

Augmented Reality Rehabilitation for People with Osteoporosis: Squat exergame (a demo)

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Abstract

In Ireland, osteoporosis is one of the greatest societal and economic health challenges, affecting between 300,000 and 500,000 people [CJ23]. A 2019 European report noted that Ireland has one of the highest rates of fracture in Europe, while the costs associated with managing fractures was 7.2% of national healthcare [JA21, JA22]. Physical exercises are considered to be a powerful non-pharmacological strategy for people with osteoporosis and/or those who are at risk of falling [Dio14]. Notwithstanding the positive impact of physical exercise, the participation in and adherence to an exercise regimen by older adults is often low due to inconvenience (i.e., lack of time, lack of motivation, accessibility issues), fear (i.e., falling, safety), cost and/or boredom [OYWALSRDKV18]. Exergames are defined as games requiring the participant to be physically active; they can be delivered through augmented reality (AR)/virtual reality (VR) [Oh10]. Despite the potential of AR task-oriented physical therapy training and exergames for people with osteoporosis, there is a notable paucity of research in this area [GNG20].

As part of our research, five physical therapy exercises targeting older adults with osteoporosis have been approved by a chartered physiotherapist, an occupational therapist and two Rheumatologist consultants at Galway University Hospital. We are currently in the process of mapping these physical therapy exercises into a set of five AR exergames. The design of these AR exergames is underpinned by a systematic literature review (in the final stages of publication) and existing guidelines. A formal investigation of the impact of AR exergames in improving balance and reducing the likelihood of falls for people with osteoporosis will take place next year, with control and intervention groups.

Our demonstration is a first version of one of these AR exergames which reproduces a squat exercise. During this exergame, the player wears an AR headset (Microsoft HoloLens 2). When they start the exergame, a menu of different levels is displayed. The player selects the level appropriate to their abilities, after which a series of clouds appear and move toward them. The goal is for the player to avoid the clouds using a squat movement. As they perform the exercise in a gamified context, the relevant biomechanical points will be checked to ensure correct alignment and the delivery of appropriate feedback. To check the status of the biomechanical points, this exergame uses a body tracking camera (Azure Kinect 2) to provide direct and real-time feedback. Ultimately, this squat exercise AR exergame will be incorporated into a series of exergames, which will adapt to the capabilities and preferences of the player with osteoporosis.

CCS Concepts

- **Applied computing** → **Consumer health; Interactive learning environments; Social and professional topics** → **Seniors;**
- **Human-centered computing** → **Wireframes; Computing methodologies** → **Mixed / augmented reality;**

1. Floor Plan

Note: The demo is a first version of the squat exergame which will be available for the Microsoft HoloLens 2 by the end of November.

Our AR exergame is part of a set of five exergames which have been designed to improve balance and reduce the likelihood of

falls for people with osteoporosis. Exergames are defined as digital games which require the player to stay physically active in order to play the game in a task-oriented and gamified context. This demo requires the player to perform a squat exercise to progress in the game. The player can select a level from the menu displayed at the commencement of the game. The levels comprise; demo, level 1, level 2 and level 3, and are differentiated by the associated settings

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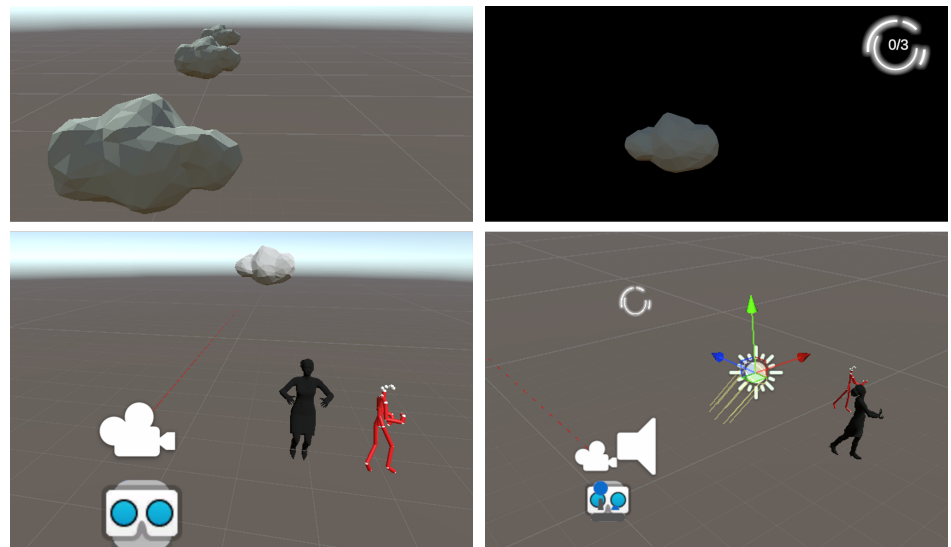


Figure 1: (a) iteratives clouds instantiation; (b) screen displayed; (c) and (d) Unity scene with body skeleton, avatar and game items

(i.e., number of repetitions, set structure, speed of objects etc.). In the context of this squat exergame, when the player selects a level, the game starts with the adapted settings and clouds are instantiated. A delay of 6 seconds is given between each cloud instantiation to give the player time to perform the squat exercise and rest. Feedback is displayed after each repetition according to how the player performs. Feedback is adapted to the player's posture and movement made in front of the camera. If the movement is not going deep enough or the back is not sufficiently straight, feedback will be displayed which will help the player adjust and ameliorate their position. This squat exergame in addition to the other exergames in the set, has been approved by social and health professionals.

Regarding specific setting:

Technological: Our game requires an Azure Kinect. A more developed version using the Microsoft Hololens 2 and including additional interaction will be ready by end of November.

Additional material: Our game requires one chair, a tripod and a non-slippery surface.

Space: The player requires sufficient space to allow them to stand behind the chair while holding on to it, and practice squats. The Azure Kinect needs to be placed to the side of the player, at a distance of 2meters and at a height of 80-100cm.

Lighting: While no specific lighting is required, the light needs to be on, but should not be too bright.

Audio: There is no audio requirement.

Time to set up: 20min.

Number of people required: 1.

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