ACTIVE GAMING USING MICROSOFT KINECT IN SOLVING OBESITY PROBLEM

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ABSTRACT

Obesity has seen an alarming rate of growth with its widespread influences at both local and global scale trigger a global urgency in solving this problem. In South East Asia, our beloved country Malaysia tops the list for the wrong reason as the fattest country in ASEAN with two of out of five adults are obese. The fattest country in the world is represented by Kuwait with a staggering number of 42.8% of total population are obese.[1] This widespread epidemic is soaring among children and teens. As a result, chronic ailments such as diabetes is becoming an unusual norm in today society.[2] In this research, electronic means are explored in order to provide a feasible solution to counter the rising problem of obesity. The study will cover the utilization of Microsoft Kinect as the viable solution in promoting active gaming among the obesity patients with the assistance of engaging and interactive gameplay that is designed to cater the physical ability of obesity patients. In addition, in this study, Microsoft Kinect would be the primary input that receive gestures performed by user while recognition of gestures will be done in Unity3D game engine as to translate the detected gestures into motion or functionalities inside the designated game. Furthermore, the core gesture advocated in this active game is none other than the running gesture which represents a good form of cardiac workout which is one of the main solution towards obesity other than proper dieting. Besides, in this game, obesity patient or user will get to know the approximate value of calories burned. Lastly, this research is intended to propose a solution in form of an active game that is designed to promote active lifestyle among obesity patients.
ABSTRAK

Obesiti merupakan suatu fenomena negatif yang mengancam kesehatan sejagat dengan rekod penyakit meliputi seluruh dunia. Fenomena ini telah mencetuskan perhatian sejagat untuk menyelesaikan masalah yang semakin memudaratkan kesehatan sedunia. Selain itu, tanah air tercinta Malaysia telah ditempatkan di petak utama antara negara yang paling gemuk di ASEAN dengan statistik menunjukkan bahawa dua daripada lima dewasa di Malaysia dikategorikan sebagai obesiti. Untuk pengetahuan anda, negara yang paling gemuk di dunia ialah Kuwait yang telah mencatat suatu rekod yang mengejutkan dengan sebanyak 42.8% daripada populasi negara tersebut dikategorikan sebagai obesiti. Tambahan pula, obesiti bukan sahaja suatu fenomena yang biasa berlaku kepada dewasa malah penyakit ini telah pun meliputi golongan kanak-kanak. Oleh itu, kejadian bahawa penyakit kencing manis melanda kanak-kanak merupakan suatu perkara ataupun berita yang teramat biasa. Dalam penelitian ini, penyelesaian masalah obesiti dengan memanfaatkan alat elektronik bersama dengan permainan video akan diperkenalkan. Di samping itu, penelitian ini akan menumpukan perhatiannya terhadap alat elektronik ataupun sensor keluaran Microsoft yang dikenali sebagai Microsoft Kinect. Penelitian tersebut akan memperkenalkan keupayaan Microsoft Kinect dalam menjadi input utama untuk menjayakan penciptaan permainan video yang disesuaikan untuk pesakit obesiti berasaskan keupayaan fizikal pesakit. Tambahan pula, input utama yang digalakkan dalam permainan video ini adalah berasaskan penyelesaian utama obesiti yang bertumpu kepada senaman kardio. Contohnya, input utama yang berasaskan senaman kardio merupakan senaman yang melibatkan berlari, berjoging, atau berjalan pantas. Akhirnya, dengan menjalani permainan video ini, pesakit obesiti akan dapat mengetahui anggaran kalori yang telah dibakar. Kesimpulannya, penelitian ini bertujuan untuk mencadangkan suatu penyelesaian kepada masalah obesiti melalui permainan video untuk mengalakkan gaya hidup yang sihat dan aktif terutamanya dalam kalangan pesakit obesiti.
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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Obesity or overweight could be defined as a condition in which excessive accumulation of body fat to an extent that it may result in negative impact on health, leading to reduced life expectancy. People are considered obese when their body mass index (BMI), a formula or measurement obtained by dividing a person’s weight by the square of person’s height, is greater than $30\text{kg/m}^2$.\textsuperscript{[3]}

The main reason behind obesity is the result of surplus energy stored as body weight which happens when intake of calories exceeds expenditure of calories. In addition, there are numbers of ‘obesogenic’ factors, in other words, factors that promoting obesity which result in increased energy consumption and decreased energy expenditure namely declining level of physical labour, higher level of food consumption (high in fat content) and etc.\textsuperscript{[4]}

In addition, dieting and physical exercise are the main solution for obesity. Balanced diet is helpful in decreasing or reducing consumption of energy rich foods such as those high in fat and sugars while increasing the intake of dietary fiber. Besides, anti-obesity drugs might be used to counter obesity by reducing the appetite or decreasing fat absorption when used together with a suitable diet.\textsuperscript{[3]}

However, other than implementation of dieting, physical exercise or medication, active gaming seems to be an alternative yet effective solution. Active gaming or Exergaming is represented by video games that are also a form of exercise. Exergaming relies on utilization of body motion tracking technology. Such genre of games has been lauded for promoting an active lifestyle.\textsuperscript{[5]}
With the introduction of Microsoft Kinect, active gaming has been seen as a great opportunity to develop active game with full body tracking feature which provides an engaging, immersive and interactive gameplay that could be pivotal in counter the widespread epidemic of obesity. Conventional solution of battling obesity such as dieting, physical exercise and medication might be effective, it is definitely not really appealing to obese patient as the discipline demanding yet repetitive nature of the tasks greatly drives down their motivation.

By using Kinect, a full featured serious game targeted for obesity patient could be achieved by integrating its invaluable marker-less motion tracking technology into the application. According to a study conducted among 2831 children aged one to twelve showed that video game was positively related to elevated weight status, yet those data were only accounted for girls aged nine to twelve who played moderate amounts of games. Some evidence even suggests that video games (passive gaming) induces or results in higher energy expenditure among children. Besides, some anecdotal evidence shows that interactive video games or active games that requires intense physical movement are contributing positive impact.161

In short, active game with utilization of Microsoft Kinect provides an engaging, interactive yet revolutionary solution in combating the widespread epidemic of obesity.

1.2 PROBLEM STATEMENT

Obesity is a serious medical condition that have garnered lot of attention lately in which kids, teenagers as well as adults have seen a galloping rise in term of their body weight. Such widespread epidemic has reached an alarming rate that demands immediate solution and countermeasure to contain this situation. While exergames are grabbing the headlines as the revolutionary solution in battling obesity, such games are not specifically dedicated to obesity patient, in other words, there is no proper obesity oriented serious game that caters obesity patients. Besides, patients are unable to make full use of such games due to their complexity and the need for a more tailored program or therapy.

Besides, in conjunction with the introduction of Microsoft Kinect sensor, active games has been afforded an opportunity for expansion while reaching out to more potential users which
is beneficial towards combating obesity. However, there is problem lies in the developed games is that the gameplay offered simply could not engage users/patients to be committed or motivated in carrying out the required task especially for obesity patient. Engaging gameplay represents a pivotal element to be kept in mind when developing an obesity oriented game as the game contents needed to be constantly motivate users in performing more exercises. While there is significant effort in commercial active games such as Kinect Fitness, Dance Central and etc; yet, there is still room for improvement for a full featured physical therapy game that could enhance the motivation level of targeted patients.

In addition, while physical based exercise represents a viable solution in battling obesity that should be definitely employed in an active game; yet, cognition based gameplay could not be left out. By combining both physical and cognition gameplays, users or patients could be further motivated or attracted in playing the game. Besides, a study suggested that passive gaming that requires users’ cognitive skills is essentially a virtual exercise itself as it helps burn energy. Thus, the combination of active gaming with cognition element could be an effective countermeasure against obesity.

As such, problem statements for this project are defined as below:

1. There is no tailor or custom made active games specifically dedicated for obesity patients
2. Lack of engaging elements or gameplays to motivate users in using the system.
3. Lack of cognition element in the existing active games that could be pivotal in motivating users.

1.3 OBJECTIVE

1. To develop a Microsoft Kinect based game to solve obesity problem by promoting active gaming.
2. To create an engaging gameplays to foster interaction between system and users in order to make users committed in performing the given tasks.
3. To develop gameplays that requires both physical as well as cognition interaction from users.
1.4 SCOPE

1. The system is targeted on users who are categorized as overweight or obese in terms of their respective BMI measurement who aged between 10 and 30.

1.5 THESIS ORGANIZATION

There are six chapters in this thesis:

i. Chapter 1 – Introduction of the research on Microsoft Kinect in solving obesity problem
ii. Chapter 2 – Literature review on existing projects or approaches
iii. Chapter 3 – Methodology on implementation of the system
iv. Chapter 4 – Design of the respective system
v. Chapter 5 – Implementation of the system
vi. Chapter 6 – Result and discussion of the system
vii. Chapter 7 – Conclusion
CHAPTER 2: LITERATURE REVIEW

2.1 OBESITY

Obesity could be defined as a medical condition of whom body mass index (BMI), a formula or measurement obtained by dividing a person's weight by the square of person's height, is greater than 30kg/m². Lot of efforts have been made to combat obesity, be it the conventional method of physical exercise or dieting; yet, there is a viable solution that could possibly revolutionize the approach in tackling obesity in which we called active game. In this context, serious game for obesity would be the representation of active game.

2.2 SERIOUS GAME

Serious game could be defined as a games designed with primary purpose other than pure entertainment. Serious game is not categorized under certain genres of games but represent a whole category of games with different purposes such as educational games, political games, or real world simulation. In this case, the development of serious game would be targeting obesity patients in an attempt to tackling the obesity with utilization of active gaming concept.

2.3 ACTIVE GAMING

Active gaming or exergaming is a term that represents video games which are also a form of exercise. Exergaming utilizes technology that tracks body movement or reactions. Exergames could be seen as an alternative games that bring more fun as well as better immersion level while promoting healthy lifestyle.
2.4 MICROSOFT KINECT SENSOR

Microsoft Kinect sensor codenamed Project Natal is a motion sensing input device by Microsoft for Xbox gaming consoles as well as Windows PC. Manufactured around a webcam-style add-on peripheral, Kinect enables users to control and interact with their console/computer without needing a game controller. In addition, Kinect enable interaction with PC and consoles through a natural user interface using gestures and spoken commands. In this case, the development of serious game would utilize the invaluable marker-less full body motion tracking technology offered by Microsoft Kinect.

2.5 SERIOUS GAME WITH MICROSOFT KINECT SENSOR

Utilization of Microsoft Kinect in serious game has seen the expansion of capabilities in serious game while charting unfamiliar territory that is previously impossible in term of implementation. With Kinect, for example, physiotherapy at home without the presence of professional therapist could be made possible. The invaluable technology of marker-less motion sensing has given an opportunity to implement revolutionary gameplay without any hassle regarding hardware and cost. Furthermore, the technology is also being used in the development of serious game regarding rehabilitation, exercise as well as fitness. In this context, the development of serious game for obesity will utilize the motion tracking technology in tackling the obesity problem.

2.6 CONSTRAINTS OF CONSUMER FITNESS GAME

In solving the obesity problem, physical exercise has been made interactive and fun with the introduction of consumer fitness game, a game developed with active gaming in mind to promote active and healthy lifestyle among gamers. This solution has seen a positive impact in term of solving the obesity problem with patients seem committed in performing the given exercises. However, the major downfall of the consumer fitness game would be its gameplay mechanics; as fitness games ranging from dancing, sports mini games and etc are not exactly tailored to solve the obesity problem. Besides, the complexity nature of the gameplay such as dancing might put off the interest or commitment of obesity patients as the required moves or actions are too difficult to be done considering the physical capability of
an obesity patient. In short, the consumer fitness games are not tailored made for obesity patients.

2.7 REVIEW OF EXISTING SYSTEM IN REGARDS OF SERIOUS GAMES WITH MICROSOFT KINECT

2.7.1 PRESCRIPTION SOFTWARE FOR RECOVERY AND REHABILITATION USING MICROSOFT KINECT

This system is designed to help in making rehabilitation tool a viable solution at home by using Microsoft Kinect.

In this system, in order enhance rehabilitation experiences of patient, the system or prescription software is divided into two parts, namely patient rehabilitation experiences (rehabilitation game), metrics and monitoring engines.

1. Patient Rehabilitation Experiences (PRE)

In PRE, a clinician is able to alter or configure the application to tailor the characteristics of their condition. The PRE could be defined as an interactive environment with objectives to be met by patients. By using gestures as input from Microsoft Kinect, patient is able to interact freely within the environment to perform certain set of tasks.

In addition, the PRE is designed with game mechanics in mind and the gameplay could be dynamically altered to fit the abilities of a patient in order to inspire or motivate patient to do better. If a patient finds it hard to complete the given action, then the next iteration of the required action would be simplified. The examples of PRE can be seen in Figure 2.1 below:
2. Metrics for Healthcare Professionals

In this case, to make a new rehabilitation method to be deemed medically relevant, the method have to be proved to have a positive impact on patient recovery. Thus, the metrics represent an evidence that could indicate the effectiveness of the system.

The data stored could be used to monitor the progress over time of the patient and this helps in determine the effect of treatment quantitatively.[12]

2.7.2 ENHANCING EFFECTIVENESS OF MOTOR REHABILITATION USING KINECT MOTION SENSING TECHNOLOGY (KINECT-O-THERAPY)

This system is designed to enhance effectiveness of motor rehabilitation by utilizing motion sensing technology of Kinect.

In this system, in order to enhance motor rehabilitation, four motion sensing exercise routines in introduced in a game developed using Unity3D engine. Besides, the software or system has been designed in a way that interaction between user and system is seamless with the natural user interface offered by Microsoft Kinect. The system is made up of four mini games that are translated by conventional rehabilitation exercises that are advocated by professional physiotherapist. Besides, the performance data recorded in game could be recorded into database and can be viewed by both patient doctor online.
The four games introduced in this system are namely Shoulder Abduction, Balloon Pop, Path Follower and Play Along. These game can be shown in Figure 2.2 below:

1. Shoulder Abduction

This routine has been integrated into the game to enhance the degree of shoulder abduction of a patient. The patient is required to move his left and right shoulder to make a straight line with his shoulder in order to register a successful attempt. If the player move his shoulder beyond the specified level, the attempt is considered invalid. In addition, if the incorrect movements is registered, an auditory clue is given to indicate correct and incorrect movements.

Balloon Pop

The exercise routine is included to helps the patient enhance his hand stability and hand-eye coordination in the X-Y plane. In this game, the patient is required to burst all the balloons
as quickly as possible. The patient has to place his hand on the balloon and wait for two seconds to make the balloon pops.

2. Path Follower

This exercise routine enhances the balance and coordination while walking. In this game, the patient has to walk on the path indicated on the screen. As patient successfully steps in the correct path, the path turns green and if patient steps out of the path; the path turns red.

3. Play Along

This mini games allows the participation of two patients in a collaborative manner. The routine is effective when one of the participants is physically challenged while the other are not. In this game, the former or the patient will try to imitate his partner’s action and would encourage himself to strive to the furthest extent possible.[11]

2.7.3 TOWARDS PERVASIVE PHYSICAL REHABILITATION USING MICROSOFT KINECT

This system is designed to demonstrate the capability of Microsoft Kinect as a viable solution in term of rehabilitation tool with a game based rehabilitation application developed using Unity3D game engine.

In this system, motor task is emphasized with the aim of improving the motor capabilities of the patients. To enhance motor capabilities, a mini game is designed for patients to perform External Rotation which is the main focus of the system. This can be seen in Figure 2.3 below:

(a) At the beginning of the game, the player is instruct to grab the capsule using right hand
(b) The green color indicates the player’s movement is correct
(c) The player successfully finishes the movement

Figure 2.3 A sequence of screenshots of our rehabilitation game
During the game, the patient is told to use his/her hand to move the virtual object from one side to another side of the screen. If this exercise is performed correctly which represent correct movement pattern, the path would be green in colour. Conversely, if the exercise is not performed correctly, the path becomes red and arrows appear on the screen to guide the player patient back into the correct position.

Lastly, when the patient has achieved the required repetition of movement in a correct way, the virtual object will be released from the patient’s hand and the patients would be encouraged to try with different virtual object and consequently perform the movement again.10

2.7.4 KINECT SPORTS

This game is a consumer game that is designed to promote active gaming among gamers by utilizing Kinect motion-sensing peripheral. This system or game consists of collection of six sports simulations and eight mini games. The six sports included are Bowling, Boxing, Track & Field, Table Tennis, Beach Volleyball and Football. In order to play these games, consumer or gamers are required to mimic the actions performed in real-life sports namely throwing javelin or kicking a football.

1. Sports Games in Kinect Sports
1.1 Bowling

In order to play bowling in Kinect Sports, players are instructed to reach their left or right to take up a ball before swinging their arm forwards to perform bowl. In this game, players are challenged to knock down as many pins as possible within a time limit. Figure 4 shows us the gameplay of bowling in Kinect Sports.
1.2 Boxing

In this game, players are instructed to use their left and right arms to punch and block at both head and body height. Figure 2.5 shows us the gameplay inside the Boxing of Kinect Sports.
1.3 Track & Field

In this game, the event is comprised of five separate events. The events are Sprint, Javelin, Long Jump, Discus and Hurdles. To play this game, players must be perform several actions namely player must jog on the spot to run, jump to clear hurdles, make a long jump and perform the relevant arm motion to throw a javelin or discus. Figure 6 shows us the main interface in the Track and Field game. In addition, Figure 2.7 and 2.8 shows us the mini games inside Track and Field namely Hurdles and Javelin.
1.4 Table Tennis

In this game, players are instructed to reach their left or right to pick up a paddle before serving before performing topspin, backspin and smash shots. In this game, a player is challenged to maintain a single rally for as long as possible. Figure 2.9 shows us the gameplay of Table Tennis in Kinect Sports.