Exercise My Game: Turning Off-The-Shelf Games into Exergames

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Abstract. Exercise video games (exergames) can motivate players to be more physically active. However, most exergames are controlled by confined and predefined movements and do not promote long-term motivation. Well-funded commercial games often excel at long-term motivation, but are not operated with motion input. *Exercise My Game* (XMG) is a design framework for turning off-the-shelf action games into full-body motion-based games. Challenges with this approach involve finding mappings from control input to game-action, as well as blending active input feedback with the game's interface. XMG facilitates transforming well-produced, non-exercise video games into captivating exergames by structuring the design space and outlining game requirements. We illustrate XMG with the example of turning the popular first-person action game *Portal 2* into the exergame *Sportal*.

Keywords: exergames, active games, design framework.

1 Introduction

Exercise video games (exergames) can motivate players to carry out physical exercises and can also provide guidance and feedback to the players. Yet current exergames are controlled by confined and predefined movements. This hinders immersion, since many patterns that players are used to from real-world embodied interactions cannot be employed when playing such games. Furthermore, the nature of current exergames is usually akin to mini-games (or casual-games), with limited story and repetitive game-play. In this manner, they do not make full use of the potential of videogames to create long-term motivation. Well-funded *AAA* games excel at providing deep story lines, high-quality assets and long-term motivation, but are almost exclusively created for standard sedentary input devices (gamepad, keyboard, mouse).

What if it were possible tap the benefits of well-produced, successful, non-exercise video games for exergames? What if one could turn an existing off-the-shelf game title with sedentary controls into an exergame? We present *Exercise My Game* (XMG), a design framework for turning regular video games into motion-based or even exercise-oriented games. It considers four stages:

1. *Choosing a game.* What are the factors in finding a suitable game to "exercise"? We discuss requirements and justify our choice of first-person action games.

2. *Creating a control overlay.* How to map a broad range of natural motion patterns onto established game controls? Our examples encompass physical locomotion for continuous spatial input in combination with a range of exercises for discrete input.
3. *Designing a feedback overlay.* Full-body motion-based input requires different feedback than standard controller input. How to blend motion feedback with the existing game interface and maintain a consistent experience? We show an example overlay that adds necessary information without disrupting the game interface.
4. *Adapting workouts.* Adding motion input to games designed for standard controllers can result in gameplay that is physically too demanding or not challenging enough. Fortunately, many game studios offer authoring tools that allow players to design their own levels, which can greatly aid in creating appropriate workouts. We demonstrate how custom-built levels can provide effective exercise regiments.

We illustrate our framework by turning the popular first-person action and puzzle title *Portal 2*[1] into *Sportal*, a version of the game featuring a full-body motion-based interface. The XMG approach has the potential to bring non-gamers who are indifferent to sedentary gaming but eager to exercise to major gaming titles *and* to generate interest to exercise in avid gamers.

2 Game Choice

Games let the player step aside from everyday life and get immersed in a virtual world. In sports and physical exercising, the equivalent is a state of *flow*, a concept which has also found adoption in the game design literature [3]. In exergames, presence and flow ideally combine to form a unique mental and physical experience [5]. To this end, player motions should be mapped as directly as possible, and both game mechanics and game world must be adequately designed to allow for enaction of the input.

The most obvious type of game to support this are *character-based action games*. In these the player controls the movement of an avatar in order to reach destinations and often needs to physically overcome obstacles and enemies with various actions such as jumping, climbing and combat. Since the avatar is usually humanoid, this provides the perfect target for direct mapping of full-body input.

Games with a *first-person view* that show the world from the perspective of the avatar increase the sense of presence. Since there is no direct visual feedback of avatar motions, they can be used most gracefully in the XMG approach since they offer more leeway in mapping gestural input to standard game controls.

Unfortunately, direct controls restrict the design of mapping physical input to avatar motions. This makes the degree to which such active games can be used for exercising dependent on the design of the game world. In many action games the player needs to traverse long distances, which can be quite challenging if controlled by physical locomotion interfaces. The complexity and large variety of games available means that there are no simple rules for choosing game worlds for a certain workout. However, in many cases this can be addressed with customisable game worlds, as discussed below.

[1] `http://valvesoftware.com/games/portal2.html`, last viewed 2013-07-10

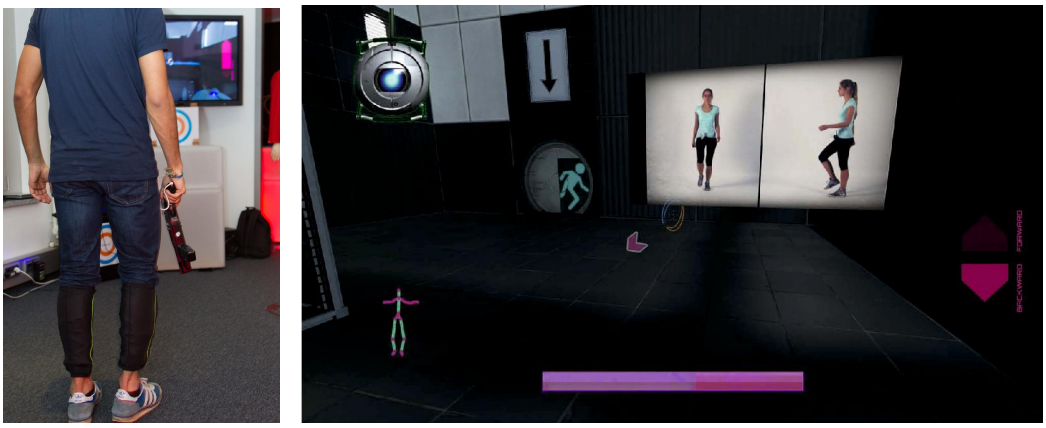

Fig. 1. *Sportal* control setup (left) and screenshot featuring feedback overlay (right, magenta interface elements). *Portal 2* game interface and game assets are copyrighted by *Valve Corporation*.

The two next steps in turning an existing first-person action game into an exergame are to design a *control overlay* that replaces standard game controllers by connecting motion detection to virtual device drivers, and the matching *feedback overlay* that augments original game feedback to support motion-based input. In the following, we illustrate these steps by reporting on how we turned the popular action and logical thinking game *Portal 2* (by *Valve*) into the exergame *Sportal*. *Sportal* features motion input through physical locomotion, a diverse range of exercises, and an augmented graphical display.

3 Control Overlay

The general design problem in exergames is to create full-body gestural controls that are also exercises. In the XMG approach, this is subject to a specific constraint: since the game controls are not changeable in terms of which actions the game avatar can be instructed to perform and which parameters can be used to detail these commands, the full-body motion-patterns need to map onto already defined traditional input-patterns.

While the specific controls of each game differ, standard input patterns have been established for certain game genres. Typical first-person game controls map continuous spatial input via mouse or joystick to continuous motions such as locomotion and aiming, discrete trigger input (hitting buttons or keys) to well-defined discrete motions such as jumping, activating, or firing, and discrete modal input (holding buttons or keys) to continuous input modes, such as crouched movement or aiming modes.

The foundation of the *Sportal* motion interface is physical locomotion. We chose a walking-in-place (WIP) technique, since it provides a good trade-off between natural interaction and technical requirements [1]. The motion tracking setup involves an infrared camera mounted on a gun prop and a Microsoft Kinect. For general locomotion, we used the state-of-the-art low-latency gait-understanding-driven (GUD) WIP algorithm [6] fed by accelerometer data gathered from sensors located on the player's shins. Avatar rotation (view direction) can be controlled by torso stance or aiming the gun.

Shoulder rotations of the player to the left or right commence a view rotation, the speed of which is given by angle between shoulder axis and sensor view plane. The alternative is to point the gun into the desired rotation direction. Heuristics on the relative vertical position of the pelvis enable discrete triggering for jumps and a discrete modal control for crouched walking.

We derived further input motions from interviews with physical training instructors and physicians and developed a gymnastics training regimen consisting of warm-up and workout. This also includes the following additional motion patterns: jumping jacks, a kickbox move, and two exercises of holding a stance. As with locomotion moves, exercise moves are detected using heuristically determined models based on the skeleton recognition provided by the Kinect SDK. Recognised commands are then sent to the game via the virtual gamepad controller *vJoy*[2].

4 Feedback Overlay

The multimodal feedback in most games is optimised for conventional game controls rather than motion-based input. With gamepads, or keyboard and mouse, players receive passive haptic and mechanic feedback from pressing buttons or thumbing joysticks in addition to the visual and audio feedback presented through the game world rendering. However, motion input requires additional feedback on gesture recognition.

Since the game interface usually cannot be changed without considerable effort, the challenge is how to *augment* the existing game interface in order to provide adequate exergame output. While every game interface is different, we can define some similarities. On the graphical level, every first-person game features a prominent view of the 3D game world, usually together with several overlaid 2D widgets. The challenge for a visual feedback overlay is to integrate additional visual information without diminishing the view or cluttering the display. Concerning audio, motion events such as jumping are often emphasised with a signature sound. This is usually clearly recognisable above ambient sound and music. The challenge for an auditive feedback overlay is not to interfere with in-game sound events. Across all available channels, the exergame feedback overlay designer has the choice of whether to integrate overlay as much as possible or to allow for a clear distinction between in-game and NUI controls. Our design choices in *Sportal* will serve to illustrate the discussion.

For *Sportal*, we integrated direct feedback on sensor image/skeleton recognition into the visual overlay. Since this should not be mistaken for a third person depiction of the avatar, we kept it small, stylised and off-centre. A progress bar was added for specific exercises where the player is required to hold a position for a time period. An arrow display at the side provides feedback on walking direction and speed. To support gun-based view orientation, a small marker in the form of an arrow pointing in rotation direction signifies where the gun is currently pointing. The arrow-shape makes it distinct from the in-game cross-hair, which is used for shooting portals in *Portal 2*. The feedback overlay was realised as a full-screen window with transparent background that is rendered on top of the game screen.

[2] `http://vjoystick.sourceforge.net/`, last viewed 2013-07-10

For the audio overlay, we integrated a voice overlay explaining the game controls for a tutorial mode, which was kept in the style of a talking artificial intelligence in order to maintain the game world atmosphere. While we did not experiment with explicit audio feedback, the discrete gestures would most likely benefit from a confirmation sound played when recognition is complete.

5 Adapting Workout with Custom Game Worlds

Control and feedback overlays facilitate turning a well-chosen off-the-shelf game into an active game. Depending on game design, this can result in an experience that is physically either too demanding or not challenging enough, since it was not designed with active input in mind. While we can influence this with gesture designs and gain factors in the control overlay to a certain extent, certain commercially available titles offer further means of adapting exercise workout—content editors.

Many games with a high development budget and large player communities sport tools for user-generated content. These empower regular users to create their own game content in the form of levels or maps. In the context of XMG, such tools offer authority over training regimens. For instance, the *Valve Hammer Editor*[3] is an authoring environment in which levels can be created for *Portal 2* via direct manipulation. We exploited this for *Sportal* by experimenting with map layouts and obstacle courses to influence order and frequency of exercises.

6 Related Work

With the introduction of motion detection systems such as the *Nintendo Wii*, *Sony Playstation Move* and *Microsoft Kinect*, a large number of exergames have entered the market. However, existing titles mostly comprise only simple games that require limited body movements. The market also offers controllers geared towards exercising, such as the PCGamerBike[4]. These can be used in place of regular controllers in order to workout while gaming, but offer only a limited range of motion and often lack appropriate feedback.

Recent research has seen an increasing number of projects on motion-based games and their effects on player engagement and health, as well as investigations into their therapeutic use for specific patient groups. In most cases these involve custom games that are far away from commercial titles regarding quality of assets and game engagement. Only few works have considered adapting off-the-shelf non-active games for purposes of exercise. The GAIM software toolkit [2] facilitates developers of active games to work independently of the device level. This enables easy switching between concrete devices, and even input categories, which the authors demonstrate with two adaptations of existing games, adding pedalling input to a racing game and controlling a 2D spaceship game with player stances. This can aid in changing the input to more

[3] `https://developer.valvesoftware.com/wiki/Valve_Hammer_Editor`, last viewed 2013-07-10

[4] `http://www.pcgamerbike.com`, last viewed 2013-07-10

physically active modes, although not without editing game code. Augmenting existing game visuals has already been proposed in the context of biofeedback games [4]. This approach uses texture-based graphical overlays to obfuscate the underlying game based on the player's physiological state, but heart rate input and feedback do not figure into actual game control.

7 Conclusion and Future Work

Turning existing video games into motion-based games makes use of their virtues of high-quality assets and long-term motivation for exergames and motion-based games for health. In order to aid the transformation from off-the-shelf game to exergame, we proposed the *Exercise My Game* (XMG) design framework. This structures the process into four steps: choice of game, input overlay, output overlay, and game customisation. We applied XMG in turning *Portal 2* into the exergame *Sportal*, demonstrating that with an adequate choice of game, control and output overlay software, and the creative use of authoring tools one can truly *exercise* a commercial video game. This approach can potentially both acquaint exercise-eager non-gamers with major gaming titles, in addition to giving many traditional gamers an incentive to exercise.

We are currently evaluating our approach in an experiment investigating how gamification level affect the motivation in exercising. We also intend to transfer the XMG framework into a software toolkit in order to further facilitate *exercising* regular games.

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