Physical Training of Seniors using Robot Based Games*

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***Abstract*— Physical activity improves the overall health and the level of self-sufficiently of seniors, but it is often difficult to motivate seniors to train hard and enough long using traditional training exercises. We have developed a robot-based training solution which motivates to do more frequent and longer periods of training based on a mobile robot platform. It is a supplement to physical training with occupational- or physiotherapists and the solution has been evaluated in in a nursing home for a 10-week period.**

I. Introduction

Due to the demographic challenges of Europe with an increasing older population, it is required to create new ways of training and motivation of seniors (+65) to achieve active and healthy ageing [1]. We have developed a robot game engine called ROGAMO using a mobile robot platform and Open Source software. Our solution allows us to develop different games tailored for seniors based on recognized training exercises. Robot games serve as a natural and enjoyable way to stay active as the social characteristics of an autonomous robot makes training captivating [2][3]. The benefits to individuals are better overall health, maintaining mobility and self-sufficiency. From a societal point of view, the economic benefit is that seniors need less care, i.e. that the cost of illness and injuries are reduced. We are using a mature telepresence robot platform and have implemented a software platform to control the robot safely in a dynamic environment. We have developed three games tailored to seniors focusing on user-friendliness game competition elements. The solution has been evaluated for a 10-week period in a nursing home in Denmark. Although the research is very initial we have received positive feedback from seniors and therapists.

II. System Description

Driven by the exponential growth of smart mobile technology, it is now possible to develop robot solutions for the masses at affordable price levels. Consequently, the costs mobile robot platforms have dropped dramatically the past five years to a fraction of the price. The abundance of Open Source software, additionally opens a new window of creating robot solutions which can be used in areas novel areas including training of seniors using robot based games.

A. Equipment

In order to ensure robustness, we have chosen to rely on mature hardware technology using a commercially available robot platform. The advantage of this approach, is that it reduces development risks, while giving the opportunity to develop robot games that are robust enough to be used in the real world. We have chosen to use the Double telepresence robot from Double Robotics which is basically a tablet on a mobile robot base [4]. It can be programmed for lots of different purposes using the public available SDK. Additionally, it is a very robust and safe platform, being useful for indoor navigations tasks. The platform works with any iPad and has an 8-hour battery life and two odometers. Using an Apple iPad, we additionally get access to the following hardware:

- A 9.7-inch widescreen with multi-touch display
- Accelerometer - Used for navigation and detection of collision and push
- Gyroscope - Used for adjusting the orientation of image
- Digital compass - Used for navigation in game implementations
- Front camera - Used in game implementations
- Built-in speaker - Used in game implementations
- WI-FI/3G Connection - Used to connect to a data broker and based image analysis unit

B. Software Architecture

The overall architecture of our solution consists in three elements:

- **The robot software platform** which holds the generic robot engine, a game-layer, a number of implemented games and the low level control of robot
- **A web platform** which holds data and statistics about the games and the robots using the system
- **A data broker** based which mitigates data between the two former parts.

The software architecture of the robot is based on a four-layer stack:

- **The Low Level Motor Control** of the robot platform consist in the firmware and SDK which comes with the Double Robot. It includes simple commands for making the robot moving forwards, turn and adjust the height of the head. It also returns readings from the odometers.
- **The generic robot engine** includes the most basic commands for controlling the robot including moving the robot a fixed distance, detection of the robot has

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collided with an object and detection whether the robot has been pushed.

- **The game engine** binds the game applications together with the robot engine. This layer is also responsible for communicating with the corresponding web platform.
- **The game applications** are built on top of the game engine. This layer includes the visual graphics of the game and the corresponding sound. Besides. It also includes a screen for adjusting the relevant parameters for each game, including speed, radius, force of touch etc.

C. *Implementation of Games*

The training exercises we have created, are light to moderate workouts implemented as interactive games, in which the robot proactively engages the seniors to participate. The design of the specific games, have followed these principles:

- Simple, recognizable narrative that is easily understood
- Extremely easy gameplay and objective, including an uncomplicated competition element that makes it more engaging
- Strong visual and aural stimulus using simple and easily recognizable images and sounds

We currently have implemented and tested three games using our robot engine:

Throwing eggs: In this game, two players are standing a couple of meters apart facing each other. The narrative is that the players are throwing an egg back and forth between them, bringing back memories from when the seniors did this as children. The robot acts as the egg and an egg is shown on the tablet's screen.

Rope Swing. The robot acts as a swing with a little girl showing on the tablet's screen. When pushed, it moves away in a straight line decreasing its speed as a swing would do before reversing and coming back while increasing its speed. If you touch the upper third part, the push is considered a powerful one. If you touch the lower part, it is interpreted as a medium or weak push respectively.

Pong: This game is for 2-5 people and the players are placed in a circle. The robot acts as a "ball" being thrown back and forth between the players. When sitting down, the robot trains the upper torso, as well as eye and hand coordination. When standing up, the game trains balancing and walking sideways.

III. EXPERIMENTS

We have evaluated all three games on a specific and steady target group consisting of four participants in their 80'es. Three women (A, H and T) and one man (E). In the first two games, only H and T participated. All of the participants of the steady target group suffer from dementia in different stages, and hence the games have to be very simple.

Although our research is very initial we have received positive feedback from the institutions that are currently evaluating it. More specifically, we have received the following testimonials from the therapists:

- *"The citizens appeared more lively after the first training session with the robot"*
- *"The citizens laughed several times during the sessions and there were a lot of smiles"*
- *"The citizens talked about the robot and the training after the training sessions"*

Therapists not directly part of the testing sessions have approached us on multiple occasions to hear more about the robot games and how they might include it in their training sessions to make their sessions more fun, motivating and engaging. Even minor adjustments to the physical appearance of the robot is a key in engaging the seniors in playing. We have found that nothing should be confusing and distracting, meaning that everything must be simple, or else it will become too difficult for the seniors to play the game.

We observed how the participants in our testing sessions gradually became more confident around the robot. Following several training sessions, the participants gained more comfort around the robot and were more engaged physically, i.e. using their wheelchair to move around to catch it and also pushing the robot with much greater force, as well as cheering and encouraging chants from the various participants towards the player that the robot targets. It is possible to see a video of a training session at: http://www.rogamo.com/rogamo-game-testing/

IV. CONCLUSION

Although our research is very initial, our solution has so far demonstrated to be are an enjoyable way to stay active and to be a useful tool for therapists. Robot based games can potentially save resources by engaging seniors to become healthier and more independent by being more active in their everyday life.

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