The NAO models for the elderly

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***Abstract*— This paper highlights initial observations from a user study performed in an assisted living facility in Spain, in which we introduced the NAO to assist regular physiotherapy practices. The NAO is introduced in order to take on one of the usual roles of the physiotherapist: modeling movements for the inpatients. We also introduced a virtual version of the NAO in order to see whether this role of modeling is equally effective in a screen-based or in a physical manner. Preliminary results show the inpatitens adjust their movements to the NAO, although they react differently to the virtual and the physical robot.**

***Index Terms*—elderly's behavior, physiotherapy, NAO.**

I. Introduction

The increase in the number of elderly in Europe over 65 by 2050 is estimated to reach the percentage of 70%. This number poses a challenge to traditional health care practice, which will need to find ways to accommodate this higher demand for healthcare [1]. Eyes are turned therefore to come up with methods and new tools to improve the effectiveness of health practice.

In this line, there has been research around applying methods and tools borrowed from other realms, like video games [3][4]. As an example, some have used high tech sensing devices from known game consoles, like the Wii [3]or the Kinect [4] and have taken advantages of its powerful sensing mechanisms in application scenarios where tracking movements is relevant for the rehabilitation [4] .

In this paper, we present preliminary observations from a user study in which we used the NAO robot from Aldebaran [5]. The user study is performed in an assisted living facility in Seville (Spain). This is a follow up of a former study in which we used a low-tech prototype to research the role of the technology in the setting of geriatric rehabilitations [2].

In this case, we specifically assigned the technology a concrete role: assisting the physiotherapist in modeling the movements performed during the physiotherapist interventions.

We are interested in researching the assistance that such technology could potentially provide in a similar setting.

Although we were mainly concerned about providing a three dimensional feedback similar to that of the physiotherapist, we also wanted to explore how feedback from a screen worked for the inpatients.

II. Background

The starting point of this study is a previous user study performed in the same assisted living facility [2], which was born to the light of the needs of that specific place: Their physiotherapist reported that some motivations why some of the elderly attended and required rehabilitation interventions were probably the emotional bond they shared with him, and the socializing element and personal attention the inpatients receive during one-to-one physiotherapy interventions.

Despite this reason seem to be enough for many inpatients who attend to the interventions, it also bring negative side implications, like some inpatients also "using" that emotional bond and demanding more indulgent and less demanding rehabilitation sessions (e.g. less repetitions).

In [2], they realized that introducing a piece of technology in the physiotherapy interventions changed this dynamic by changing the roles of the physiotherapist and the behavior of the inpatient in an interesting way: the technology became "the bad cop" whilst the physiotherapist and the inpatient joint forces to "beat the system".

Following up on that previous study, we would like to research different settings with different configurations in terms of roles, responsibilities, and capabilities of "the players" on the scene: physiotherapist, inpatients, and technology.

III. Methodology

We programed the NAO robot so that it could perform 9 exercises that were previously specified by the physiotherapist of the assisted living facility. These exercises are performed with regularity in their rehabilitation sessions.

We used also the NAOSim provided by Aldebaran to be able to record the virtual version of the NAO doing the exact same movements. This would comprise our virtual version of the physical NAO.

The workshop consisted in one-to-one sessions. Thirteen inpatients participated in these individual sessions. Two researchers were also present during the rehabilitation. We recorded the sessions with two cameras, capturing different angles of the scene.

The exercises were randomly assigned to one of these three conditions: 1) Physiotherapist only: The exercises will be done as usual. 2) Physiotherapist + virtual: The physiotherapist will use a virtual representation of NAO to show the movement and the inpatients should mimic it. 3) Physiotherapy + robot: The physiotherapist will use NAO robot to model the movement and the inpatients should mimic it.

In addition to the 9 preset movements, we also designed and implemented, in collaboration with the physiotherapist of the centre, a list of associated wrong movements for the virtual and physical NAO. These movements are selected since they are frequent mistakes or inaccuracies that inpatients usually do in the execution of the required movements. For example, while the abduction of shoulder some of the elderlies tend to lean their torso to the side at the end of the movement. During the study, the physiotherapist was free to trigger the different inaccurate movement whenever necessary by touching one of the sensors in the NAO's forehead, for example.

IV. Initial Observations

Even if the analysis of the video sessions and the interviews are still on going, we already have interesting on site observations:

The speed of the execution of the NAO's movement seems to be a very relevant element to take into consideration. The movement of the NAO was usually slower than the inpatients in the first sessions. This made that the physiotherapist encouraged the inpatients to follow their own pace.

We changed in situ the speed of the movements and observed and interesting behavior:

- When the speed of the movement was similar to that of the inpatient, she or he usually paid more attention to the movements of the NAO. In cases in which the execution speed was different, the inpatients were less focused.

When we increased the speed of NAO, many inpatients seemed to synchronize their movements more during the exercises. Still there were some exercises done by NAO that had a slower velocity than the inpatients, which entailed that the inpatient didn't follow the robot that much. So it seems that there is a region of time when if NAO is quick enough and the inpatient and it will synchronize each other. This relates to some other effects we noted:

1) When the inpatients did the movement in synch with the robot, their velocity would decrease causing an improvement of the movement's technical quality.

2) This seemed to give the inpatients the opportunity to pay more attention to the technique of the movement, and movements seemed to be more precise than usually.

3) On the other hand we also observed a negative side effect: the limitations of the robots were also mimicked by the inpatients. If the robot would have some limitation doing the exercise as a hardware limitation (that is a smaller range of movement) the inpatients will mimic this limitation causing them reaching less space than they could reach.

V. Future work

We are doing an analysis of the videos, questionnaires, and iterviews from the study. We are focusing on the performance of movement, as well as the behavior of the elderly in relation to the exercises and the NAO.

We have plan a next study, in which we are giving a step further in the distribution of roles among the technology and physiotherapist: a system in which the technology is in charge of both the modeling and the output or judging. We would like to see whether this automation would make for the more pedagogical role of the physiotherapist. In order to do so, we are planning to use the use Kinect from Microsoft.

Acknowledgment

We would like to thanks all the people from the assisted living facility "Nuestra Señora de la Soledad" (owned by Tocina's town council, and Fonserrana S.C.A de interés social).

Special thanks to the elderly participating in this project, to the staff, who gave us their completely support.

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