Mobile Exergames - Burn Calories While Playing Games on a Smartphone

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Abstract

Exergames combine exercising with game play by requiring the users to perform some kind of physical activity (and exercise) in order to score points in the game. In this paper, we present a novel mobile exergaming framework, which requires the users to physically move and jump in order to score points in a game that is played on a smartphone. Our system uses a custom designed Exercising Pad (called ExerPad) in order to track the user's physical movement, and then automatically updates the corresponding game character's position on the screen. The ExerPad contains different shaped images, which are captured from the smartphone's inbuilt camera, and are automatically detected by our shape detection algorithm. We also use the smartphone's inbuilt accelerometer and gyroscope to detect other physical movements from the user such as jumping, turning etc. The experimental results show that the proposed mobile exergames helps its users to burn calories and have fun at the same time.

1. Introduction

Obesity is an increasing epidemic in the modern sedentary lifestyle. One possible solution to this problem is to embed increased physical activity in daily routine. Exergames provide a mechanism to increase physical activity by playing fun and addictive games. Hence exergames are recently gaining a lot of popularity in the video gaming industry [1, 2]. Some popular examples are arcade based exergames such as *Dance Dance Revolution (DDR)*, and fitness equipment based exergames such as *Exerbikes*. The main limitation with these exergames is that they are very expensive and hence are not affordable to everyone. Recently console based games have also adapted the concept of exergames by designing controllers that require the users to physically move in order to progress in the games (for example *Nintendo Wii, Xbox Kinect, Sony Move* etc). Even though the consoles are much affordable, the main limitation with console based exergames is that the they are not portable and the users are confined to a fixed room in front of the television.

Recently researchers started exploring mobile exergames [3, 4], which use the smartphone's in-built GPS to detect user's current location in the real world and map it to the character in the virtual game world. The user has to walk or run in the real world in order to move the character in the virtual world. The main limitation with these games is that the GPS can detect user's physical movements only if he/she moves at least a few meters in distance. Hence the game cannot respond to user's subtle physical movements such as jumping in air, walking for only few steps etc.

The mobile exergames proposed so far do not take advantage of the fact that the smartphones these days come equipped with more advanced sensors that can be used to detect subtle movements from the user. For example, an iPhone has in-built motion sensors such as an accelerometer and a gyroscope (technology used in Wii controller), and also an in-built camera (technology used in Xbox Kinect and Playstation Move controllers). In this paper we present a novel framework for developing exergames on mobile platform using a combination of smartphone's in-built hardware features.

2. Proposed Mobile Exergames

As shown in figure 1, the user will need just a smartphone (with inbuilt camera, accelerometer, gyroscope) and an ExerPad in order to play our mobile exergames.

2.1. Game Design

We implemented the popular *Space Invaders* game in the proposed mobile exergaming framework, where the user has to move horizontally on the ExerPad in order to move the laser cannon horizontally in the game, and has to jump in order to shoot the aliens that are dropping from the top (please see figure 1). The goal is to shoot all the aliens and clear the screen before they reach the bottom the screen,

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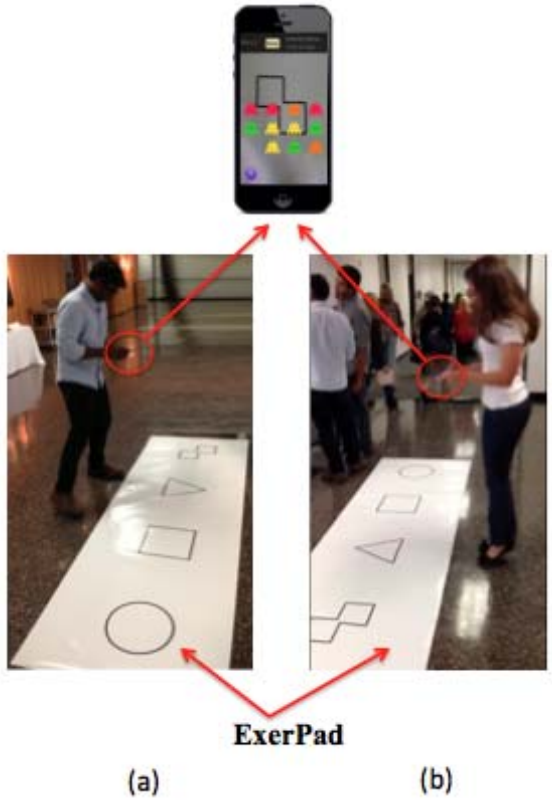

Figure 1. Users playing the proposed mobile exergame. (a) horizontal movement (b) jumping

hence requiring the user to continuously move and burn calories.

2.2. Physical Activity

Horizontal movement: We have designed an ExerPad that contains different shape images that are arranged horizontally as shown in figure 1. Each shape on the ExerPad is mapped to a unique horizontal position of the laser cannon in the game. As the user moves on the ExerPad, we first capture live feed from the smartphone's inbuilt camera, then apply a robust shape detection algorithm to determine the user's current position on the ExerPad, and finally update the corresponding position of laser cannon on the game screen.

Jumping: The smartphones in the current market are equipped with accurate and highly sensitive motion sensors such as an accelerometer and a gyroscope. An accelerometer measures the device acceleration whereas a gyroscope measures the device rotation along each of the x,y, and z directions. We developed a robust algorithm that first reads the values from the smartphone's accelerometer and gyroscope, then automatically detects whenever the user jumps in the air, and finally fires a bullet on the game screen to kill the alien that is immediately on top of the laser cannon.

3. Experimental Results

We have asked a total of 20 participants in our University campus (12 male, 8 female) between the ages of 21 and 33 to play the proposed mobile exergame, and also to fill a survey questionnaire at the end to measure the effectiveness of the game. To one of the survey questions that says *"I had a good workout while playing today's mobile exergame"*, 15 participants responded as either *"Strongly Agree"* or *"Agree"*, 4 participants responded as *"Neutral"*, and only 1 participant responded as *"Disagree"*. To another survey question that says *"I think mobile exergames such as this are addictive and fun to play"*, 17 participants responded as either *"Strongly Agree"* or *"Agree"*, and 3 participants responded as *"Neutral"*. Hence, it is evident that the proposed mobile exergames help its users to have a good workout while having fun at the same time.

4. Conclusion

In this paper, we have proposed a novel mobile exergaming framework that allows its users to have a good workout and burn calories while playing games on their smartphone. The advantage of proposed exergames over other exergaming technologies such as console, arcade, and fitness exergames is that the mobile exergames are extremely portable allowing the users to take it with them wherever they go. As a future work, we are working on extending the ExerPad to also detect user's vertical movements, adding more 2D games to the suite, and finally we will perform extensive experiments involving more younger subjects (ages 10-20).

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