The Advantages of Exergaming

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Introduction

It is well accepted among people that physical movement and activity leads to a healthier life. Performing physical exercises on a regular basis has proven to be healthy for people. For example, exercise science showed that physical activity can reduce the risk of coronary heart disease, obesity, type 2 diabetes and other chronic diseases. Moreover, a recent study estimated that at least 16% of all deaths could be avoided by improving people's cardio-respiratory fitness. An effective way of improving cardio-respiratory fitness is to regularly perform muscle strengthening exercises. Such exercises are recommended even for healthy adults as they were shown to lower blood pressure, improve glucose metabolism, and reduce cardiovascular disease risk. [Velloso et al., 2013] Exergames make people perform physical activity, but is it as effective as normal exercises and sports? In this paper we will identify the main advantages and positive effect of exergaming and by performing a literature study on the subject of exergaming. This paper consists of 5 sections. First we look into the background of exergaming, followed by an overview of the main publications. Next we examine two cases studies, future developments and we will conclude in section 5.

1 Background

The word 'exergaming' is a combination of 'exercise' and 'gaming'. Exergames are video games that are also a form of physical activity. Exergaming has become popular the last couple of years, but is not new; In the 1980's exergames were introduced with Atari 2600's foot pad controller and became more popular in the 1990's with Konami's Dance Revolution product. [Stach., 2009] give an overview of input devices used in the early years of exergaming. Input devices include accelerometers and gyroscopes, mats and pads that track the movement of the user with touch sensors and whole equipment systems such as stationary bikes linked with controllers and balance boards. Newer systems such as the Nintendo Wii, Microsoft Xbox and Sony Playstation use alternative input devices such

as the Kinect and Playstation Move. The Move uses image analysis to extract the motion of the user against a background and uses these motions to control the character in the game. The Kinect uses a combination of a infrared depth camera and color camera, to provide 3D motion tracking of the user. The Kinect is also available for Windows. The Wii is a controller that uses an accelerometers and gyroscopes and is a typical example of a platform for exergames. Nowadays modern cellphones also have a build-in accelerometer, gyroscope and a Global Positioning System(GPS). This opens up the possibility to play exergames on mobile devices.

2   Overview of main Publications

One of the main applications found in literature for exergaming is child obesity. Child obesity is caused by several factors, such as a poor diet and lack of physical activity. [Lamboglia et al., 2013] have conducted a research on child obesity and electronic devices. According to this research the electronic devices children grow up with in the 21st century have become a major contributing factor of child obesity. Recent studies have shown a positive relation between time spent in front of the TV and increasing obesity among school children. Thus sedentary behaviors associated with electronic entertainment (computers, TV, and video games) contribute to increasing the prevalence of overweight and obesity in children. The number of hours spent in front of the TV may be directly related to the increase in body mass index (BMI), cholesterol levels, smoking prevalence, and loss of overall fitness.

So it is not strange to assume that exergaming can help reducing child obesity, by using the same electronic devices that kids like and increases their obesity to make them perform physical activity. One way to achieve this is by letting children only use the electronic devices when they have done some physical activity. [Epstein et al., 1998] connected a television, a VCR and a video game console to an exercise bike. The bike required cycling in order to activate the other equipment. The study found that when given a choice of activities, the children studied were prepared to undertake the physical activity, cycling the bike, in order to access the desired activities of television watching, videos or video games. This was despite the option of undertaking other 290 activities, such as reading or drawing, without having to use the exercise bike. [Goldfield et al., 2000] performed a similar study. In this case there was no direct feedback from the physical activity performed. Subjects accumulated points on a pedometer by performing physical activities. These points could then be redeemed at a later point for desirable activities, such as television or video games. This study also demonstrated that children would be willing to undertake physical activity, in order to obtain access to television watching and video games.

Another way to reduce obesity is to let children or adults play an exergame. People are naturally fond of games, so playing a well designed exergame should be just as fun to play. As we said before: exergames make the user perform phys-

ical activity and physical activity is healthy, but how effective is an exergame in increasing a person's health, compared to regular exercising?

We found several studies that tried to answer this question with different conclusions.

[Daley, 2009] concludes: There is some evidence that exergaming uses significantly more energy than sedentary activities, but evidence to date is mixed on whether they engage children in levels of activity that are consistent with public health recommendations for physical activity and improving cardio-respiratory fitness.

In a more recent study [Perusek et al., 2014] an exergame is compared to its traditional counterpart. In this case the exergame is Wii Boxing. The results showed no significant difference in energy cost for Wii Boxing versus heavy bag boxing, which suggests that the Nintendo Wii may be a sufficient replacement for traditional activities. [Devereaux, 2012] even suggest that exercising with the Nintendo Wii Fit requires less effort compared to normal exercising, while the metabolic cost was equal across modes of exercise as reflected by the heart rate values. So this may lead to an increased level of exercising for the user, because they can exercise for a longer time.

The exact effect of exergaming is still under discussion, but there is no doubt that playing an exergame has a positive effect on the players health. But apart from health benefits, exergaming also has several other benefits. Exergames are a form of entertainment and offer the user a way of motivation. With other forms of exercise, people will usually be thinking about how exhausted they are; with exergaming, their mind is immersed in the game and they are just having fun. As a result, the level of motivation to stick with the exercise program is also much higher than with traditional exercise.

Some people are not comfortable with their own body and therefor do not want to go to a fitness class or join a sport club, because they are afraid other people might look at them. Exergames can be played at home in a 'safe' environment, where these people can workout without the uncomfortable feelings and in their own private room. This can help them increase their self confidence, and ultimately making them more comfortable with their own body.

Exergames can be played alone at home, it can also offer a social way of getting fit. Friends and family can join the games at home, and there are plenty of games that offer on-line communities where people can motivate and help each other. Some games are completely build around an on-line coach, such as Your Shape: Fitness Evolved and Nike+ Kinect Training. These virtual coaches provide the user with a personalized training plan and keep track of all the activities performed by the user. The coach gives feedback about how well the exercise is performed by the user, and tries to motivate the user by talking.

Giving feedback about executing a training in the right way is another field where exergames can help. A correct technique when performing an exercise is very important to avoid injuries. Incorrect technique has been identified as the main cause of people getting injured while performing physical exercises [Gallagher., 1996]. Especially when using free weights (such as dumbbells), users are more prone to injuries caused by wrong movements. The best solu-

tion to this is the guidance of a personal trainer. While this solution is very effective, the presence of a professional trainer is not always possible, because of availability, cost and time dependency. Personal guidance does not scale well with the number of people requiring assistance, as the number of people requiring assistance is much higher than the number of personal trainers available. Each personal trainer has a number of athletes and it is hard for the trainer to stay involved with everyone when the number of athletes increases. This is where exergames step in: the number of trainees for one trainer is unlimited. Not only are exergames resource efficient, they are also cost and time efficient. Exergames are available on all sorts of platforms such as Sony Playstation, Microsoft Xbox, Nintendo Wii, PC, Mobile, and more. Most people already own one of these platforms, and buying the game is a one time purchase, which is cheaper than a subscription to a sport or fitness club. Exergames can also be played at home, which takes less time than going to another location and is not weather dependent.

For revalidation and physiotherapy the correct movement is more important than in normal exercising. Exercises for people that recover from injuries usually get special exercises that strengthen the injured muscle. It is important that the exercises are done on a regular basis and motivation is kept high. Exercises after injuries are often seen as heavy and/or boring, which are the main reasons why people quit the program. Exergames can help by offering distraction, fun and positive feedback that make people more motivated and increases the chance of a successful revalidation. Exergames can also progressively raise the difficulty and motivate you to beat your personal best.

For revalidation several specialized exergames have been proposed. For example for the revalidation of people with Parkinson disease several exergaming solutions can be found in literature, to compliment the rehabilitation of problematic motor symptoms. [Barry, 2014] have performed a systematic review of proof for the effectiveness of exergames for people with Parkinson disease. They concluded that there are a reasonable amount of studies about the subject of exergames and Parkinson disease. Almost all studies have a positive outcome. In general all studies found some positive effect on the motor functions of the subjects. However most studies can be called weak, taking into account the quality of scientific studies. For example only one randomized control trial was reported. This study, which did met the standards for quality of scientific research, concluded that the balance of subjects increased about the same with exergames as it would for usual exercises with a physiotherapist. The feasibility of commercial games was also looked at. Despite these promising results and the potential of commercial exergames as a means of low-cost home-based exercise, there is a concern that these games are too difficult for some people with Parkinson disease. However the game aspect, with continuous feedback on your own score, proved also for people with Parkinson disease as highly motivating. Everything added together the research concluded that the use of exergames for the revalidation of Parkinson disease looks very promising however there should be games designed specifically for this target group and full effect studies have to be done in order to have real proof about the effect of exergames.

3 Selection of case studies

3.1 Nintendo Wii & Wii Sports

The release of the Nintendo Wii in 2006 boosted the discussion about exergames. The Wii uses a hand-held remote controller as its primary game controller. It uses a combination of built-in accelerometers and infrared detection to sense its position in 3D space when pointed at the Wiis console. This design allows users to control the game with physical gestures as well as button-presses. Wii Sports was released together with the console and featured a number of sports to be played. Tennis is one of the sports that could be played on the Wii. For example in real tennis the player holds and swings the racket at about waist level. In Wii Sports - Tennis the player can use the same motions as in real tennis, and the Wii system will translate this movement to a 2D on-screen character.

The Wii controller is generally seen as easy to use. The simple controller and motion-based play style makes it accessible to a wide range of people. People can master the controller in a short time, as most games require very little button-pushing. As described earlier in section 3, the Wii Sports games showed no significant difference in energy cost with their traditional counterpart, which makes it a good alternative for people who do not like to do the traditional exercises. In late 2007, Nintendo released the exergame Wii Fit, which utilized a new peripheral, the Wii Balance Board. This Balance Board can measure the users weight and center of balance by using pressure sensors. The game Wii Fit, together with its successors Wii Fit Plus and Wii Fit U, has been used successfully for revalidation purposes [Fung et al., 2012], [11, 2012], [Bieryla and Dold, 2013]. Over the last few years a number of researches has been done on the use of the balance board in combination with the Wii for specific purposes. [Reed-Jones et al., 2012] used the Wii Fit Plus balance tests for balance assessments of elderly people, and they reported it is a promising and useful device for promoting fall prevention among the elderly. Studies have also indicated that the Wii Fit balance board is a easily purchased device that can train or treat the imbalance symptoms of numerous diseases, such as Parkinson's disease, cerebral palsy, stroke, and multiple sclerosis [Chang et al., 2013].

The games on the Wii offer motivation through competition against other players, tracking high-scores and variation from daily or weekly exercise. When played together, the Wii also promotes social interaction. The Wii system is cost effective and user friendly. However the Wii only tracks rough motor movement, there is no direct feedback on the performance of the movement which makes it only usable for improving cardio-respiratory fitness, but not for real training. With the expansion of the balance board the Wii is also usable for balance related revalidation. Even though the Nintendo Wii seems to be a promising tool for rehabilitation, its adaptation into therapy also has its limitations. The console itself was created for entertainment purposes and the games are designed to be played by people without physical constraints. Because the difficulty of the standard Wii games is calibrated for healthy players, many of these games are too challenging or even unplayable for people with motor impairments. The

system also does not provide a rehabilitation-specific feedback which makes it difficult for patients and health practitioners to track progresses over longer periods of time [Anderson et al., 2010].

3.2 Kinect

The Kinect is a motion sensing input device by Microsoft for the Xbox 360 gaming console. It allows the user to interact with the system with motion of the human body. The fact that the user does not have to wear anything, makes the Kinect an interesting tool for quick exercising. The Kinect was released in late 2010. Due to the popularity of the Xbox 360 and the low cost of the device, it was the fastest selling electronic device in history [20, 2011]. Support for Microsoft Windows was added in in 2012 with the official release of a software development kit (SDK), although open source SDK's were already available earlier, because of the fact the Kinect uses an USB protocol which is not encrypted. With the Kinect you will get the game Kinect Adventures for free. Kinect Adventures uses full body motion and let the user play six different mini games. The games are quite intense, so they are not really suitable for elderly people. No research could be found in literature that looks at the intensity and impact of this Kinect game. The games in Kinect Adventures all focus on the gaming aspect and do not give much qualitative feedback on motion. Soon after the release of the Kinect, Ubisoft came up with the game: Your Shape: Fitness Evolved. This game does focus on the qualitative feedback of movement, and provides the player with a wide range of exercises that can be done in front of the Kinect. [Yang et al., 2014] Conducted a test on participants with the game Your Shape: Fitness Evolved. They conclude that the feedback is both motivating and helpful, and the game itself can help all people meet the recommended physical activity each day, especially for persons that are just starting with an activity program. Furthermore the game was highly enjoyed by the participants and the combination of enjoyment and decreased barriers may result in motivation for people to become more physically active and thus, decrease the health risks associated with a sedentary lifestyle.

4 Future developments

The number of researches on exergaming is rising in the last couple of years. For example in the number of researches on Wii-Fit balance training has shown an exponential increase. [Goble et al., 2014] In the future, more researches will be conducted to test exergames for specific purposes such as balance training for elderly, revalidation after a stroke, helping people with Parkinson. But probably more use cases will be tested and evaluated. More evidence is needed to proof that exergames can really help in these specific cases, and in the future we will see exergames more and more being used for revalidation processes.

Another view of exergames is to not design a specific game for exergaming, but to make an existing game into an exergame. An example is the Viruix

omni, which basically replaces the controller of a game by a treadmill. On the treadmill you can walk or run in all possible directions, and the movements on the treadmill are then translated to ingame movement. In addition to running and walking, actions like jumping, sitting and rotating are also possible. The Viruix omni works together with the Oculus Rift, a virtual reality headset. The headset tracks movement of the head and these movements are used to look around in a virtual world. Because the Viruix omni together with the Oculus Rift are a replacement for the controller of a game, such as keyboard and mouse, they can be used in games where you can move around in a virtual world, while using full body motion. No research has been done yet if using these devices has any impact on the health of the user.

Nowadays a lot of people own a smartphone. Smartphones can also be used for exergaming, by using the GPS(Global Positioning System) tracker and/or the accelerometer which nearly every mobile device have built in. Input for the exergames on mobile devices are in general limited to the GPS and accelerometer, unless the smartphone is connected to another input device, such as a heart rate meter. There are already mobile exergames made that use the number of steps walked by the user, which can be counted using the accelerometer, and use this to earn achievements and reach objectives within a certain time limit. The accelerometer can also be used to track actions like jumping, which can also be used in exergames. Another example of an exergame on a mobile device is Ingress. Ingress is an app which allows users to capture landmarks all over the world. The players are separated into two teams, which battle against each other in capturing the most landmarks and gaining territory in the progress. To capture the landmark a player has to travel to the actual location of the landmark. The game can be a motivator to take a walk to landmarks in the neighborhood of the player. Mobile exergames can become more popular in the future, as there are plenty of possibilities to game-ify apps for health and fitness.

5   Conclusion

In this paper we looked at the different advantages of exergaming found in literature. Advantages of exergaming found in literature include that exergames can be time- and resource effective, as they can be played at home and dont require a personal trainer or fitness location. Overall exergames tend to be good for health as it is shown that the exergame variation of a specific exercise can be just as intense as the regular version. The game aspect of exergames are in general seen as fun and motivating, which can lead to higher persistence of an exercise program. Several exergames have been suggested for different purposes.

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