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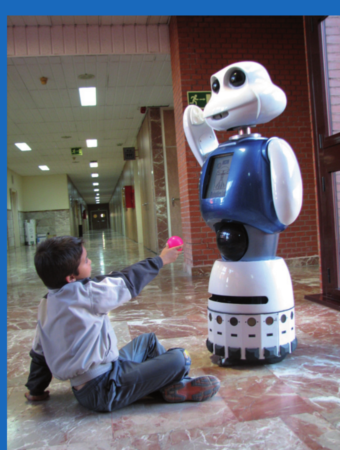

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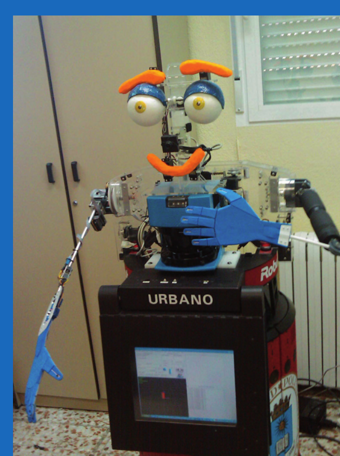

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CAPÍTULO 12

ROBOTS APPLIED TO DEMENTIA: A PRACTICAL EXPERIENCE

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Personal assistance robotics has increasingly become an importante focus of attention in robotics research in recent years. The age of the population is growing and it requires more resources to their care. Robots are becoming a good alternative to ensure elder care. This application requires a collaboration between reasearches on health and robotics disciplines to develop new metohodologies and tools for assitive robotics. This article describes the experience of several years on using robots in therapies for dementia patients. We present the key features of the study, the main actors involved on it and the methodology developed. Our intention is to describe the methodology carried out in order to be useful for scientific who start similar iniciatives. This study has been carried out with real patients and real robots in collaboration with a centre of research in neurodegenerative diseases. As a result of the use of the robot in therapies, we achieved a slight or mild improvement in neuropsychiatric symptoms over other traditional therapy methods.

1 Introduction

Traditionally, Robotics is focused on developing robots which help humans to perform dangerous or tedious tasks. In recent years, robotics has evolved from traditional industrial or research to home environments where robots share this space with common people for being a companion or helping the daily task. In countries like Japan, where the population is becoming older, the robots are emerging as the caregiver of the future. For this reason, the assitive robotics assistance is receiving an increasing attention. In assistive robotics discipline not only researchers are involved, but doctors and psychologists. The basic idea is to design platforms and applications adequately to support humans who require special care due to illness or their old age. Assistive Robotics occupies a preferential role in AAL technologies (Ambien Assitive Living), focused on designing future spaces where humans (specially old or sick peope) live constantly assisted by the resources that technology can provide.

The application of robots in the therapies on cognitive disorders have focused mainly to autism and dementia. Unfortunately, most of the work is focused on the development of robotic platforms handcrafted whose replication is not enough affordable for a widespread application. Often, the design of these platforms has no the direction of groups of psychologists, resulting inefficient to the goals pursued initially. In recent years, emerging commercial robotic platforms are carefully designed to be visually pleasing and to awake human empathy, suitables for asstive or pets applications. Moreover, the cost of these platforms is affordable, providing spare parts and repair services. These factors are crucial when you want to generalize healthcare applications.

This paper provides a practical experience in the application of robots in therapy in patients with dementia. This is intended as a reference for scientists who start similar studies. When we began this study there was not similar experience as references. Even today there are serious works like this. The goal of this study is developing an effective tool which can be used by therapists during cognitive therapy sessions and so enhancing the effect of the existing therapies without robot. This was carried out in several stages in which sequentially analyzed robots accepting candidates, the viability of the approach and long extensive analysis. Failure in any of these phases would have led to the complete rethinking of the study, or even cancellation. Fortunately, the phases have performed reasonably successful to initial expectations.

We will describe this study, conducted with real patients, real environments and real robots during a period of just over two years. The working group consists of researchers in robotics and researchers in neurodegenerative diseases. After an initial evaluation, which will be described in this article, the robotic platform is the humanoid robot Nao (Fig. 1). The technical description of the infrastructure has been widely presented in

(Martin, 2013) , but the goal of this paper is giving a strong review of the application of robotic technology analysis.

Fig. 1. Humanoid Robot Nao

After presenting the works related with this study and the metodology used, the steps of the study will be described in a chronological. In section 5 will provide quantitative results of the study with a real robot with real patients.

2 Related work

In recent years there have been an increasing interest in AAL technologies. There are several projects in the eurpean FP7 program which support this research field: Mobiserv[11], Companionable[12], Domeo[13], Florence[14], KSERA[15] and SRS[16]. The goal of these projects is to design an environment for elderly care, where robots are fundamental pieces of interaction. Of these projects have emerged overviews systems (Pigini, 2011) and methodologies (Garzo, 2012) (Renteria, 2012) generalizable. (Broekens, 209) systematic reviews the literature on the effects of social robots in the health care of the elderly, especially in the role of company for the patient. The robotics platforms are wheeled, equipped with tactil screens to interact

[11] http://www.mobiserv.eu/
[12] http://www.companionable.net/
[13] http://www.aal-domeo.org/
[14] http://www.florence-project.eu/
[15] http://www.ksera-project.eu/
[16] http://srs-project.eu/

with humans (Fig. 2). Among the works of robotics applied to therapy, we can reference the works carried out by the Aurora project with children with autism (Ferrari, 2010) and several robotic platforms.

Prof. Mataric Matja also pioneered the development of robotic platforms for therapy with autistic children and with dementia (Tapus, 2008) (Tapus, 2010). The platform is handcrafed (Fig. 3, right) and the experiments are limited to small test without a rigorous medical analisys.

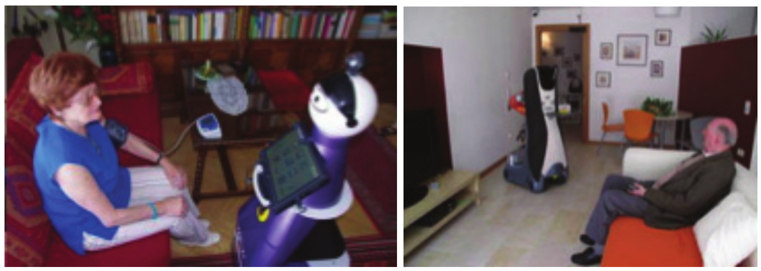

Fig. 2. Robots involved in FP7 AAL projects

The robot Paro (Fig. 3, left) is probably one of the commercial robots applied to cognitive therapy better known diseases. His appearance baby seal awakens empathy for patients, but their capabilities are very limited limitdas and making sounds and moving the eyelids in response to touch. The only work that provides experimental results to its application is (Wadal, 2007). In this paper, the robot is a passive element placed on the table in a residence. This robot catches the attention of patients and gathers around the robot, measuring the increase in the interaction between patients, motivated by this congregation.

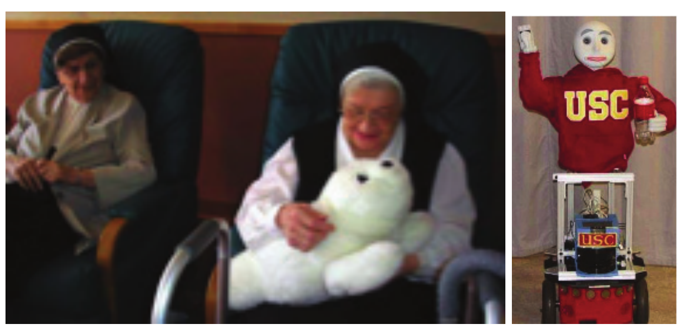

Fig. 3. Robot Paro (left) and robot developed at USC (right)

3 Robot evaluation

The physical appearance of a robot is crucial in relation to a human. If a person feels intimidated or anxious about the robot, the interaction will not be full. If the objective is to awaken a positive reaction from a patient, this factor should be taken into account. There are several studies on the acceptance of a robot by human beings. Probably the most famous is the case of the uncanny valley (Masahiro, 1970). This work relates the degree of acceptance of a robot as a human appearance when it approaches to the human one. Figure 4 can see how our brain reacts to rejection when a robot looks too much like a human, without being exactly identical. "Rejection" is a strong word, but it's reality, and we should pay attention to this factor. Besides the similarity to a human, factors as the relative size with respect to the patient or the robot design are important for a nice and effective interaction.

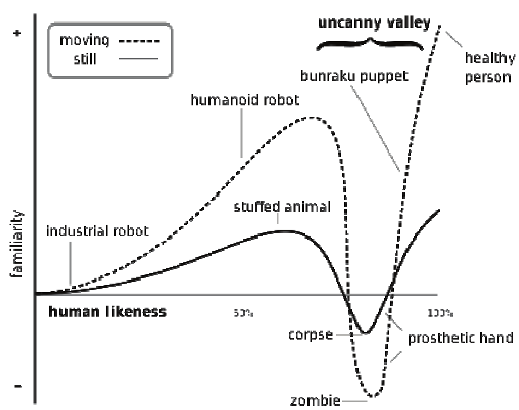

Fig. 4. Uncanny Valley

The first phase of our study was to evaluate the platforms available at the time by our group: the seal robot Paro, the robotic dog Aibo and the Nao humanoid. This test was carried out with patients of moderate/mild dementia grade. We presented the robots at duty and several experts analized the reaction of the patients. In all cases patients paid attention to the robots and they did not feel intimidated by the robots. They were very likely to interact with them. The seal robot Paro made the shortest reaction due to its limited capabilities. Experts believe that this robot is designed to make arise feelings of empathy for the patient, and so its application is more effective applied to patients with autism. The other two robots had a longer effect. We were afraid that they would not feel interested for any of them, or they could produce any fear on them. With this results, we considered this test as satisfactory.

Fig. 5. Robot evaluation session

Once identified the reaction of the patients, we had to take a decission between Aibo and Nao. Both of them are equipped with the basic elements needed for the desired interaction: cameras, microphone, lights, speakers and touch sensors. Our recommendation was the Nao robot because it is easer to develop application for it, repairs and the human design is useful for phisiotherapy sessions.

4 Designing therapy sessions and interfaces

Therapy sessions with patients with dementia aim cognitive and psychomotor stimulation. Cognitive stimulation therapies were based on riddles problems, calculation, memory stimulation and music therapy. There is also a separate session of physiotherapy, conducted by a physical therapist, patients trying to conduct a basic gymnastics in the best of its ability.

The first option was to adapt these therapies to be performed by the robot, always controlled by a therapist or physiotherapist. The session were coded into sequential scripts. It is essential that a therapist design of the robot actions to be carried out in the therapy sessions. The robotics expert can only advise which actions the robot can perform and which not. It is important to share with therapists that the robot will always be a tool that enhances the effect of their work and that the robot will never replace the therapist. The collaboration of the therapist is key to the success of the project and if this point is not clear, there may be fears when collaborating in the study.

Fig. 6. Tecnical support during a session. Therapist uses a Wiimote to teleoperate the robot

One of the main tasks of roboticist is to provide the effective tools to therapist to properly control the operation of the robot during therapies. The robot is always connected to a wifi network, which could send commands to the robot. At initial, the therapist was assisted by a technician (Fig. 6) connected to the robot. Its unique interface with the robot were the buttons, which were used to advance the therapy script. The technician was who tele-operated robot to walk or move his head to simulate patients watched it. Subsequently, we used a control equipped with buttons and accelerometers (Wiimote) for the therapist to control the movement of the robot. Finally, the therapist's tool is a tablet which controls the movement of the robot and random access to any point in the script.

5 Study design and evaluation

The study aims to measure the impact of the robot as a tool in therapy. This study was conducted in several phases. At the end of each phase an evaluation was made based on the recorded video. The following describes these phases and features:

Fig. 7. Therapy session with real patients

1. **Pilot study**: Two groups of patients (mild and moderate) of 10-15 patients. Sessions of 30-45 minutes each. The duration of this phase was three months and aimed to test the feasibility of this approach.
2. **Extensive phase**: Three groups of patients (mild, moderate and severe). We compared three types of sessions: with robot with robot robot off without. This study was carried out in three control groups with 10 to 15 patients for 24 months. During this period there patients who, due to the degenerative nature of their condition, migrated group.

To evaluate the effects of using the robot in therapy, all sessions are registered on video for 3-4 cameras (Fig. 7) located at different positions to cover the reactions of patients. Neurodegenerative disease experts analyze these videos to compare the effect of the sessions with robot and robot sessions. Measure factors such as apathy, aggression, etc ...

6 Conclussion

Some preliminary medical results have been presented in medical forums and are better explained in [15]. All scale showed a trend to improvement in neuropsychiatric symptoms, apathy and quality of life, although Wilcoxon test showed no significant statistical differences betwee baseline and follow-up. Patients accepted well the robot and participate as actively in therapy sessions with robot as in the regular sessions.

This study showed that a clinical study using robots for cognitive therapy in dementia institutionalized patients is possible. Currently we are using robots as a new tool for dementia therapists in a pilot clinical assay to discover the effect of this new non pharmacological treatment compared to habitual treatment. We involve more than a hundred patients, use a control group to compare and the evaluators are blind to the therapy.

Beyond the medical results, we have proved an effective methodology to analyze the impact of a robot in therapies. As weaknesses, you should increase the number of patients on this study and limit its duration for the groups are constant and are not unduly affected by the evolution of the disease. The next steps are to increase the study population, redesign therapies to increase their effectiveness and evaluation of new robotic platforms (cheaper and equally effective).

Acknowledgements

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