

Virtual Gym: aiding older adults with exercise compliance through serious gameplay

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SUMMARY

Many older adults are interested in activities to maintain or improve their health.¹ Although there are several options for seniors to remain fit, individualized exercise sessions prescribed by health practitioners lead to the best results.

Virtual Gym is an exercise platform for health practitioners to provide game-like exercise for older adults, with individualized configurations to match the user's capabilities. Virtual Gym effectively connects health practitioners with older adults, particularly during this pandemic time of social distancing.

Introduction

Physical and cognitive abilities decline with age. In addition, lethargy increases the vulnerability of the elderly population — several factors could obstruct them from exercising regularly, such as limitations related to mobility, finances, transportation, or weather. Serious games (SG),² and more specifically Silver Games,³ are useful tools to encourage older adults to exercise at home.^{4,5} However, current commercial games are focused mostly on healthy young adults. Adapting commercial games correctly for older adults can be challenging, and it certainly requires the presence of a health practitioner to supervise and provide the necessary adjustments to suit a commercial game into a silver game. One recent example is tailoring the game "Kinect Sports Bowling" for people with dementia residing at a long-term assisted living facility.⁴

Virtual Gym is a Serious Game exercise platform. For health practitioners, the editing capability supports their expertise in guiding older adults in a personalized exercise session. They can create or edit their exercise catalogue, monitor their patients' exercise sessions, and analyze the data being collected. For older adults, the gameplay catalogue prioritizes the importance of the design so that they can understand the activities. Additionally, the customized configuration adapts the gameplay to the needs of individual

seniors by providing intuitive interactions and guidance within various game metaphors, similar to having a personal trainer.

Background

The purpose of Virtual Gym is to support health practitioners, who may work with many seniors, and to aid older adults in their daily exercise sessions. The platform provides individual exercise prescriptions while offering activities that are physically demanding. The platform also has built-in personalized interaction settings with a cognitive challenge. The Virtual Gym Editor Tool⁶ assists practitioners to add or edit existing exercise prescriptions to the catalogue by following a few simple steps.

The Virtual Gym Editor Tool makes it easier for the practitioner to describe the posture. A posture or body pose is a specific configuration (position and orientation) of a set of joints (hip, hand, shoulder, elbow, or knee).

The design is centred on older adults' needs, and it highlights the importance of understanding the activities. When designing the prototype, it was important to facilitate interaction with the game mechanics. Examples of design elements include a simple environment creation, uncomplicated mechanics, and short and easy-to-follow instructions.⁵

The Virtual Gym's creation team includes occupational therapists, computer scientists and older adults. We collected and analyzed information through a three-phase evaluation (Pilot usability; Remote usability, and Effectiveness). Input from practitioners and seniors enabled us to identify requirements that can help both groups.

Virtual Gym Platform

Virtual Gym Editor

Embedded in Virtual Gym is an innovative language, and health practitioners can use the editor tool in Virtual Gym to describe each exercise as a sequence of postures.⁵

In a few simple steps, a practitioner can create a proprietary exercise catalogue. First, the practitioner demonstrates the exercise facing a full-body tracking camera. Next, the editor facilitates the capture of body posture to create an exercise session as a sequence of body poses.

The editor tool includes an optional feature that allows the practitioner to adapt a given exercise to a specific client according to their capabilities. The practitioner can configure the individual profile by inputting specific information about the user's range of movement and velocity per joint.

Practitioners can create a catalogue of exercises once and then personalize them for multiple clients.

Virtual Gym Play Platform

As we mentioned before, the platform has two parts. One component is dedicated to health practitioners to facilitate the prescription of personalized activities. This device supports stretching and balancing exercises.

STRETCHING AND BALANCING EXERCISES

This gameplay is inspired by the game Simon Says. The user embodies a transparent avatar on the screen, which overlaps with a coaching avatar, who demonstrates the exercise to the user based on the guidance provided by the health practitioner. The user mimics the coaching avatar poses, and the platform monitors the user's postures and movements to compare them with the specification, providing feedback in real-time as needed.

VIRTUAL GYM^{VR} IN VIRTUAL REALITY

The other component is the Virtual Gym play, which is compatible with various devices, such as Orbbec and Oculus-Quest. Hence, the exercise description is connected to the gameplay. This device supports immersive and enjoyable gameplay experiences.

Virtual Gym includes a variety of virtual reality games. Each gameplay is designed around a specific exercise goal. It stimulates the user to assume the correct postures using the proper joints and upper limbs in the virtual environment.

The virtual reality paradigm has two main advantages. First, the full immersion helps the user to embody an avatar and immediately identify themselves in the virtual environment. Second, the first-person perspective facilitates the expansion of the routines available in the exercise catalogue with the inclusion of three-dimensional dynamics, limbs' coordination, and rhythm.

The Virtual Gym games' catalogue is classified into three categories based on their mechanics.

The first category encourages users to adopt a coherent body posture, by using simplified interactions of their hands touching virtual objects.

1. Virtual Gym^{VR} Bubbles

This game requires the player to use both hands to reach pairs of bubbles in a series of stretches. To reach the bubbles, the player must stretch up, down, and to the side. This game assists the user to assume the correct posture as they play, encouraging them to exercise. This is the simplest game because the player doesn't need to learn complex interactions.



2. Virtual Gym^{VR} Balloons

This game introduces a different interaction for the left and right hands. The player can use their left hand to pop balloons and their right hand to push balloons around. Unlike in the bubble game, the player has to touch the balloons with both hands at the same time.⁷

The second category of games requires coordination of upper limbs. When the player makes the correct motion, they advance in the game. Movements include grabbing, holding, pointing, pulling, and pushing. The platform tracks movements and the position of the virtual objects based on the exercise description.

3. Virtual Gym^{VR} Archery

This game requires the player to make a sequence of coordinated movements to hold the bow and arrow. The movements in this game coordinate the hands together to grab the bow and arrow, then extend one hand to point the target. The target appears in front of the player and gradually moves up and further away from them. The Archery game places the targets at the proper length and elevation based on the posture information.⁶

4. Virtual Gym^{VR} the Climbing game

In this game, the user reaches and stretches in a step climbing environment. Participants attempt to climb a mountain using the controllers to reach climbing rocks and advance at a proper rhythm to grasp the next climbing rock with coordinated hands to reach the top. The placement of the rocks and the climbing speed are calculated based on the exercise description.

The third category is a combination of a) body postures, b) limbs coordination, and c) rhythm. This category is continuous play with no posture corrections. Each exercise session has an individual configuration to promote physical and cognitive activity with rhythm and coordination.

5. Virtual Gym^{VR} Rhythm Saber

This is an adaptation of the popular game Beat Saber. In this game, the users grab two distinctly coloured lightsabers, one in each hand, while coloured blocks appear on the horizon. The players must cut the blocks in half, following the direction indicated on the

block. Several two-colour blocks are placed in front of the users with a sufficient distance to coordinate their movements. The position of the blocks stimulate the users to adopt the postures when they slice the cubes with the correct direction and hand. This game supports an additional cognitive challenge when the lightsaber switches colours. The personal configuration of the gameplay sets the position, orientation, texture, and the speed of the cubes. Each exercise session has an individual setting to promote physical and cognitive activation with rhythm and coordination.



The third category is the one with the most potential for older adults. Its continuous playing makes the mechanics enjoyable for older adults. The user does not perceive the exercise as an obvious adaptation from the exercise description file. Also the user feels more successful and relaxed when the game does not demand perfect performance.

The purpose of these games is to get the user to focus on playing the game while the platform takes care of monitoring the exercise.

Virtual Gym Data Analysis

The Virtual Gym platform recognizes joints on-demand. It gathers information about the joints continually during the exercise session. Based on the data collected about the joints, the platform makes suggestions for the practitioner to consider inline with predefined goals. Practitioners can replay their client's session, using an avatar to examine details

from multiple points of view. The platform allows the practitioner to tag precise segments for future adjustments.

Compatibility

The Virtual Gym platform works independently of any particular hardware. While Virtual Gym is compatible with numerous devices, the platform concentrates on all-in-one devices, i.e., [Orbecc Persee](#) and [Oculus Quest](#). Such devices are more affordable, easy to transport, install, and deploy. As additional systems come on the market, they can be easily incorporated to the platform.

Conclusions

The Virtual Gym platform is a tool to improve the quality of life of older adults. The purpose of the platform is to extend the capabilities of health practitioners to provide personalized activities for their clients. It is a complementary option to exercise on-demand and does not substitute face-to-face exercise sessions.

The play component offers a game-like experience specially designed for older adults. The platform provides personalized gameplay with an individual configuration to match the user's capabilities. These activities aim to be cognitively stimulating and physically demanding.

The platform is independent of specific hardware and capable of adopting emerging technologies, such as full-body tracking cameras and immersive devices. The exercise routine files will continue to be compatible with future devices.

Health practitioners can offer these services within a short space at their clinics or prescribe the activities to complete at home. The clients can lend the device from the clinic or buy a personal system for a minimal fee as early adopters.

Next Steps

We are migrating the system online to deploy it as software-as-a-service, and we are targeting older adults and health practitioners who are eager to participate as early adopters.

If you are interested in participating in the trials or for more information, visit the [Virtual Gym website](#) or email [Victor Fernández @ vf@ualberta.ca](mailto:vf@ualberta.ca).

Here's a quick promotional video on how Virtual Gym can help you:

About the Authors

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Victor Fernández, PhD, is a postdoctoral fellow at the University of Alberta. He is interested in Serious Games design to aid older adults with their exercise routines. He is the CEO and founder of VIRTUAL GYM. His research focuses on creating enjoyable virtual experiences for older adults that guide them through personalized exercise routines.



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