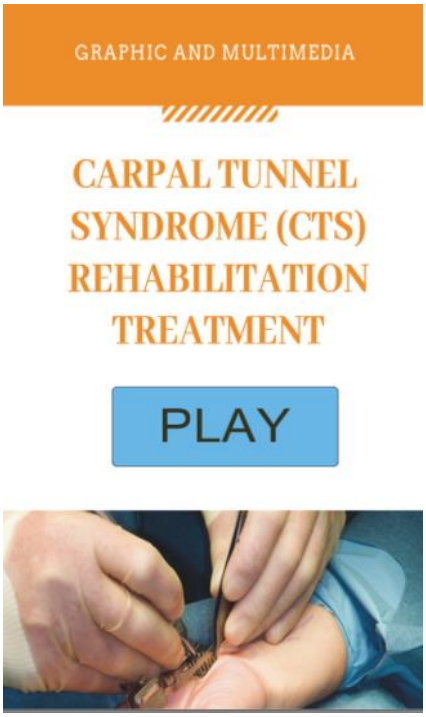
Figure 3.7: Content Diagram

Figure 3.7 shows content diagram for overall Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment.

3.2.1.5 Storyboard

The main interface of Carpal Tunnel Syndrome (CTS) rehabilitation treatment main interface is shown in Table 3.1.

Table 3.1: Main Interface CTS Game

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>1</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>None</td>
</tr>
<tr>
<td>Interface description</td>
<td>The main interface of Carpal Tunnel Syndrome (CTS) rehabilitation treatment, player need to select button play to start and play the game.</td>
</tr>
<tr>
<td colspan="3">Information :
 

Button play to start and play the game</td>
</tr>
</table>

The option interface CTS game of Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.2

Table 3.2: Option Interface CTS Game

<table>
<tr><td rowspan="5"> 
</td><td>Title</td><td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td></tr>
<tr><td>Interface</td><td>2</td></tr>
<tr><td>Next interface</td><td>Game type interface (Interface 3)

About CTS interface (Interface 4)

How to play interface (Interface 5)</td></tr>
<tr><td>Previous interface</td><td>Main interface (Interface 1)</td></tr>
<tr><td>interface Description</td><td>Option interface consist of 3 button and for player to choose other they want Play, About CTS and How to play.</td></tr>
<tr><td colspan="3">Information:

Button play to start and play the game

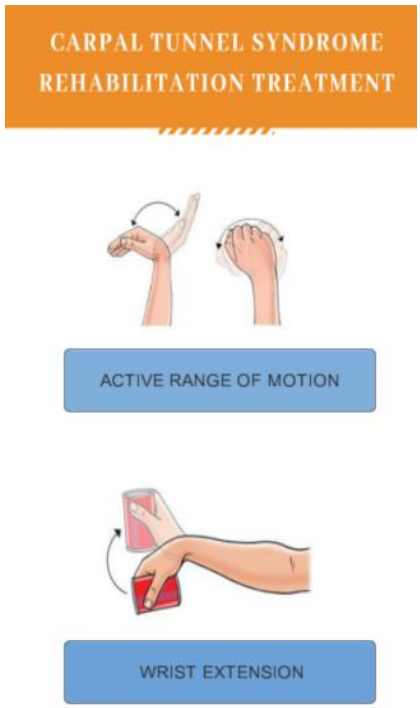
Button about CTS, detail about CTS

Button how to quit the game</td></tr>
</table>

The type of game interface of Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.3.

Table 3.3: Type of Movement Game

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>3</td>
</tr>
<tr>
<td>Next interface</td>
<td>Active range of motion game interface (Interface 3.1)

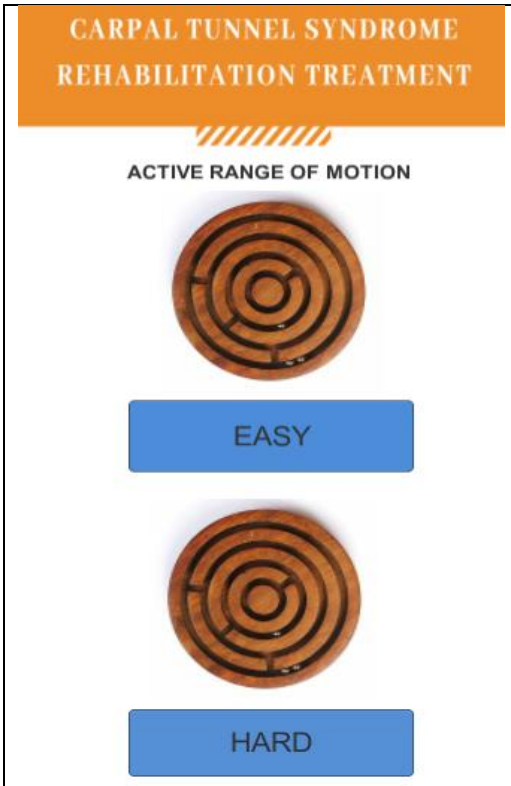
Wrist extension game interface (Interface 3.2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Interface description</td>
<td>Type of movement interface, there is 2 type of motion, it’s depend on player what they want to choose base on their condition.</td>
</tr>
<tr>
<td colspan="3">Information

ACTIVE RANGE OF MOTION — This button to play active range of motion game

WRIST EXTENSION — This button to play Wrist extension game</td>
</tr>
</table>

Level of active range of motion game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.4.

Table 3.4: Level of Active Range of Motion Game

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>3.1</td>
</tr>
<tr>
<td>Next interface</td>
<td>Easy Active range of motion game interface (Interface 3.1.1)

Hard Wrist extension game interface (Interface 3.1.2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Game type interface (Interface 3)</td>
</tr>
<tr>
<td>Interface description</td>
<td>Active range of motion and wrist extension game, this interface will appear for player choose the level which is easy or hard.</td>
</tr>
<tr>
<td colspan="3">Information
 

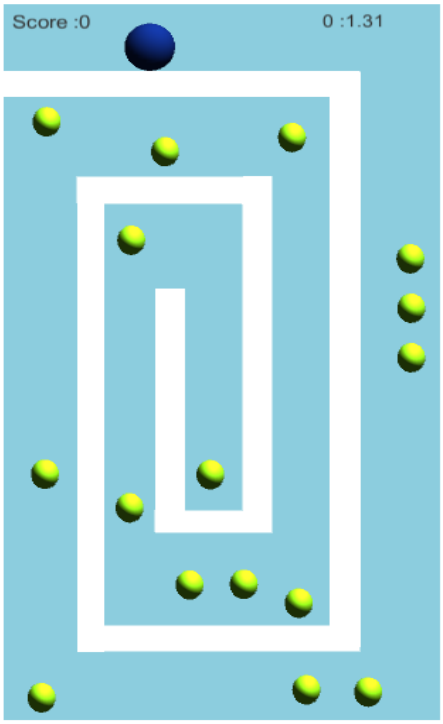
This button to play easy active range of motion game

This button to play hard active range of motion game</td>
</tr>
</table>

Level easy of active range of motion game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.5.

Table 3.5: Level Easy Of Active Range of Motion Game

<table>
<tr><td rowspan="5"> 
</td><td>Title</td><td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td></tr>
<tr><td>Interface</td><td>3.1.1</td></tr>
<tr><td>Next interface</td><td>Option interface (Interface 2)

Hard Wrist extension game interface (Interface 3.1.2)</td></tr>
<tr><td>Previous interface</td><td>Game level interface (Interface 3.1)</td></tr>
<tr><td>Interface description</td><td>Active range of motion this interface will appear for player choose the level which is easy</td></tr>
<tr><td colspan="3">Text :

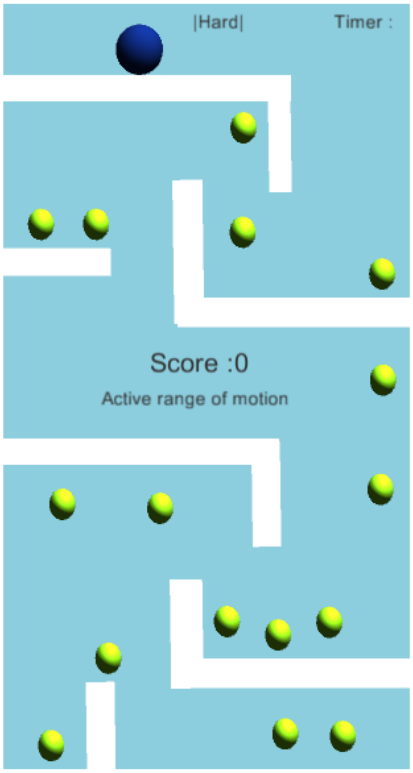
1. Bahnschrift Condensed
2. Calibri (Body)

Information

Player need to complete the score until 200 point.</td></tr>
</table>

Level hard of active range of motion game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.6.

Table 3.6: Level Hard of Active Range Motion Game

<table>
<tr><td rowspan="5"> 
</td><td>Title</td><td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td></tr>
<tr><td>Interface</td><td>3.1.2</td></tr>
<tr><td>Next interface</td><td>Option interface (Interface 2)</td></tr>
<tr><td>Previous interface</td><td>Game level interface (Interface 3.1)</td></tr>
<tr><td>Interface description</td><td>Active range of motion this interface will appear for player choose the level which is hard.</td></tr>
<tr><td colspan="3">Text :

1. Bahnschrift Condensed
2. Calibri (Body)

Information

Player need to complete the score until 200 point.</td></tr>
</table>

Level of wrist extension game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.7.

Table 3.7: Level of Wrist Extension Game

	**Title**	Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment
	Interface	3.2
	Next interface	Option interface (Interface 3) Easy Wrist extension game interface (Interface 3.2.1) Hard Wrist extension game interface (Interface 3.2.2)
	Previous interface	Game type interface (Interface 3.1)
	Interface description	Wrist Extension game, this interface will appear for player choose the level easy or hard.

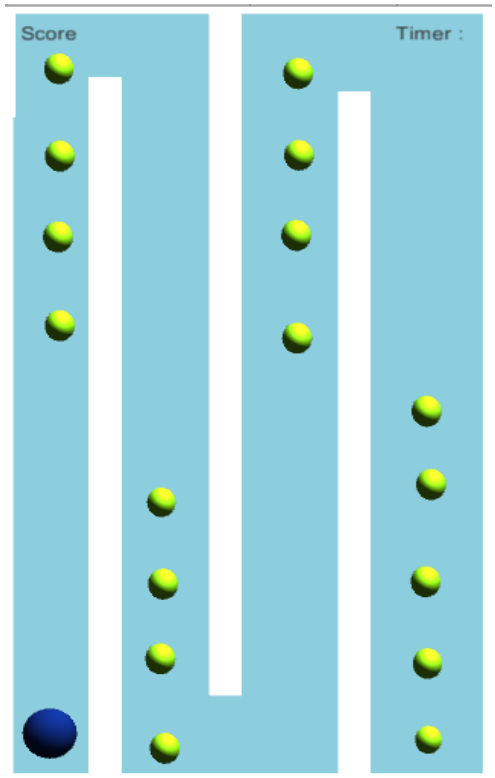
Information

EASY — This button to play easy Wrist Extension game

HARD — This button to play hard Wrist Extension game

Level easy of wrist extension game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment is shown in Table 3.8.

Table 3.8: Level Easy of Wrist Extension Game



Title	Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment
Interface	3.2.1
Next interface	Option interface (Interface 2) Hard Wrist extension game interface (Interface 3.2.2)
Previous interface	Game level interface (Interface 3.2)

	Interface description	Wrist Extension this interface will appear for player choose the level which is easy

Text :

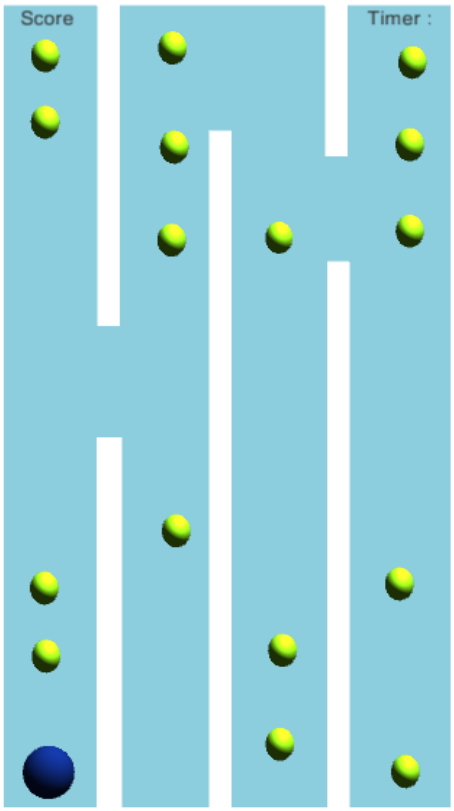
1. Bahnschrift Condensed
2. Calibri (Body)

Information

Player need to complete the score until 200 point.

Level hard of wrist extension game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.9.

Table 3.9 Level Hard of Wrist Extension Game

<table>
<tr><td rowspan="5"> 
</td><td>Title</td><td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td></tr>
<tr><td>Interface</td><td>3.2.2</td></tr>
<tr><td>Next interface</td><td>Option interface (Interface 2)</td></tr>
<tr><td>Previous interface</td><td>Game level interface (Interface 3.2)</td></tr>
<tr><td>Interface description</td><td>Wrist Extension this interface will appear for player choose the level which is hard.</td></tr>
<tr><td colspan="3">Text :

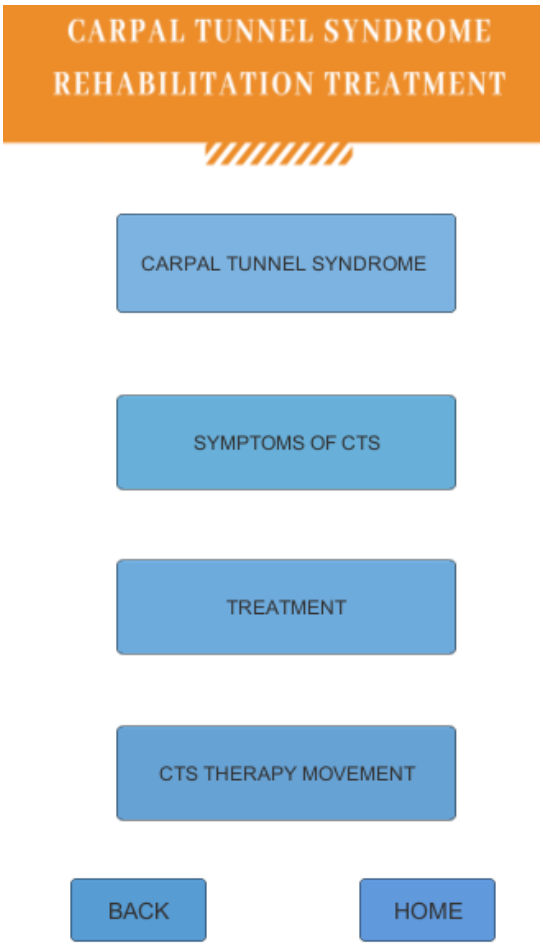
1. Bahnschrift Condensed
2. Calibri (Body)

Information

Player need to complete the score until 200 point.</td></tr>
</table>

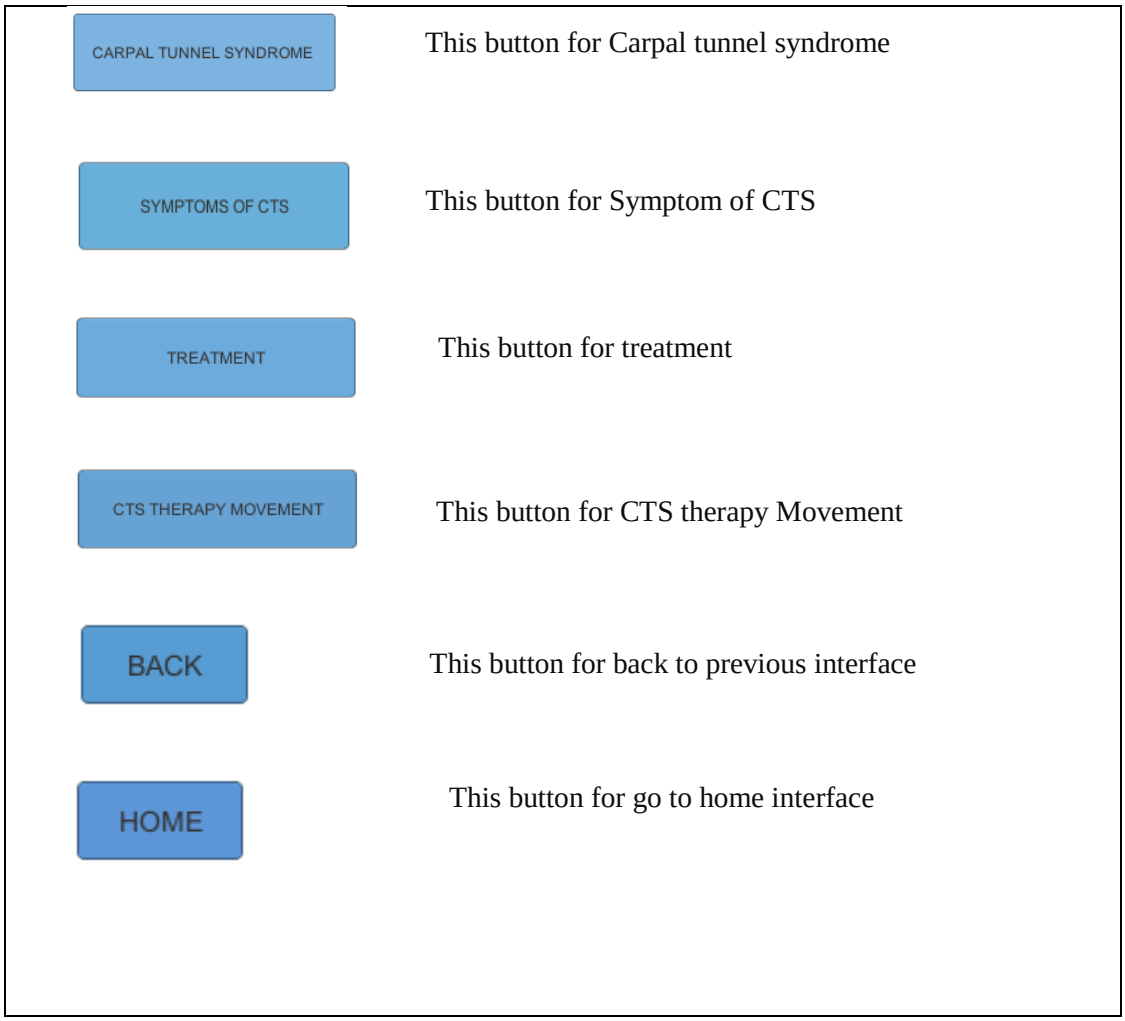
Option interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.10

Table 3.10: Option about CTS Game

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>4</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Page Description</td>
<td>About CTS interface, this interface will appear when player select button About CTS and there is some information about CTS.</td>
</tr>
<tr>
<td colspan="3">Text :

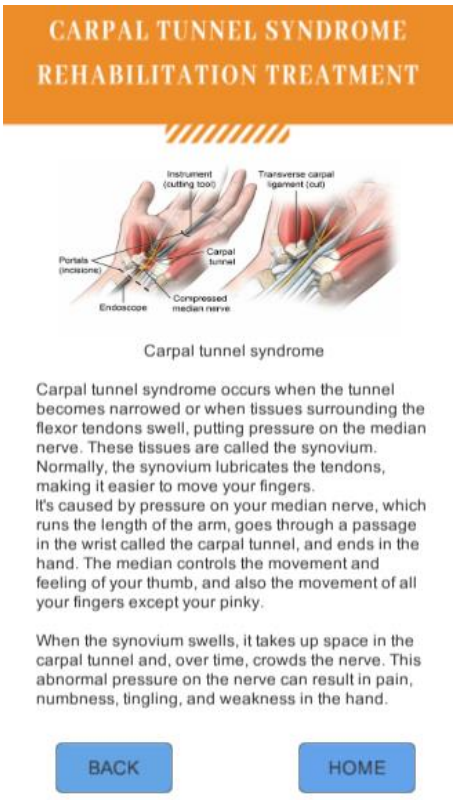
1. Bahnschrift Condensed
2. Calibri (Body)

Information:</td>
</tr>
</table>


CARPAL TUNNEL SYNDROME
This button for Carpal tunnel syndrome
SYMPTOMS OF CTS
This button for Symptom of CTS
TREATMENT
This button for treatment
CTS THERAPY MOVEMENT
This button for CTS therapy Movement
BACK
This button for back to previous interface
HOME
This button for go to home interface

About CTS interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.11.

Table 3.11: How to about CTS

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Page Description</td>
<td>About CTS interface, in this interface contain detail information about CTS.</td>
</tr>
<tr>
<td colspan="2">Text :
1. Bahnschrift Condensed
2. Calibri (Body)

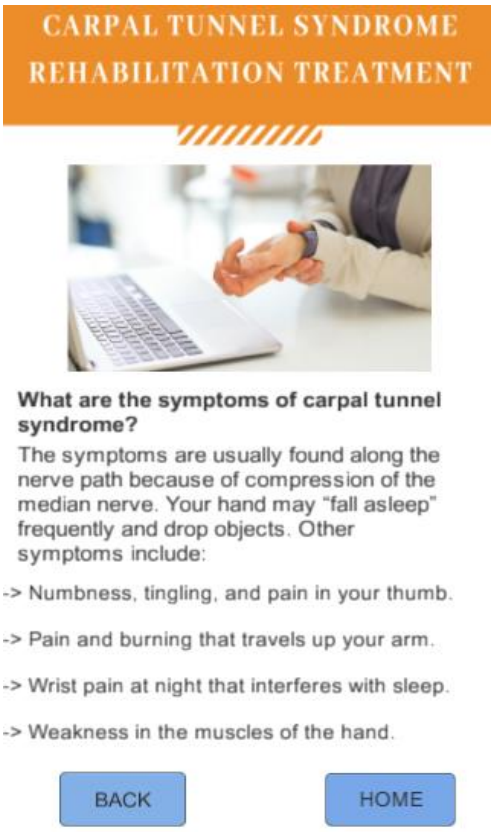
Information:

BACK — Help player back to pervious interface

HOME — This button for home interface</td>
</tr>
</table>

Symptoms CTS interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.12.

Table 3.12: Symptoms of CTS

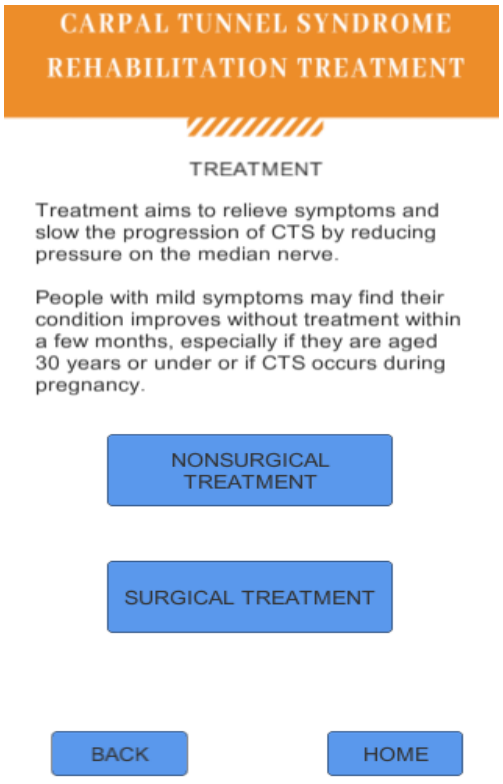
<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Symptoms CTS interface, in this interface contain symptoms CTS.</td>
</tr>
<tr>
<td colspan="3">Information:

BACK — Help player back to previous interface

HOME — This button for home interface</td>
</tr>
</table>

Treatment CTS option interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.13.

Table 3.13: Treatment option

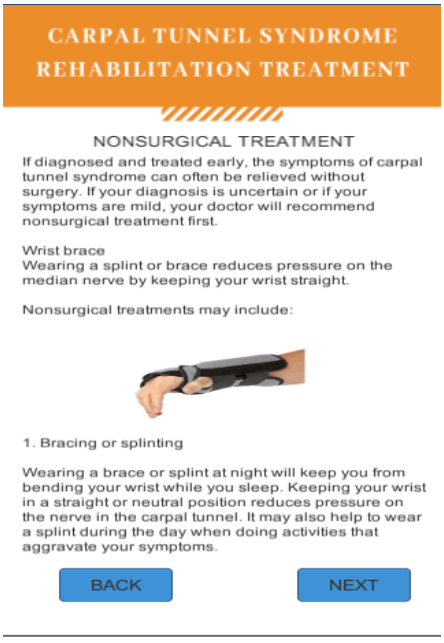
<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 2)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Treatment option interface, in this interface contain explanation about treatment.</td>
</tr>
<tr>
<td colspan="3">Text :
1. Bahnschrift Condensed
2. Calibri (Body)</td>
</tr>
</table>

Information:

NONSURGICAL TREATMENT	Button for Nonsurgical treatment
SURGICAL TREATMENT	Button for Nonsurgical treatment
BACK	Help player back to previous interface
HOME	Help player back to home interface

Nonsurgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.14.

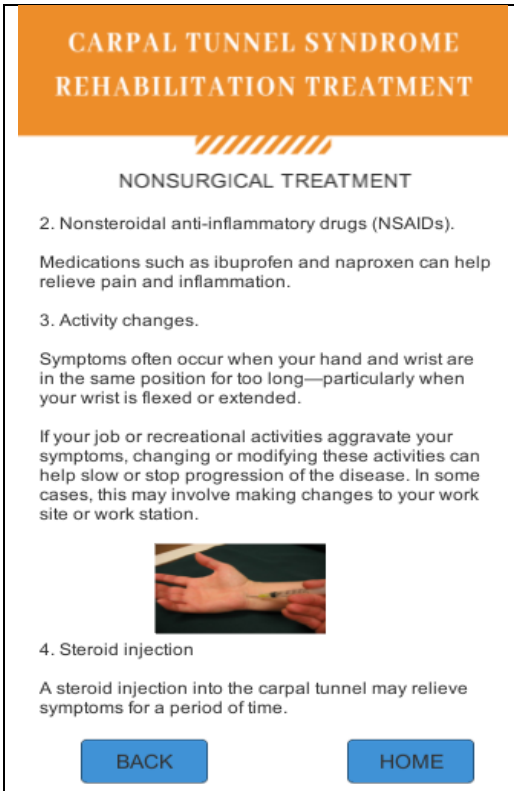
Table3.14: Nonsurgical treatment 1



Title	Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment
Interface	5.1
Next interface	Option interface (Interface 5.1.1)
Previous interface	Option interface (Interface 5)
Page Description	This interface contain about nonsurgical.

Nonsurgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.15.

Table 3.15: Nonsurgical treatment 2

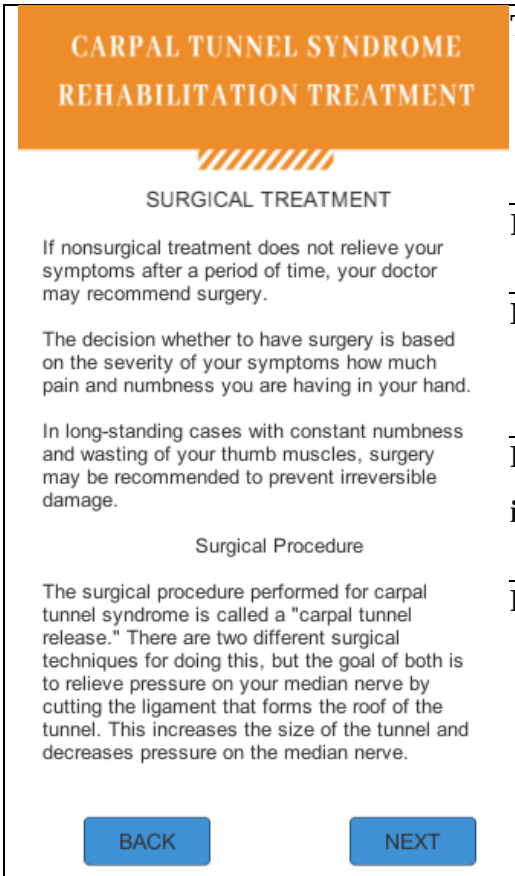
<table>
<tr>
<td rowspan="4"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5.1.1</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 1)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 5.1)</td>
</tr>
<tr>
<td colspan="3">Information:

BACK Help player back to previous interface

HOME Help player back to home interface</td>
</tr>
</table>

Surgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.16.

Table 3.16: Surgical treatment 1

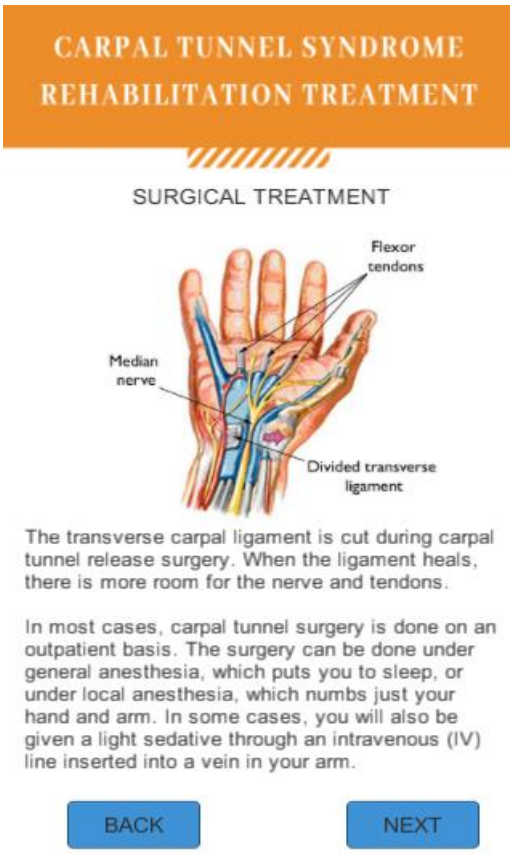
<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5.2</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 5.2.1)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 5)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Surgical interface, in this interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:
 

Help player back to previous interface
 

Help player back to next interface</td>
</tr>
</table>

Surgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.17.

Table 3.17: Surgical treatment 2

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5.2.1</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 5.2.2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 5.2)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Surgical interface, in this interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:
 

Help player back to pervious interface
 

Help player back to next interface</td>
</tr>
</table>

Surgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.18.

Table 3.18: Surgical treatment 3

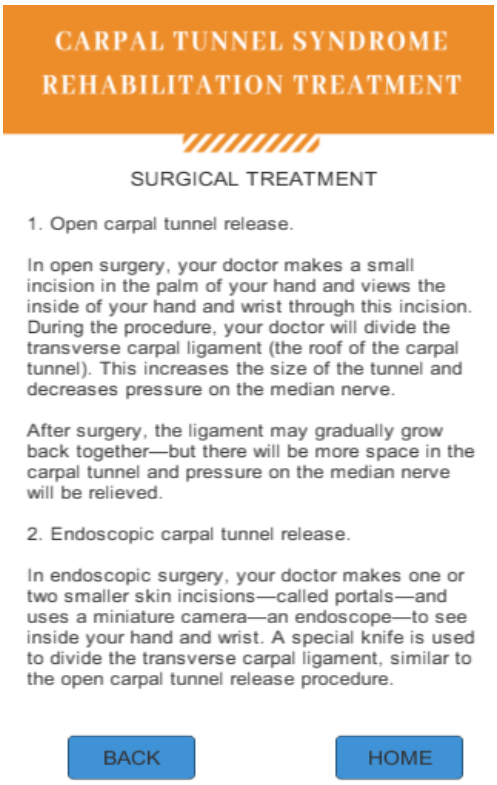
<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5.2.2</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 5.2.3)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 5.2.1)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Surgical interface, in this interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:

BACK Help player back to previous interface

NEXT Help player back to next interface</td>
</tr>
</table>

Surgical treatment interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.19.

Table 3.19: Surgical treatment 4

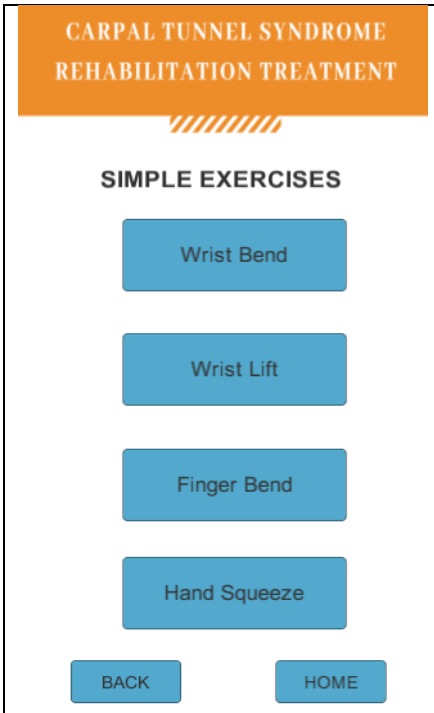
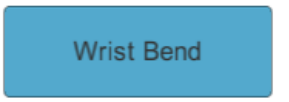
<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>5.2.3</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 1)

Option interface (Interface 5.2.2)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 1)</td>
</tr>
<tr>
<td>Page Description</td>
<td>This interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:

BACK — Help player back to pervious interface

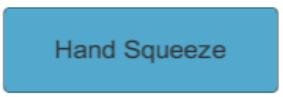
HOME — Help player back to home interface</td>
</tr>
</table>

Table 3.20: Option for CTS exercise

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>6</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 6.1)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 3)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Exercise CTS interface, in this interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:
 

Button for wrist bend
 

Button for wrist lift
Help player back to home interface
 

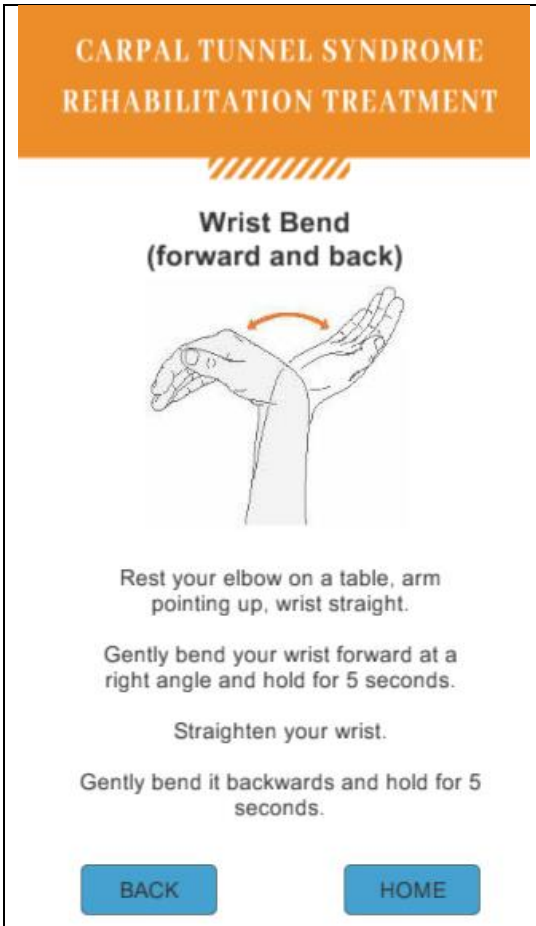
Button for finger bend
 

Button for hand squeeze
 

Help player back to pervious interface</td>
</tr>
</table>

Exercise interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.21.

Table 3.21: CTS exercise 1

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>6.1</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 1)

Option interface (Interface 6)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 6)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Exercise CTS interface, in this interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Text :

1. Bahnschrift Condensed</td>
</tr>
</table>

2. Calibri (Body)

Information:

BACK	Help player back to previous interface
HOME	Help player back to home interface

Exercise interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.22.

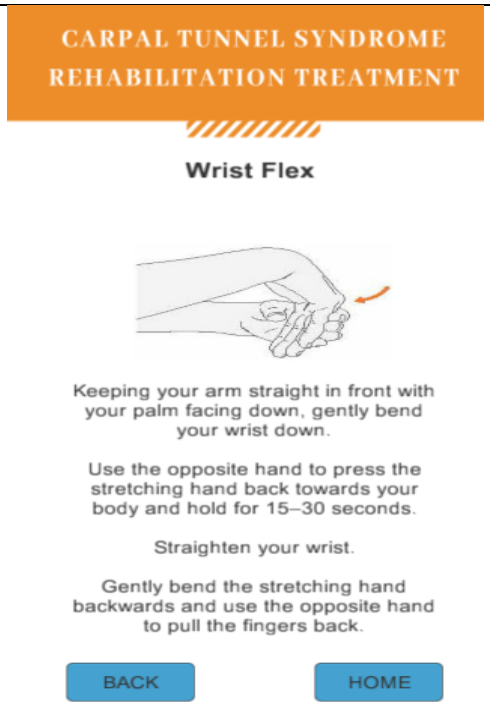
Table 0.22: CTS exercise 2

Title	Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment
Interface	6.2
Next interface	Option interface (Interface 1) Option interface (Interface 6)
Previous interface	Option interface (Interface 6)
Page Description	Exercise CTS interface, in this interface

		contain explanation about nonsurgical.
Information:  Help player back to previous interface  Help player back to home interface		

Exercise interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.23.

Table 3.23: CTS exercise 3

 	**Title**	Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment
	Interface	6.3
	Next interface	Option interface (Interface 1) Option interface (Interface 6)
	Previous interface	Option interface (Interface 6)

	Page Description	This interface contain explanation about nonsurgical .

Text :

1. Bahnschrift Condensed
2. Calibri (Body)

Information:

Help player back to previous interface

Help player back to home interface

Exercise interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.24.

Table 3.24: CTS exercise 4

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>6.4</td>
</tr>
<tr>
<td>Next interface</td>
<td>Option interface (Interface 1)

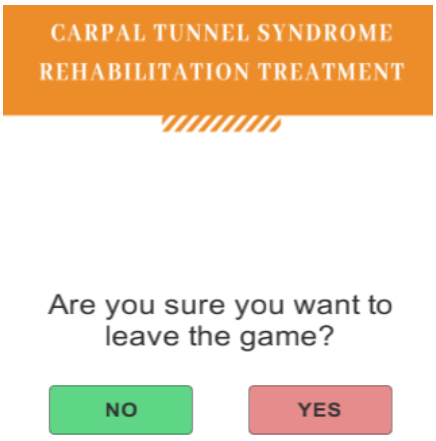
Option interface (Interface 6)</td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 6)</td>
</tr>
<tr>
<td>Page Description</td>
<td>This interface contain explanation about nonsurgical.</td>
</tr>
<tr>
<td colspan="3">Information:

BACK — Help player back to previous interface

HOME — Help player back to home interface</td>
</tr>
</table>

Exit game interface Carpal Tunnel Syndrome (CTS) rehabilitation treatment as shown in Table 3.25.

Table 3.25: Exit game interface

<table>
<tr>
<td rowspan="5"> 
</td>
<td>Title</td>
<td>Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment</td>
</tr>
<tr>
<td>Interface</td>
<td>7</td>
</tr>
<tr>
<td>Next interface</td>
<td></td>
</tr>
<tr>
<td>Previous interface</td>
<td>Option interface (Interface 3)</td>
</tr>
<tr>
<td>Page Description</td>
<td>Exit game interface, in this interface confirmation to exit the game.</td>
</tr>
<tr>
<td colspan="3">Text :
1. Bahnschrift Condensed
2. Calibri (Body)

Information:

Button for player stay to play game

Help player leave game.</td>
</tr>
</table>

3.2.3 Development

Third phase are development where start develop game according to the design specifications that will be heavily guided by the prototype/storyboards at this point. Each element of the course should be developed to match the design phase. The core of the content has already been decided. All you need to add is a level of detail and polish to the courses.

3.2.4 Implementation

In the fourth phase of the ADDIE process, implementation of the lesson that has been planned (analysed, designed, and developed). It is here that the course content, objectives, delivery methods, and assessments are conducted. All materials that were created in the development phase are implemented with the instruction in the manner it was designed. The decisions made in the design phase will influence how this is actually carried out. It also should consistently analyse, redesign and enhance the product to ensure effective product delivery

3.2.5 Evaluation

The final phase of the ADDIE model is the evaluation phase. After implementation of a course or program is over, a summative evaluation is done for instructional improvement. Throughout the evaluation phase the designer should ascertain whether problems relevant to the training program are solved, and whether the desired objectives are met. This stage in which the project is being meticulous final testing regarding the what, how, why, when of the things that were accomplished (or not accomplished) of the entire project.

3.3 HARDWARE AND SOFTWARE SPECIFICATION

To develop this game, a few hardware and software are used. Table below show the description of the hardware and software that to develop this system. Hardware and software are interconnected, the computer hardware would have no function without software. The hardware is limited to specifically designed tasks, which are very simple and independent. Software implements algorithms that allow the computer to perform much more complex tasks.

HARDWARE

The list of hardware used for Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment as shown in Table 3.26.

Table 3.26: List of Hardware

HARDWARE	SPECIFICATION
Personal laptop	▪ Prepare the proposal and documentation of this project ▪ Design and develop the game.
Smartphone	▪ Hardware platform for the operating system run. ▪ The final system must convert to smartphone.
Printer	▪ Print the documentation and related sources of the system.
USB storage device	▪ Data transfer ▪ Backup data of the project

SOFTWARE

The list of software used for Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment as shown in Table 3.27.

Table 3.27: List of Software

SOFTWARE	SPECIFICATION
Microsoft word 2010	▪ To perform documentation work of the project. ▪ This software easy use for student to create and documentation.

Unity5.5.1-Game Engine	▪ To develop and construct the game. ▪ This software is good platform to create any 2D and 3D games.
Accelerometer	▪ Accelerometers are used to determine acceleration, though a three-axis accelerometer could identify the orientation of a platform relative to the Earth's surface.

3.4 GANTT CHART

Carpal Tunnel Syndrome and rehabilitation treatment Gantt chart following ADDIE methodology this model has five phases to develop an analysis, design, development, implementation and evaluation system. This Gantt chat have 14 week to finish the application by following schedule below.

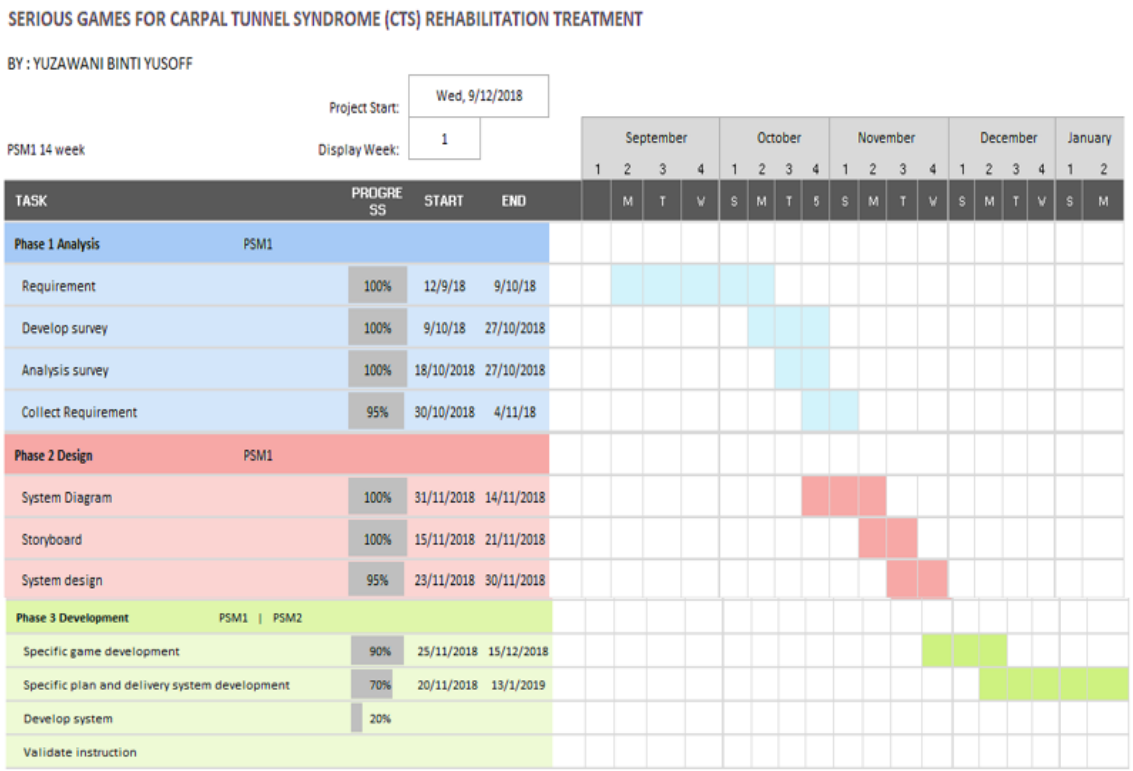


Figure3.8: Gantt chart 1

Figure3.8 shows Gantt chart for PSM1 Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment.

SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT

BY : YUZAWANI BINTI YUSOFF

Project Start: Wed, 9/12/2018

PSM2 14 week Display Week: 1

TASK		PROGRESS	START	END
Phase 3 Development	PSM2			
Develop system		100%	28/1/2019	15/3/2019
Validate instruction		100%	14/3/2019	4/4/19
Phase 4 Implementation				
Training and checking		100%	6/4/19	2/5/19
Effectiveness		100%	24/4/2019	5/5/19
Phase 4 Evaluation				
Measure performance		100%	18/4/2019	5/5/19
System objective		100%	29/4/2019	4/4/19
Revise System		100%	4/4/19	8/5/19

JANUARY (1 2 3 4) FEBRUARY (1 2 3 4) MARCH (1 2 3 4) APRIL (1 2 3 4) MAY (1 2)

S M T W S M T S S M T W S M T W S M T W S M

Figure 3.9: Gantt chart 2

Figure 3.9 shows Gantt chart for PSM2 Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment.

3.5 SUMMARY

All in all, this chapter discussed methodology used which is ADDIE model and design element of Serious Games for Carpal Tunnel Syndrome Rehabilitation Treatment. ADDIE model consist of five phases to develop an analysis, design, development, implementation and evaluation system. To get user requirement by conducting the survey to collect the requirement and followed by design such as flowchart, context diagram, Storyboard and content diagram to illustrate game. Schedule of developing this game follow the methodology. The study and information of the project have been described in this chapter. The analysis and design for this project have been explained in detail.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

CTS serious game is implemented by using Unity tool. This serious game is built for Android platform. This serious game consists of two parts which is the maze ball game and the exercise feature. By playing the CTS game, users will be exposed to the information about CTS and do exercise base on physiotherapy movement in fun way.

In this chapter, the development of the serious game will be further presented and discussed. This chapter consists of three phases which are implementation, results and discussion.

4.2 IMPLEMENTATION

In this section, the implementation of the game is further explained. This includes environmental setup for developing the game and modules of the game itself.

4.2.1 Environmental Setup

Start with development tool the development tool for this game is Unity. Unity is a game engine and it is well known for producing some famous both mobile and pc games.

Figure 4.1: Unity

Figure 4.1 show the development tool for CTS serious game, Unity is the world's most popular development platform for creating 2D and 3D multiplatform games and interactive experiences.

Figure 4.2: MonoDevelopment

Figure 4.2 show MonoBehaviour, a scripting engine integrated with Unity.

Development Language the language used for developing this game is C# which is implemented in MonoBehaviour, a scripting engine integrated with Unity. Moreover, for the platform CTS serious game Android SDK tools and API documentation for developing android based games. Android SDK was integrated with Unity in order to build a fully functioning Android game. Platform The targeted platform for this game is Smartphone so that to connect unity and smartphone unity remote 5 need to be install in smartphone.

Figure 4.3: Unity Remote 5

Figure 4.3 show unity remote 5, Unity Remote 5 is a downloadable app designed to help with android, iOS and tvOS development. The app connects with Unity while running project in Play Mode from the Unity Editor. The visual output from the Editor is sent to the device's screen, and the live inputs are sent back to the running project in Unity. This allows to get a good impression of how your game really looks and handles on the target device, without the hassle of a full build for each test.

4.2.2 Module

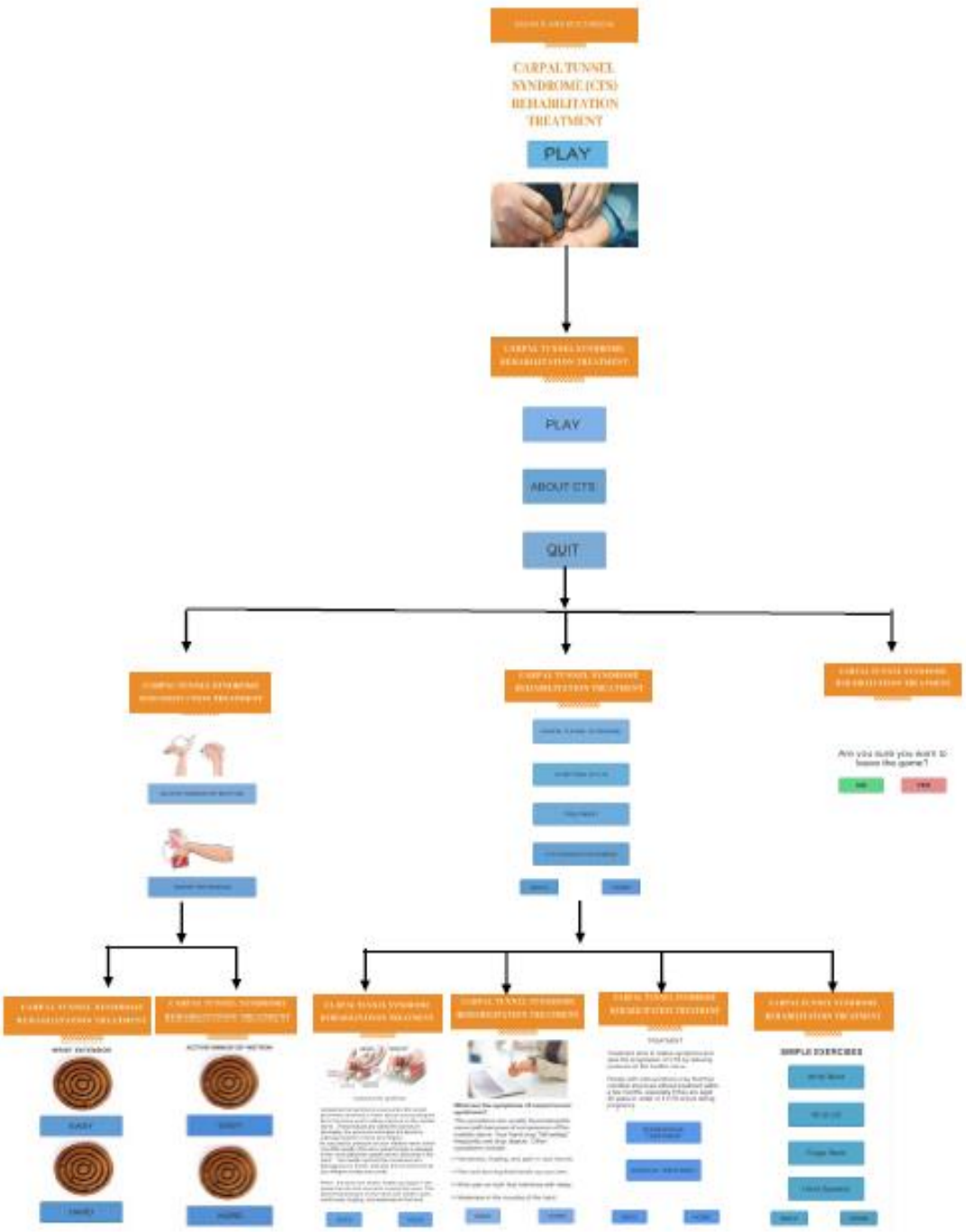


Figure 4.4: Module in hierarchy diagram

Figure 4.4 show module in hierarchy diagram wish consist of three module including serious game, Physiotherapy movement and About CTS.

This game has been divided into three modules first module is about CTS this section user will get information about CTS like the symptom, therapy and rehabilitation, what to do if they have CTS and also the movement that help them to recover CTS.

Second, Physiotherapy movement this section enables the user to do exercise and help them to do a correct movement physiotherapy with information image and video.

Third, Serious game this section where user can play serious game and it consist of two type of exercise wish is active range of motion and wrist Extension.

4.2.3 Home interface

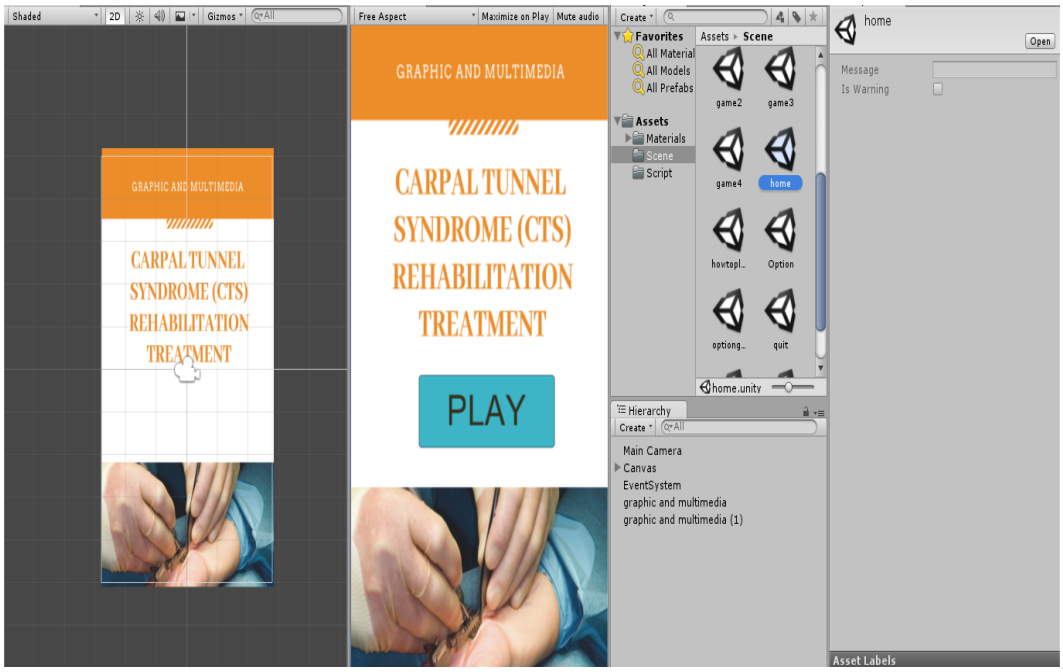


Figure 4.5: Shows the first interface of CTS serious game

Figure 4.5 shows the first interface or the start menu of the game. It consists of three buttons which are Play Game. The Play Game buttons enables the users to option page.

```
public class accelorometer : MonoBehaviour
{
    public bool isflat = true;
    private Rigidbody rigid;

    // Start is called before the first frame update
    private void Start()
    {
        rigid = GetComponent<Rigidbody>();
    }

    // Update is called once per frame
    private void Update()
    {
        Vector3 tilt = Input.acceleration;

        if (isflat)
            tilt = Quaternion.Euler (90, 0, 0) * tilt;

        rigid.AddForce(tilt);
        Debug.DrawRay (transform.position + Vector3.up, tilt, Color.cyan);
    }
}
```

Figure 4.6: Script for acceleration

Figure 4.6 show the script for acceleration function for how game will rotate while player play the game by following accelerometer function.

The first page is home page contain one functioning buttons which is “Play”. This button will navigate player to the next scene called “Option”. For the button to function, a script of code is created in Notepad using C#. Below is a part of the coding for the button to navigate to the specific scene

```
    public void sstartthegame () {
        SceneManager.LoadScene (SceneManager.GetActiveScene().buildIndex + 1);

    }

    public void QuitGame ()
    {
        Debug.Log ("Game already QUIT!!!!");
        Application.Quit ();
    }
```

Figure 4.7: Start function and quit function for CTS game

Figure 4.5 show the script button PLAY in the first interface to start the application, this script function to load from scene to other scene.

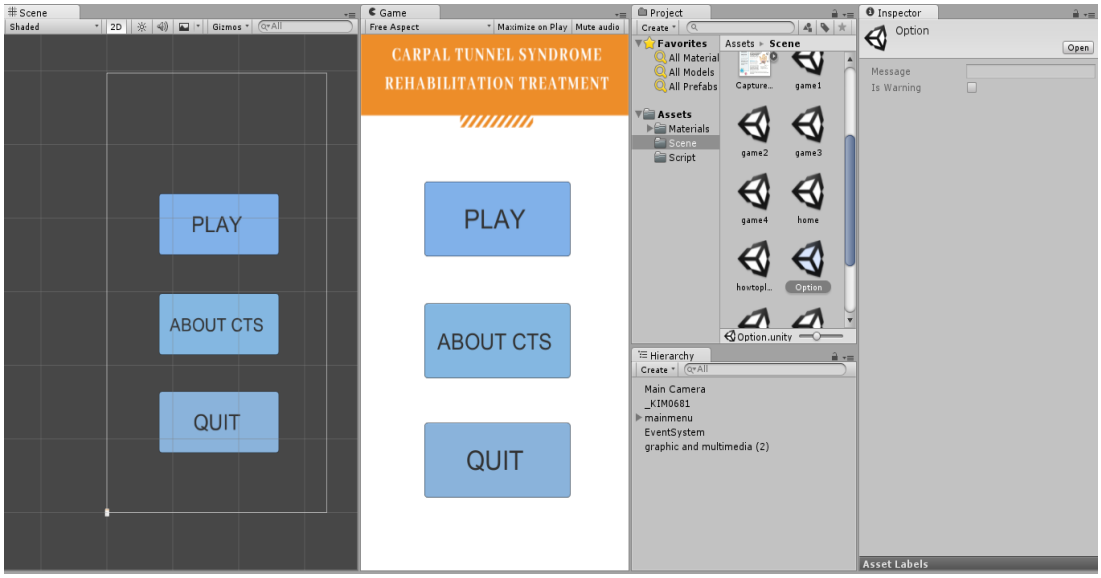


Figure 4.8: Script for acceleration

Figure 4.8 show the script for acceleration function for how game will rotate while player play the game by following accelerometer function

4.2.4 Game Interface

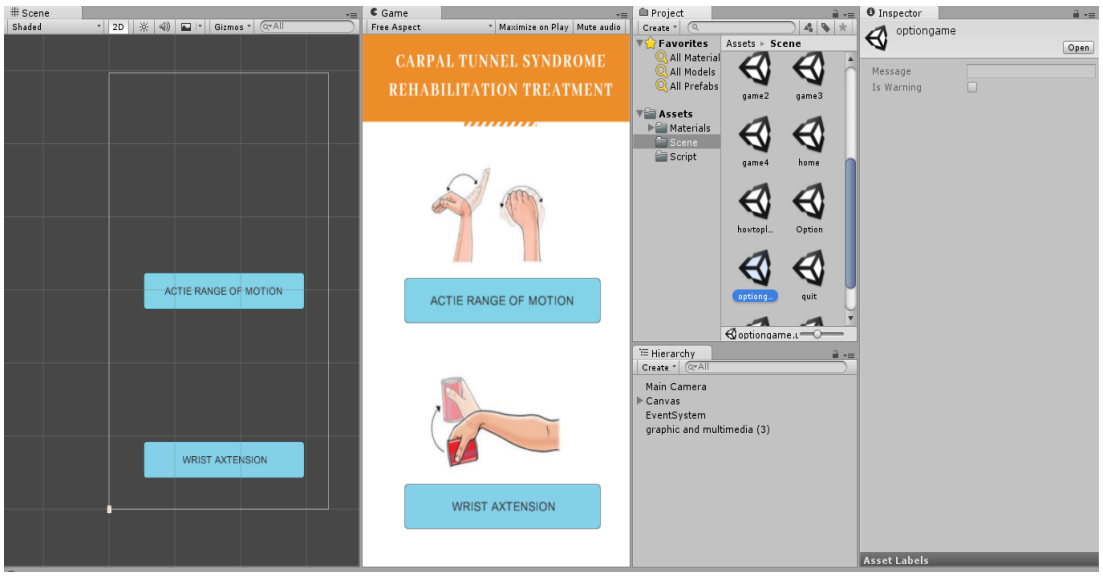


Figure 4.9: Game Option

Figure 4.10 show the option game interface wish contain two game movement wish is Active range of motion (up, down, left and right) and Wrist extension (up and down).

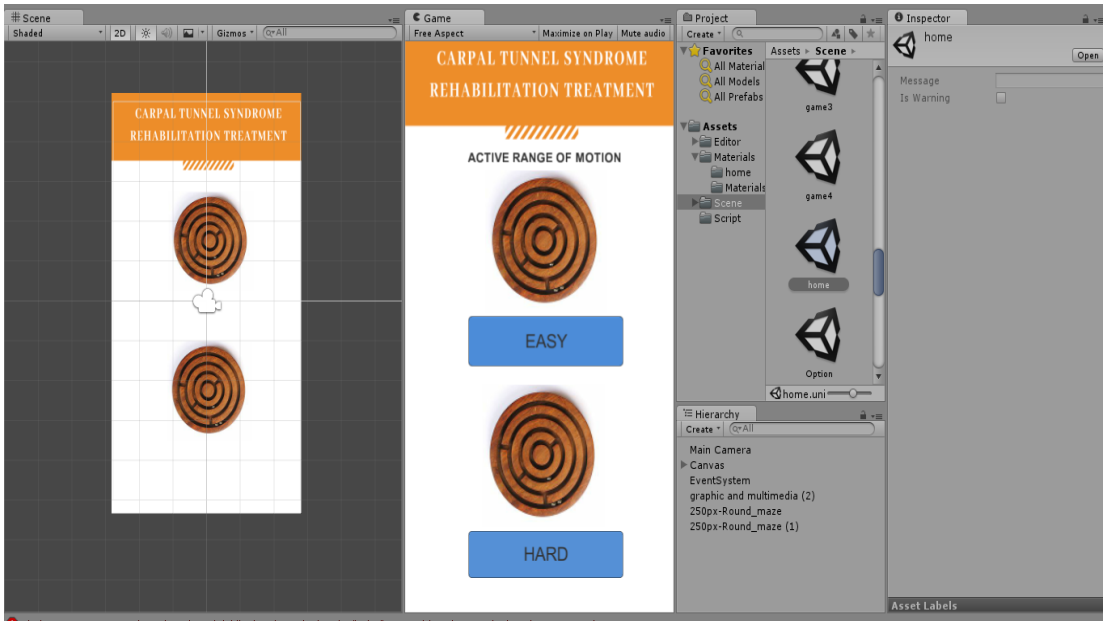


Figure 4.10: Game option

Figure 4.10 show the option active range of motion game interface wish contain two which is easy and hard and also same for wrist extension

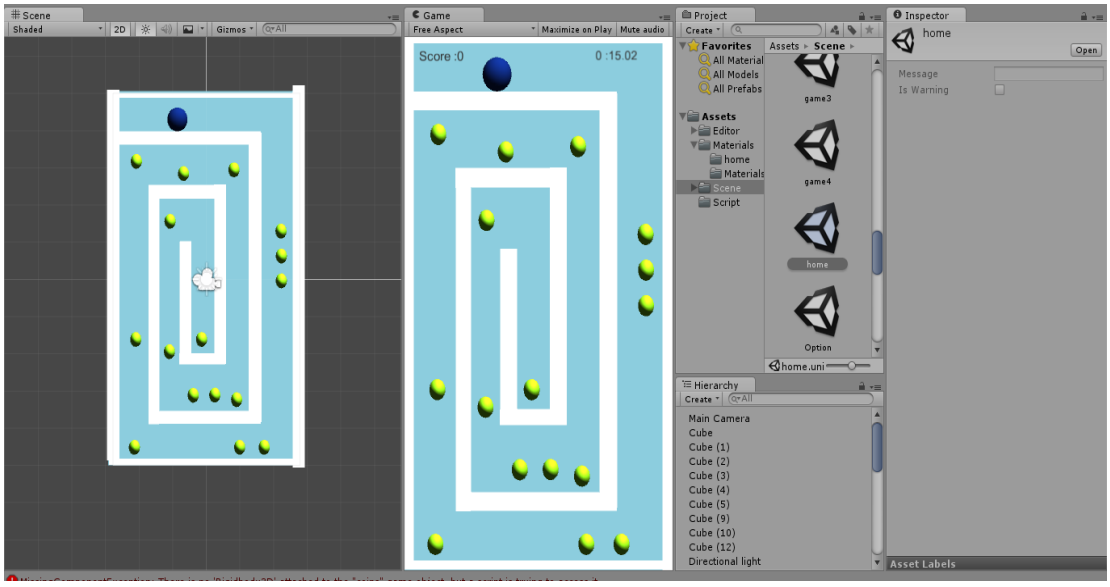


Figure 4.11: Easy game for Active range of motion

Figure 4.11 shows interface of Active range of motion (up, down, left and right). Top time Player will be save to motivated player to be better next time.

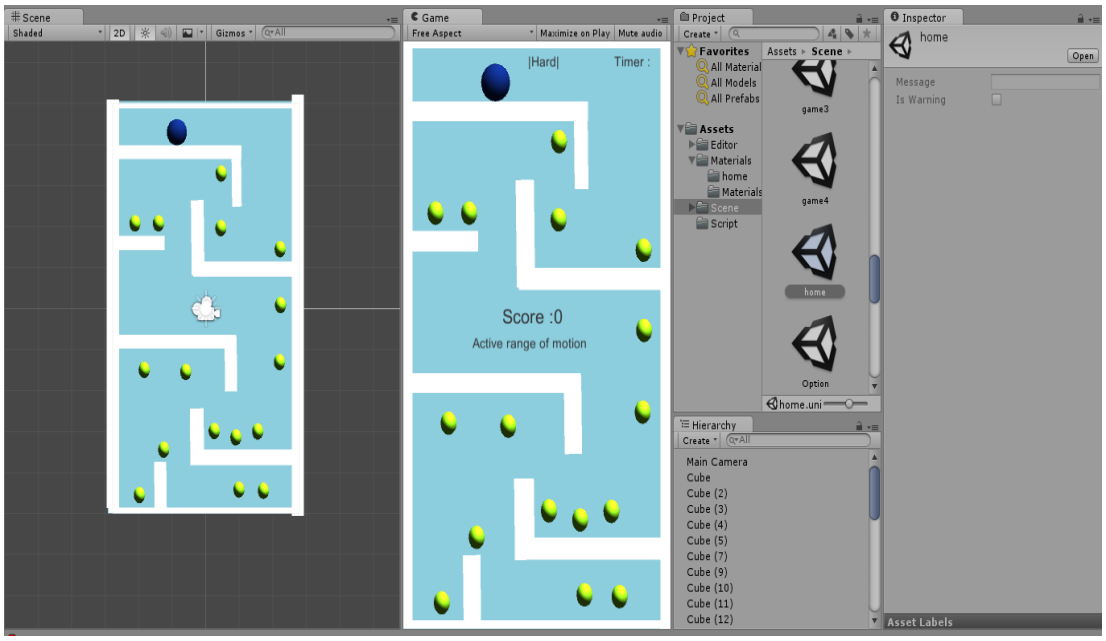


Figure 4.12: Hard game for Active range of motion

Figure 4.12 shows interface of Active range of motion (up, down, left and right). Top time Player will be save to motivated player to be better next time.

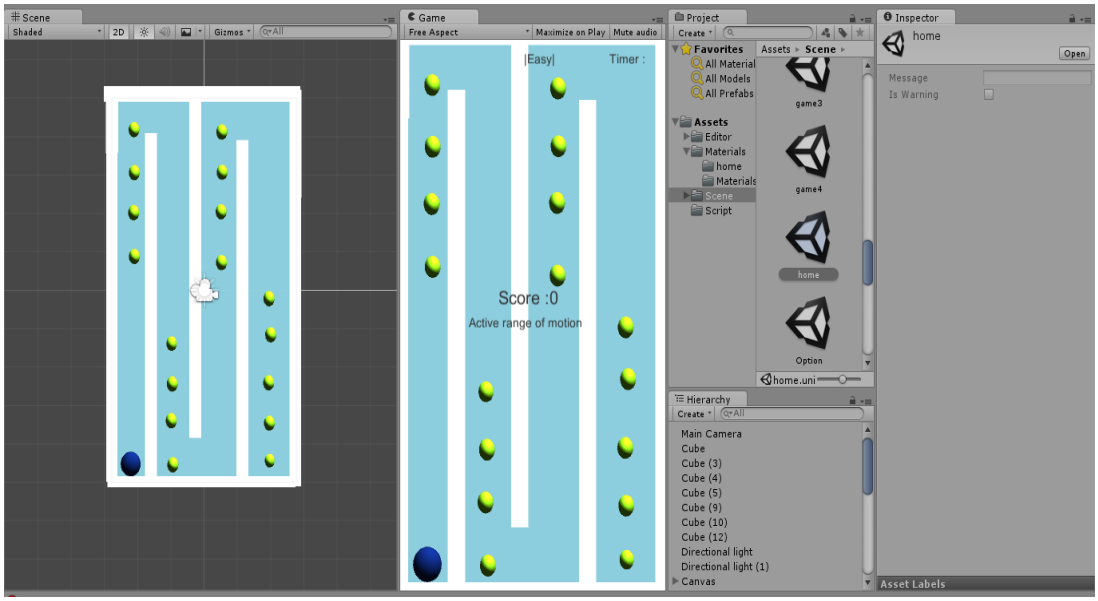


Figure 4.13: Easy game for Wrist Extension

Figure 4.13 shows interface of easy game of Wrist Extension (up, down). Top time Player will be save to motivated player to be better next time.

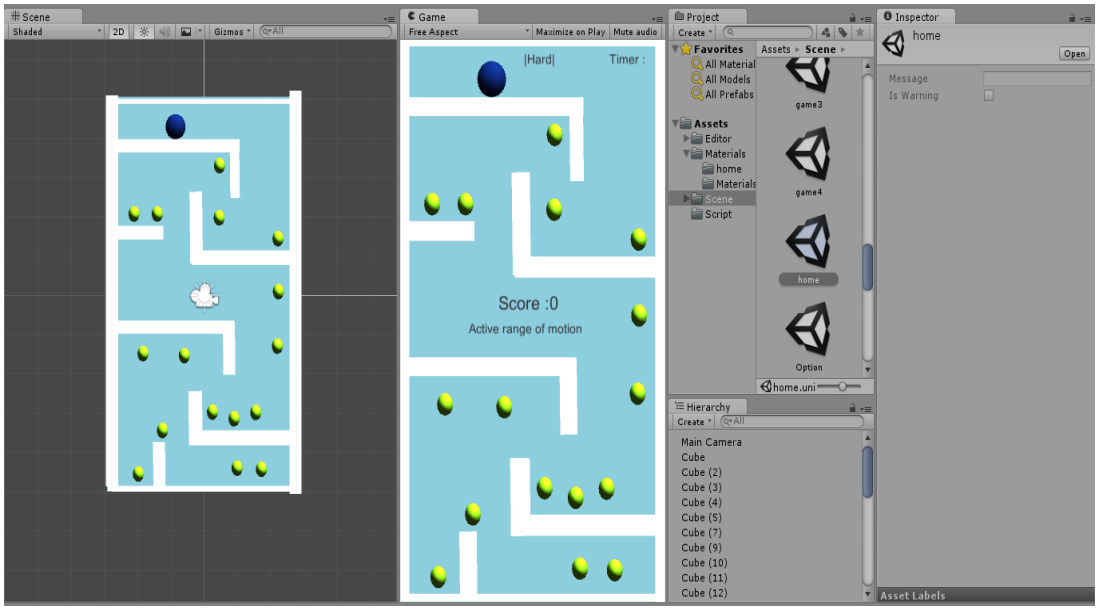


Figure 4.14: Hard game for Wrist Extension

Figure 4.14 shows interface of hard game for Wrist Extension (up, down). Top time Player will be save to motivated player to be better next time.

```
private void Update()
{
    totalTime -= Time.deltaTime;
    UpdateLevelTimer(totalTime );
}

public void UpdateLevelTimer(float totalSeconds)
{
    int minutes = Mathf.FloorToInt(totalSeconds / 60f);
    int seconds = Mathf.RoundToInt(totalSeconds % 60f);

    string formatedSeconds = seconds.ToString();

    if (seconds == 30)
    {
        seconds = 0;
        minutes += 1;
    }

    timer.text = minutes.ToString("00") + ":" + seconds.ToString("00");
```

Figure 4.15: Game countdown timer

Figure 4.15 shows the Script to countdown the timing for player to finish the game so it because of following physiotherapy concept it can't over 30 second playing game.

```
public class rollball : MonoBehaviour {
    public bool isFlat = true;
    private Rigidbody rigid;

    // Use this for initialization
    void Start () {
        rigid = GetComponent<Rigidbody>();

    }

    // Update is called once per frame
    void Update () {
        Vector3 tiltyThing = Input.acceleration;

        if (isFlat)
        {
            tiltyThing = Quaternion.Euler (90, 90, 90) * tiltyThing;
        }
        rigid.AddForce (tiltyThing);

    }
}
```

Figure 4.16: Function for acceleration android to control the ball

Figure 4.16 shows the implementation of the spawn function. This function is used to control the ball by following accelerometer so that it will work smoothly.

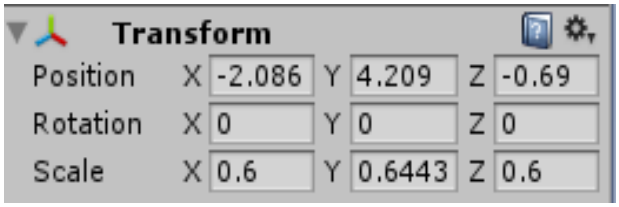


Figure 4.17: Ball settings for size and position

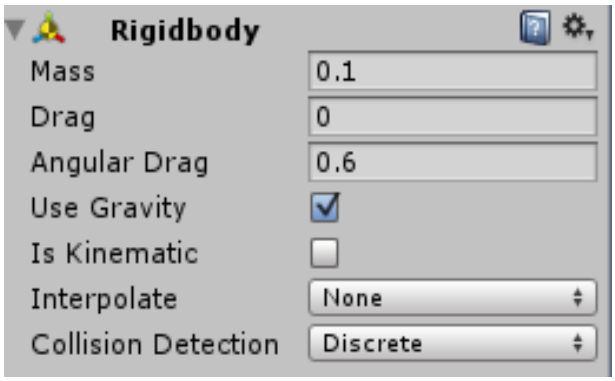


Figure 4.18: Ball settings for rigid body contain mass and angular drag.

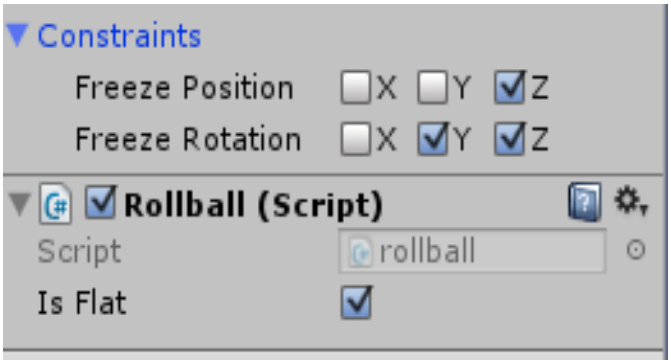


Figure 4.19: Ball settings for constraints and Script.

Figure 4.17, 4.18 and 4.19 shows the ball settings for game movement. The ball will roll based on setting and script so ball will follow how the script debug like freeze position Z to make sure that ball not fall from the platform and control the rotation ball.

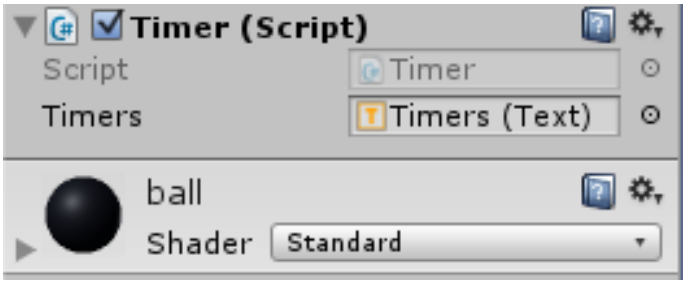


Figure 4.20: Ball settings for time moving

```
public class Timer : MonoBehaviour {

    public Text Timers;
    private float startTime;
    private bool finished = false;

    // Use this for initialization
    void Start () {
        startTime = Time.time;

    }

    // Update is called once per frame
    void Update () {
        if (finished)
            return;
        float t = Time.time - startTime;

        string minutes = ((int) t / 60).ToString();
        string seconds = (t % 60).ToString ("f2");

        Timers.text = minutes + ":" + seconds;

    }

    public void Finish()
    {
        finished = true;
        Timers.color = Color.red;
    }
}
```

Figure 4.21: Ball script for ball time moving

Figure 4.21 shows the ball script for ball time based on ball moving. The ball will roll based on setting and script time so that time will count based on ball start moving after 30 minute text colour will change to red that mean time for play game already over.

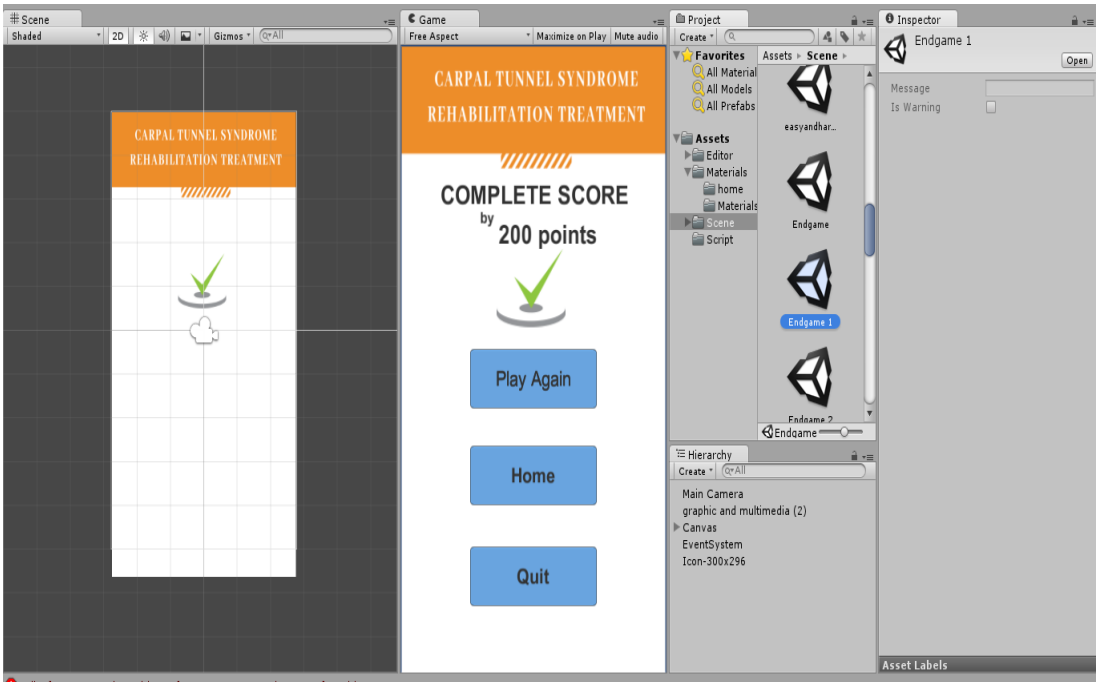


Figure 4.22: Score interface

4.2.5 About CTS Interface

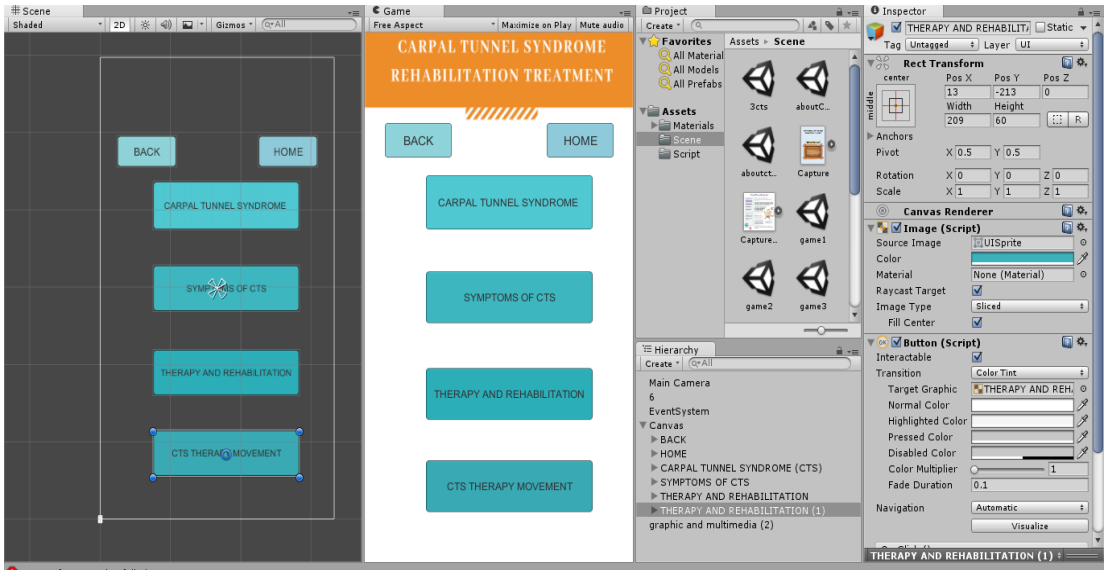


Figure 4.23: About CTS option.

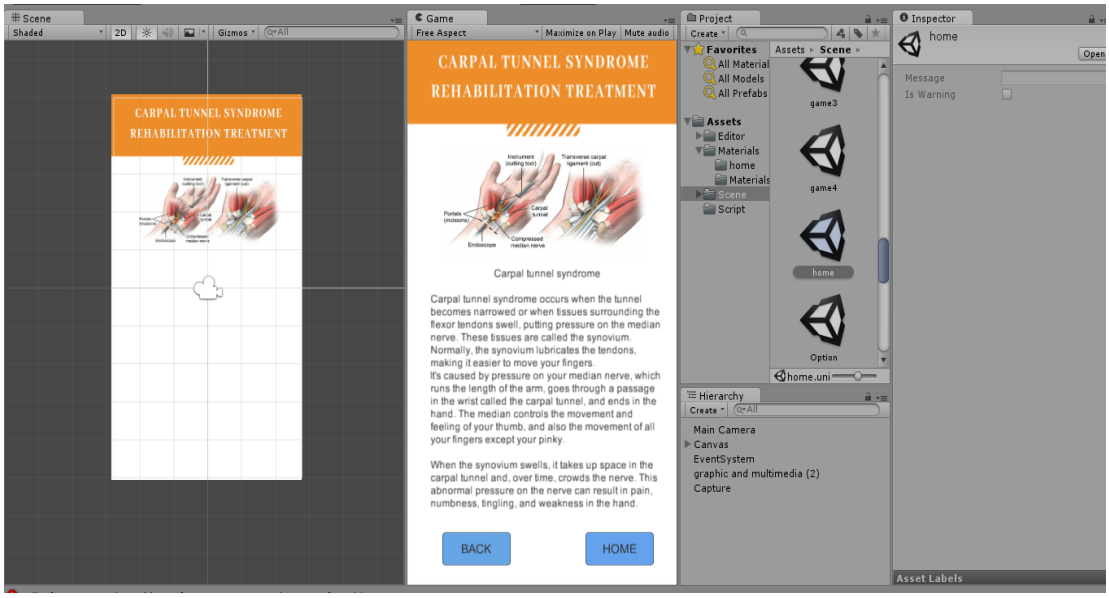


Figure 4.24: Basic information about CTS

Figure 4.24 shows the about CTS for reference to player about CTS know their condition. There a few information that able to help CTS patient know more about CTS and help to reduce the pain.

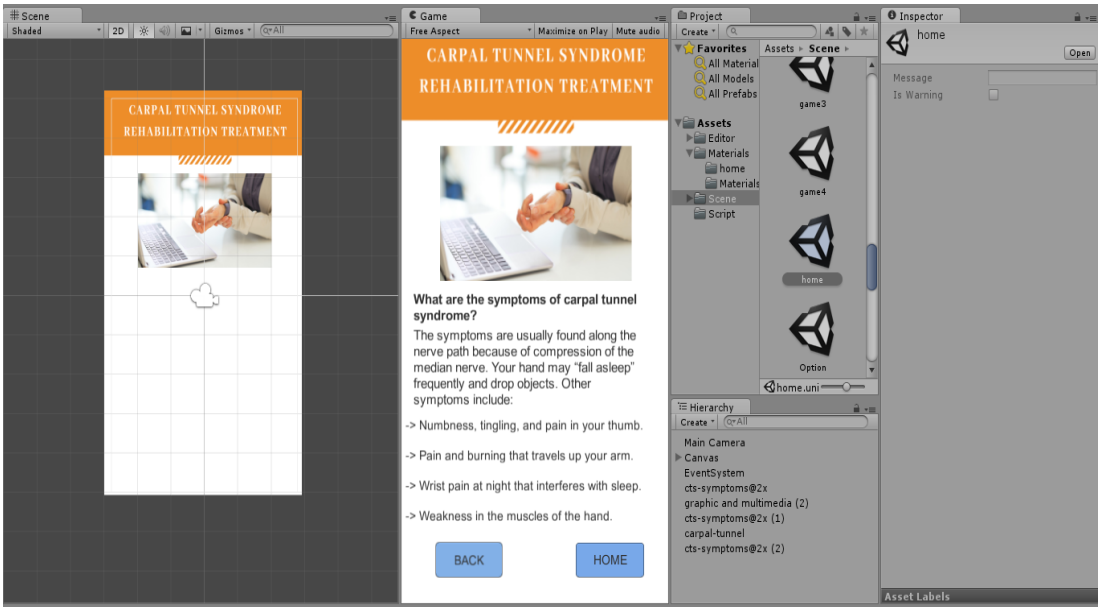


Figure 4.25: Symptoms CTS

Figure 4.25 shows the symptoms CTS for reference to player about CTS. There a few information that able to help CTS patient know more about CTS and help to reduce the pain.

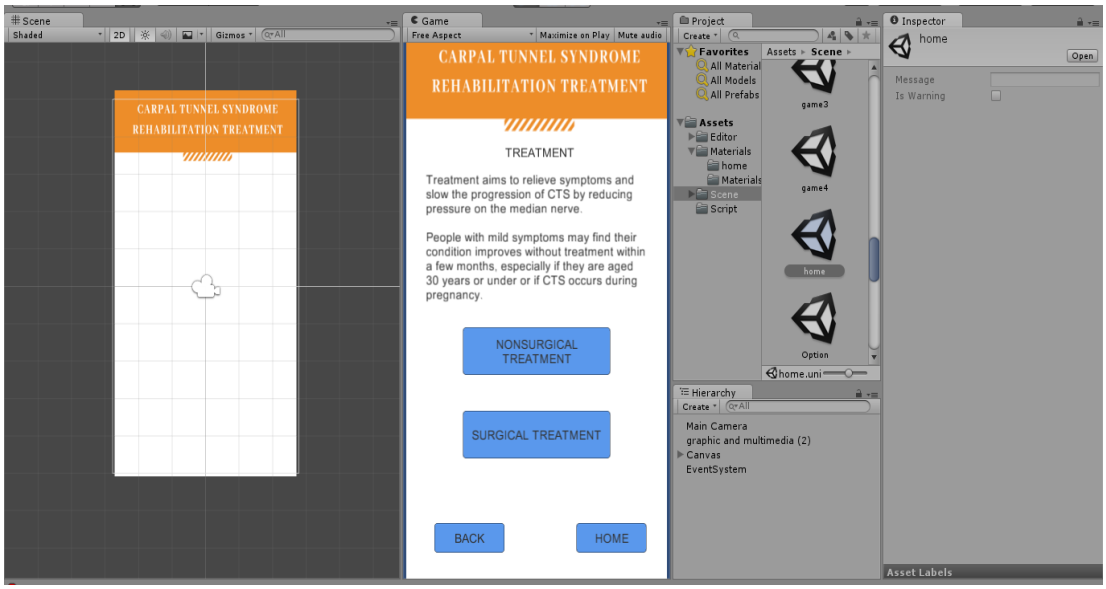


Figure 4.26: Rehabilitation and treatment CTS

Figure 4.26 shows the rehabilitation and treatment wish consist of two nonsurgical treatment and surgical treatment for reference to player about CTS know their condition and what they should do.

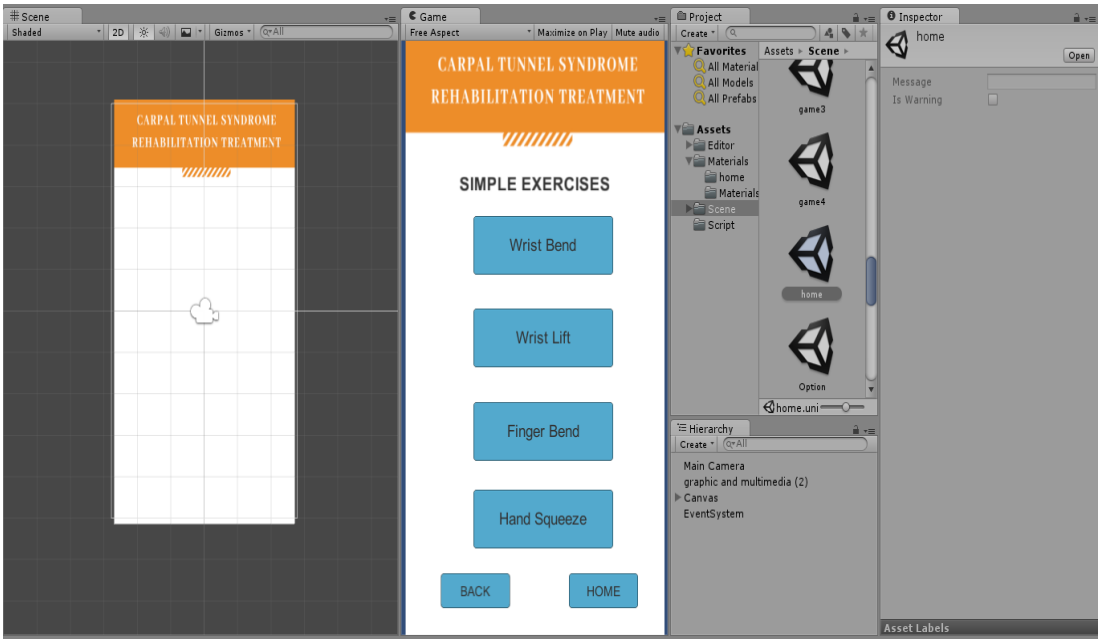


Figure 4.27: Exercise option

Figure 4.27 shows list simple exercise that patient can help CTS patient know more about CTS and help to reduce the pain.

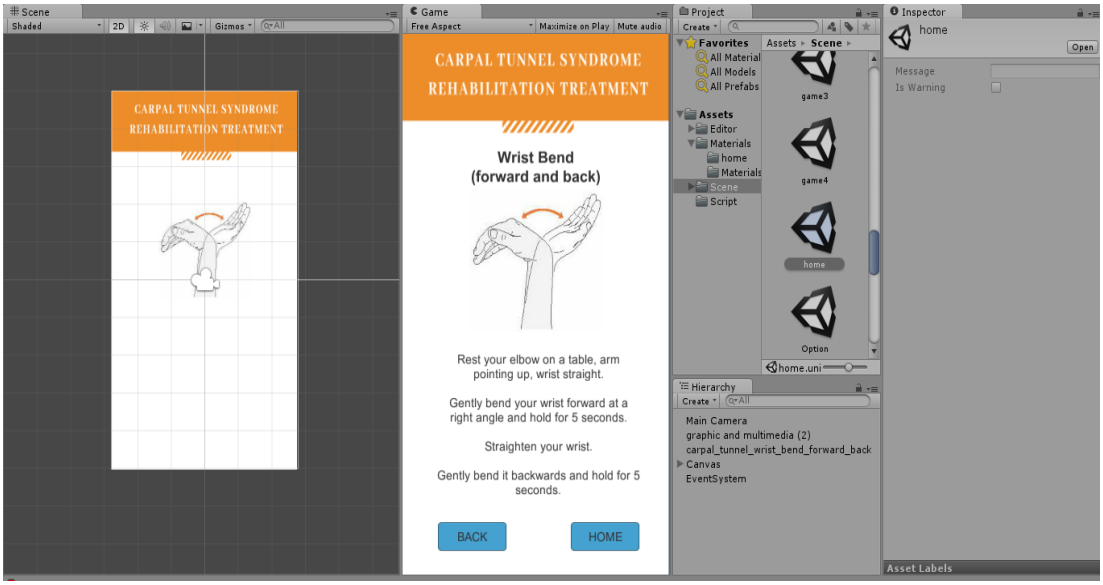


Figure 4.28: Exercise interface for wrist bend

Figure 4.28 shows wrist bend exercise and explanation how to do the exercise list simple exercise same goes to another 3 exercise.

4.3 STRENGTHS AND WEAKNESS

STRENGTHS

1) The game offer an interesting way of doing physiotherapy for CTS patients ant it is consist of two physiotherapy movements.

2) Patients can use their mobile device as part treatment compare to traditional device it will make game more interesting.

3) CTS game also can be used for hand exercise for normal people to prevent CTS and help to reduce the pain.

WEAKNESS

1) Currently available for android user.

2) Game setting with time limit (30 second) is quite difficult for CTS patient because they need to repeat a few time and it might be boring and patient may left the game.

3) 2D interface is not attractive enough for user compare to 3D game. Currently, all module is use the same ball movement.

4.4 RESULT AND DISCUSSION

In the testing part, serious games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment has been testing by patients and Mr. Azeri as a medical rehab at Pusat Kesihatan Pelajar, UMP Gambang and questions is being used to collect their feedback. This part also shows the questionnaire that was given to patients and medical rehab.

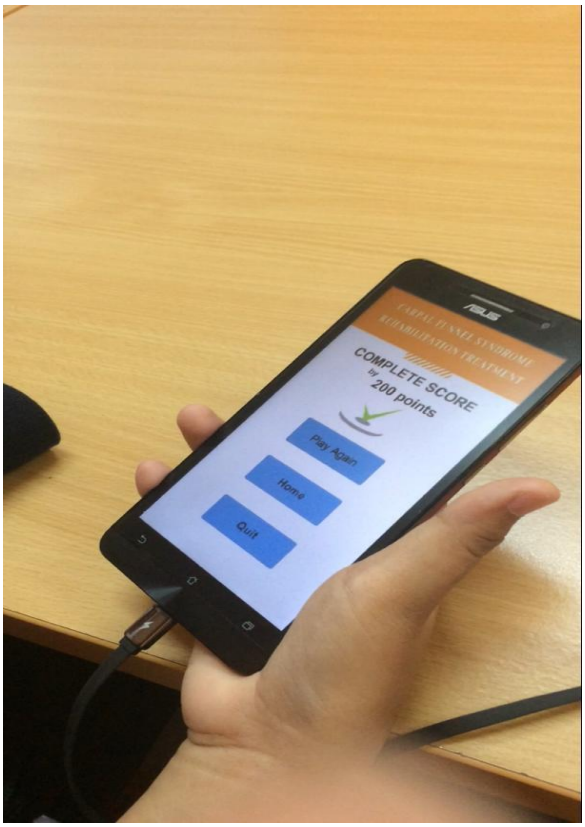


Figure 4.29: Patient play the game

Figure 4.29 show patient testing and give feedback of the game other it suitable and useful for them.

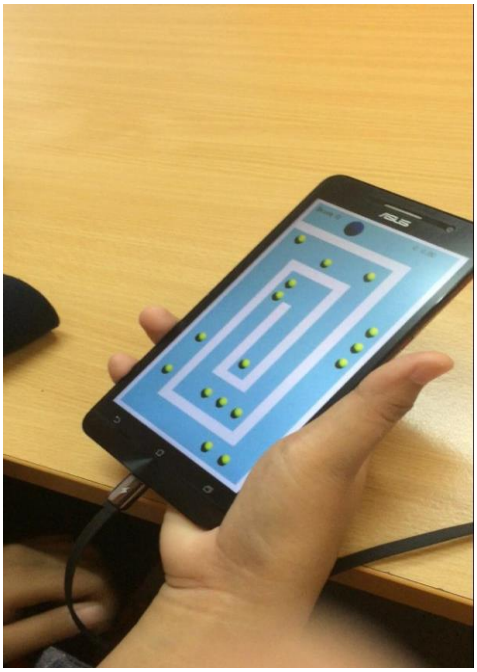


Figure 4.30: Patient play the game

Figure 4.30 shows patient testing and give feedback of the game other it suitable and useful for them.

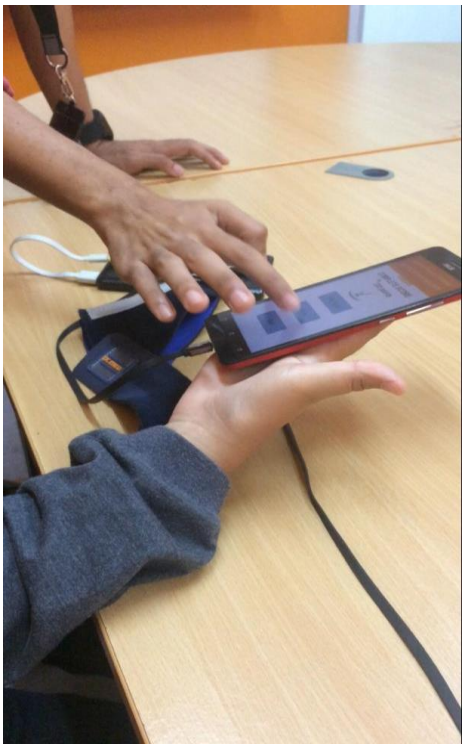


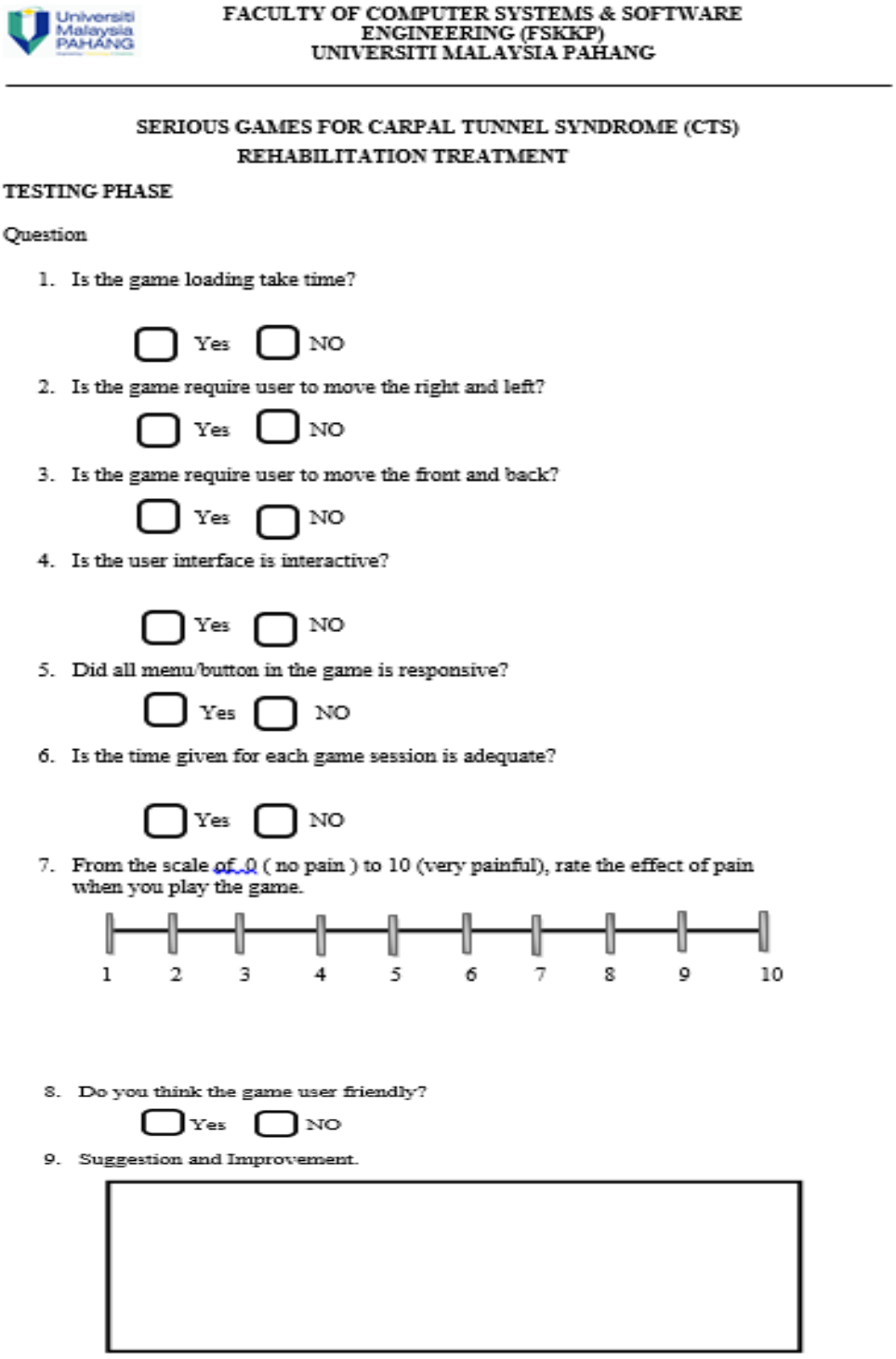
Figure 4.31: Medical rehab functionality game

Figure 4.31 show medical rehab testing and give feedback of the game other it suitable and useful for CTS patient.

Figure 4.32: Medical rehab test the game

Figure 4.32 show user testing and get feedback of the game other it suitable and useful for CTS patient.

Question after using this the game is as below



FACULTY OF COMPUTER SYSTEMS & SOFTWARE ENGINEERING (FSKKP)
UNIVERSITI MALAYSIA PAHANG

SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT

TESTING PHASE

Question

1. Is the game loading take time?

☐ Yes ☐ NO

2. Is the game require user to move the right and left?

☐ Yes ☐ NO

3. Is the game require user to move the front and back?

☐ Yes ☐ NO

4. Is the user interface is interactive?

☐ Yes ☐ NO

5. Did all menu/button in the game is responsive?

☐ Yes ☐ NO

6. Is the time given for each game session is adequate?

☐ Yes ☐ NO

7. From the scale of 0 (no pain) to 10 (very painful), rate the effect of pain when you play the game.

1 2 3 4 5 6 7 8 9 10

8. Do you think the game user friendly?

☐ Yes ☐ NO

9. Suggestion and Improvement.

Figure 4.33: Question

This game was especially effective when patient start playing the game that is good for their knowledge because this game gives clear explanation on CTS information, symptom

CTS, movement of treatment and physiotherapy and also consists of game following physiotherapy movement. Patient playing the game for the first time takes more time to finish the game and they are more comfortable with the movement for the second time. This game is suitable to play for patient with CTS from the test result and can help to reduce pain for patient with CTS it has been agreed upon by patient and medical rehabilitation. Adding more movement to the game for suggestion and improvement from them.

4.4.1 User Acceptance Test

Test Case for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment

Table 4.1: User Acceptance Test

Test Id	**Test Condition**	**Current Situation**	**Input**	**Expectation**	**Actual Result**	**Comment**
T01_001	Play button able to start game in CTS scene	Player at main menu phase	Click the play button	Move to CTS option scene after click play button	Move to CTS option Scene	Pass
T01_002	Play button will start the game	Player at main option phase	Click the Play button	The game will load option game	Move to option game	Pass
T01_003	About CTS button will load to option CTS	Player at main option phase	Click the About CTS button	The game will load to information CTS	Move to information game	Pass

Table 4.1: (Continue)

T01_005	Quit button will exit Game	Player at main option phase	Click the quit button	The game will quit from main option	Move to quit game	Pass
T01_006	Active range of motion button will load game option	Player at main option game phase	Click the Active range of motion button	The game will load from game option	Move to game option	Pass
T01_007	Wrist Extension button will load Game option	Player at main option game phase	Click the Wrist Extension button	The game will load from game option	Move to game option	Pass
T01_008	Easy button will load game option	Player at option game phase	Click the Easy button	The game will load from game option	Move to game	Pass
T01_009	Hard button will load game option	Player at option game phase	Click the Hard button	The game will load from game option	Move to game	Pass
T01_0010	Carpal tunnel syndrome button will load information CTS	Player at option about CTS phase	Click the Carpal tunnel syndrome button	The game will load from game about CTS	Move to information CTS game	Pass

Table 4.1: (Continue)

T01_0011	Symptom of CTS button will load Symptom of CTS	Player at option about CTS phase	Click the Symptom of CTS button	The game will load from about CTS game	Move to Symptom of CTS game	Pass
T01_0012	CTS therapy movement button will load CTS therapy movement	Player at option about CTS phase	Click the CTS therapy movement button	The game will load from about CTS game	Move to CTS therapy movement game	Pass
T01_0012	Play again will load game option	Player at score game phase	Click the Play again button	The game will load from game	Move to score game	Pass
T01_0014	Home button will load game option	Player at home game phase	Click the Play again button	The game will load from game	Move to home game	Pass
T01_0015	Back button will load game option	Player at option about CTS phase	Click the back button	The game will load from game	Move to game option	Pass

4.5 SUMMARY

For this chapter, improvement and result from the test that have been done by patient and medical rehab. This test shows how effective this game to the patient. This test helps to achieve this game's goal. This game helps and benefits the carpal tunnel syndrome patient so that pain can be reduced and CTS avoided. According to the testing it help patient to relief their pain by play CTS game and give them more information about CTS.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

The purpose of this chapter is to conclude the findings of Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment to achieve the objectives and find the solution for the problem. The summary of all four chapters including introduction, literature review, methodology and implementation, testing and discussion of results will be described from this chapter. In addition, this chapter will explain how to improve and expand this project more based on its features and technologies. Moreover, this chapter also elaborate on the project constraints such as the error in the development phase, the benefits and disadvantages of this project.

5.2 PROJECT CONSTRAINT

The main constraint for this project is to allocate enough time. Time management in the development of any project is very important. The time should be managed wisely so that the project is completed as planned and the schedule of works must be followed.

Secondly, the development constraint for Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment is software and hardware used because some don not support the element in the game that is important to choose the right software and hardware to support this game.

Third, the source of reference and the data collection on the internet is a major issue to be developed as this game requires a fact from the medical like physiotherapy movement and other information. In addition, code programming language is a bit hard to understand for development.

5.3 FUTURE WORK

There are few improvements from the project constraints discussed earlier to make it more effective and interesting for the user such as add move movement for maze ball game and improve the pattern game movements so that patient can have many option to play game. In addition, add more element such as video, image and other interaction to the game. Moreover, available for android and IOS so that it will give benefit to all people. Change current 2D game to 3D game to make the game more interesting and more fun.

5.4 ADVANTAGES AND DISADVANTGES

Table 5.1: Advantages and disadvantage

Advantages	Disadvantages
The movement of game are suitable because it follow physiotherapy movement	Only have two game option game and four pattern of maze
CTS game help patient to reduce their pain	Patient might be bored to do the exercise
Does not need internet connection	Only available on Android devices

In Addition, Serious games for carpal tunnel syndrome (CTS) rehabilitation treatment develop for help and benefits the patient with Carpal Tunnel Syndrome. This game develop by following physiotherapy movement for the game and all the element and requirement in this game from medical rehab so that it more effective to user. This game make patient feel fun to do the exercise. The ADDIE methodology model is chosen because it provides a systematic structure while this game is developing. This model has five phases

to develop which are the analysis, design, development, and implementation and evaluation system. Serious games for carpal tunnel syndrome (CTS) rehabilitation treatment consist of two main major including game and about CTS. Game for CTS patient develop by following physiotherapy movement and it consist of two movement which is active range of motion and wrist extension and each movement have two level, for each level have difference pattern of game for user to complete.

In addition, about CTS consist of information about CTS, symptoms of CTS, treatment and exercise for user to refer. Serious games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment has been test by patients and Mr. Azeri as a medical rehab at Pusat Kesihatan Pelajar, UMP Gambang test the effectiveness this game to the patient. This test helps to achieve this game's goal. This game helps and benefits the carpal tunnel syndrome patient so that pain can be reduced and CTS avoided. According to the testing it help patient to relief their pain by play CTS game and give them more information about CTS.

REFERENCES

Aldoobie, N. (2015). *ADDIE Model*. *American International Journal of Contemporary Research* (Vol. 5). Retrieved from www.aijcrnet.com

Pachoulakis, I., & Tsilidi, D. (2016). Technology-assisted Carpal Tunnel Syndrome Rehabilitation using serious games: the Roller Ball example. *Advances in Image and Video Processing*, *4*(4). https://doi.org/10.14738/aivp.44.2181

Thim-Mabrey, C. (2006). Sprachwandel in übersetzungsbearbeitungen zwischen 1846 und 1999. *Neuphilologische Mitteilungen*, *107*(3), 361–373. https://doi.org/10.13140/2.1.4687.6169

(Thim-Mabrey, 2006)Aldoobie, N. (2015). *ADDIE Model*. *American International Journal of Contemporary Research* (Vol. 5). Retrieved from www.aijcrnet.com

Pachoulakis, I., & Tsilidi, D. (2016). Technology-assisted Carpal Tunnel Syndrome Rehabilitation using serious games: the Roller Ball example. *Advances in Image and Video Processing*, *4*(4). https://doi.org/10.14738/aivp.44.2181

Thim-Mabrey, C. (2006). Sprachwandel in übersetzungsbearbeitungen zwischen 1846 und 1999. *Neuphilologische Mitteilungen*, *107*(3), 361–373. https://doi.org/10.13140/2.1.4687.6169

Aldoobie, N. (2015). *ADDIE Model*. *American International Journal of Contemporary Research* (Vol. 5). Retrieved from www.aijcrnet.com

Atroshi, I. (1999). Prevalence of Carpal Tunnel Syndrome in a General Population. *JAMA*, *282*(2), 153. https://doi.org/10.1001/jama.282.2.153

Canny Technologies. (2011). Carpal tunnel Syndrome 1.0 APK Download - Android Health & Fitness Games. Retrieved October 26, 2018, from https://apk-dl.com/carpal-tunnel-syndrome/com.canny.CarpalTunnelSyndrome

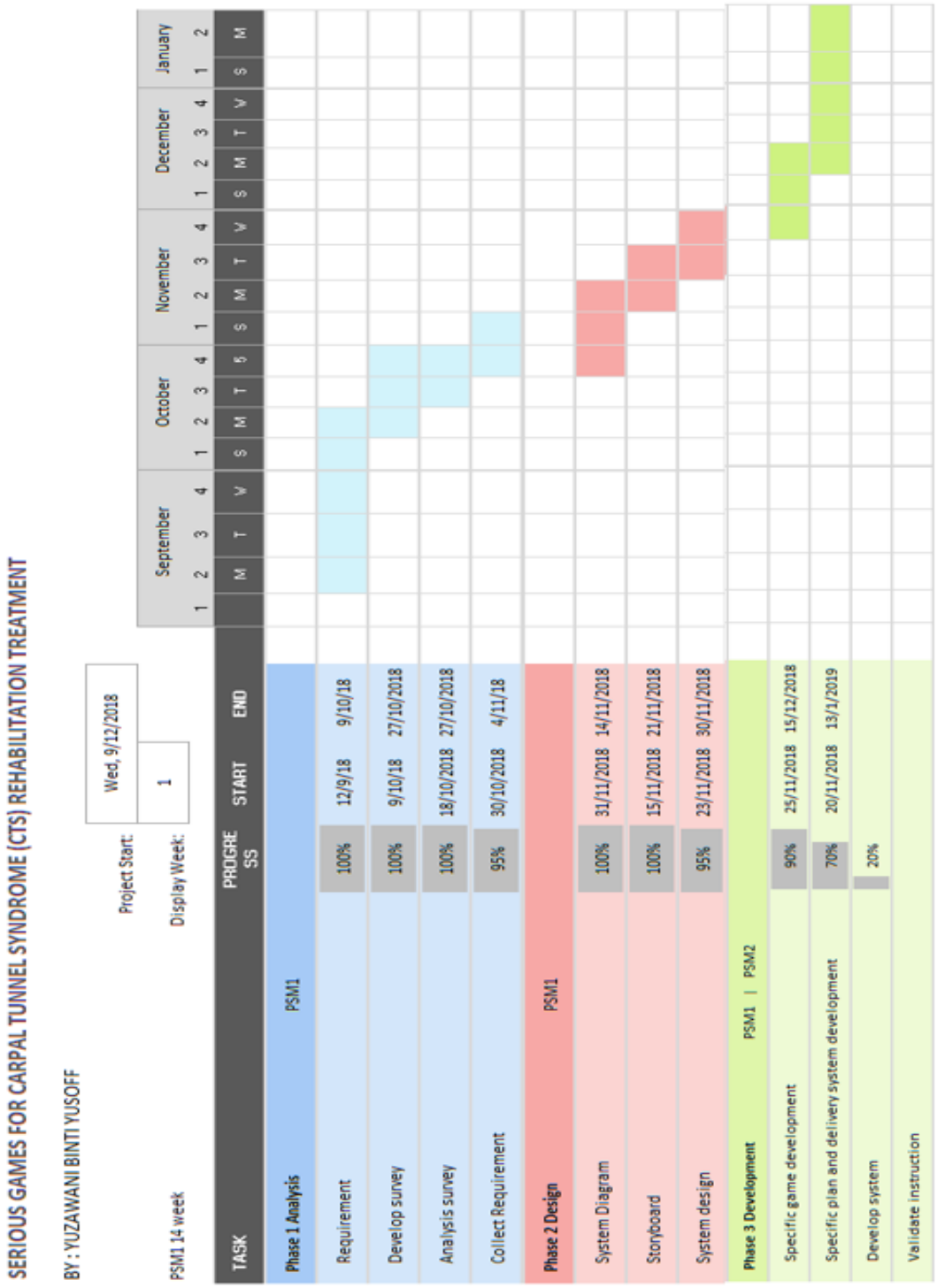
Pachoulakis, I., & Tsilidi, D. (2016). Technology-assisted Carpal Tunnel Syndrome Rehabilitation using serious games: the Roller Ball example. *Advances in Image and Video Processing*, *4*(4). https://doi.org/10.14738/aivp.44.2181

Padua, L., Aprile, I., Caliandro, P., Carboni, T., Meloni, A., Massi, S., … Tonali, P. (2001). Symptoms and neurophysiological picture of carpal tunnel syndrome in pregnancy. *Clinical Neurophysiology*, *112*(10), 1946–1951. https://doi.org/10.1016/S1388-2457(01)00637-X

Song, G. bin, & Park, E. cho. (2015). Effect of virtual reality games on stroke patients' balance, gait, depression, and interpersonal relationships. *Journal of Physical Therapy Science*, *27*(7), 2057–2060. https://doi.org/10.1589/jpts.27.2057

The star online. (2016). Three hours a day on smartphones - Nation | The Star Online. Retrieved October 26, 2018, from https://www.thestar.com.my/news/nation/2016/01/21/three-hours-a-day-on-smartphones-users-spend-40-of-their-time-on-social-networking-and-chatting-repo/

APPENDIX A


SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT
BY : YUZAWANI BINTI YUSOFF
Project Start:
Wed, 9/12/2018
Display Week:
1
PSM1 14 week
TASK
PROGRESS
START
END
September
October
November
December
January
Phase 1 Analysis PSM1
Requirement 100% 12/9/18 9/10/18
Develop survey 100% 9/10/18 27/10/2018
Analysis survey 100% 18/10/2018 27/10/2018
Collect Requirement 95% 30/10/2018 4/11/18
Phase 2 Design PSM1
System Diagram 100% 31/11/2018 14/11/2018
Storyboard 100% 15/11/2018 21/11/2018
System design 95% 23/11/2018 30/11/2018
Phase 3 Development PSM1 | PSM2
Specific game development 90% 25/11/2018 15/12/2018
Specific plan and delivery system development 70% 20/11/2018 13/1/2019
Develop system 20%
Validate instruction

APPENDIX B

SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT
BY : YUZAWANI BINTI YUSOFF
Project Start:
Wed, 9/12/2018
Display Week:
1
PSM2 14 week
JANUARY
FEBRUARY
MARCH
APRIL
MAY
TASK
PROGRESS
START
END
Phase 3 Development
PSM2
Develop system
100%
28/1/2019
15/3/2019
Validate instruction
100%
14/3/2019
4/4/19
Phase 4 Implementation
Training and checking
100%
6/4/19
2/5/19
Effectiveness
100%
24/4/2019
5/5/19
Phase 4 Evaluation
Measure performance
100%
18/4/2019
5/5/19
System objective
100%
23/4/2019
4/4/19
Revise System
100%
4/4/19
8/5/19

APPENDIX C

FACULTY OF COMPUTER SYSTEMS & SOFTWARE ENGINEERING (FSKKP)
UNIVERSITI MALAYSIA PAHANG

SERIOUS GAMES FOR CARPAL TUNNEL SYNDROME (CTS) REHABILITATION TREATMENT

TESTING PHASE

Question

1. Is the game loading take time?

   ☐ Yes ☐ NO

2. Is the game require user to move the right and left?

   ☐ Yes ☐ NO

3. Is the game require user to move the front and back?

   ☐ Yes ☐ NO

4. Is the user interface is interactive?

   ☐ Yes ☐ NO

5. Did all menu/button in the game is responsive?

   ☐ Yes ☐ NO

6. Is the time given for each game session is adequate?

   ☐ Yes ☐ NO

7. From the scale of 0 (no pain) to 10 (very painful), rate the effect of pain when you play the game.

8. Do you think the game user friendly?

   ☐ Yes ☐ NO

9. Suggestion and Improvement.

APPENDIX D

An interview has been conducted with Mr. Azeri as a medical rehab at Pusat Kesihatan Pelajar, UMP Gambang. Question and answer given during interview with physiotherapy as below.

1. Signs and symptoms CTS?

Signs and symptoms CTS is feel numbness, tingling, and pain in your thumb and the first three fingers of your hand. Moreover pain burning that travels up your arm wrist pain at night and weakness in your muscles hand.

2. Mostly male or female?

Most females compared to males and pregnant women may also have CTS.

3. Range age?

Late 40 and above because CTS may develop from an early age, but people don't take it seriously.

4. Occupation/profession that might have CTS?

Mostly people who use their hand to do work like a programmer and teacher.

5. What need to do if hand in pain?

If you feel pain at night put ice and soak your hand do exercise to reduce the pain and meet doctor to get treatment.

6. Holding the smartphone and using computer or laptop for long periods can cause hand and wrist fatigue?

Yes, both computer and smartphone might cause CTS because it will make hand feel numbness and tingling.

7. How we want to know, we had CTS?

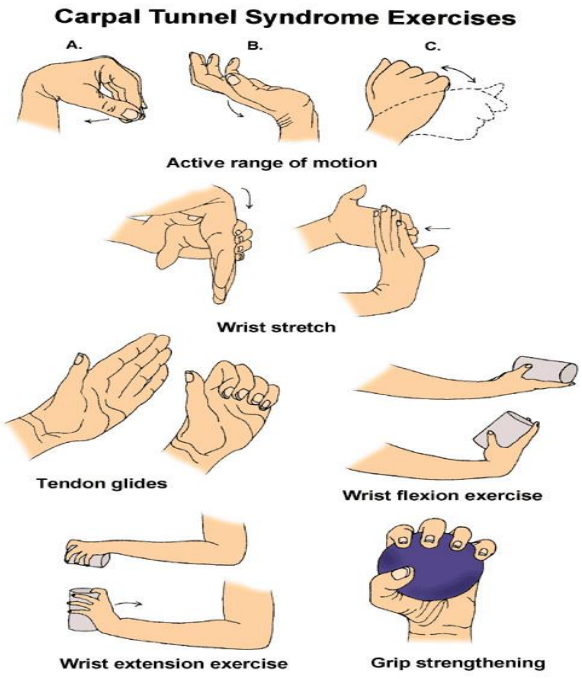
Feel the symptoms as below

- numbness, tingling, and pain in your thumb and the first three fingers of your hand
- pain and burning that travels up your arm
- wrist pain at night that interferes with sleep
- weakness in the muscles of the hand

8. How to recover?

It depend on our condition it is need surgery or no need surgery

9. Movement?



10. Did you think that Serious Games for Carpal Tunnel Syndrome (CTS) Rehabilitation Treatment will help you reduce the pain?

Yes by following physiotherapy movement and time to play game