The Therapeutic Use of Humanoid Robots for Behavioral Disorders

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ABSTRACT

In this work, we illustrate an innovative treatment for patients affected by Behavioral Disorders, that relies on the use of Pepper humanoid robot. This new therapeutic methodology was created to support and make the therapist's work more attractive. Pepper is equipped with a tablet and two identical cameras. The tablet is used to let the patient interact with the application, while the cameras are used to capture their real-time emotions to understand the degree of attention and any difficulty that they may have. The interaction with the tablet takes place through some exercises in the form of games. The exercises performed by the subject are analyzed and combined with the data captured by the cameras. The combination of these data is processed to propose appropriate levels of therapeutic activities. This process leads to the digitization of the patient's healing path so that any improvement (or worsening) is monitored and causes Pepper to become a reliable and predictable technological intermediary for the child. The work has been developed in collaboration with a diagnostic and therapeutic center. Interacting with a humanoid robot, children exhibit a higher engagement, which can be explained, according to the psychologists, by the fact that a robot is emotionally less rich than human beings, and the patient feels less scared.

CCS CONCEPTS

• Human-centered computing ~Human computer interaction (HCI)~Interaction devices

KEYWORDS

Behavioral Disorder; Emotion recognition; Socially Assisted Robotics.

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1 Introduction

One of the main fields of application of current Socially Assisted Robotics (SAR) research is in the clinical setting for children with behavioral disorders [1][4][12]. Usually, the problems of behavioral disturbances concern isolated episodes or delicate, temporary developmental phases. However, in some cases, they may represent the prelude to subsequent psychopathological disorders. It is essential to investigate the psychological and relational aspects of the child to prevent the onset of major problems. Behavioral disorders may include Attention / Hyperactivity Disorder (ADHD), Oppositional Disorder (OD), or Conduct Disorder (CD) [8][11]. Therefore, the origins of behavioral disorders can be different. To develop effective intervention strategies careful observation of these behaviors. In connection with their deficit in social and communication skills, children with behavioral disorders often experience depression and anxiety when interacting with other persons [3][6].

The application of robotics in the treatment of children with behavioral disorders should aim to teach children basic social skills, communication, and interaction. Currently, researchers have focused on achieving these goals mainly in the area of autistic disorder [2][7][13]. Scassellati [10] indicates that robotic devices can provide quantitative data that could be of use by physicians in diagnosis, tracking the progress of patients, and for the comparison of patients. Robots are shown to generate a high degree of motivation and engagement in subjects, including subjects who are unlikely or unwilling to interact socially with human therapists [9]. Some individuals with behavioral disorders even prefer robots to humans [14][15].

The contextual analysis we performed in collaboration with a diagnostic and therapeutic center, led us to investigate the adoption of SAR solutions to improve the clinical contexts where children undergo a therapeutic path. An empowerment-driven analysis method was adopted to elicit user experience (UX) requirements, as illustrated in [18][19][20].

The main goal of this work is to use humanoid robot technology together with the psychological and engineering sciences to improve the social skills of children with behavioral disorders. Besides the beneficial effects coming from the interaction with a humanoid robot, the data collected during

therapeutic sessions can be used to monitor the progress of the patient suffering from behavioral disorders.

2 The Proposed System

The goal of our system is to assist the doctor and make therapy less boring to the patient. It is perfectly integrated with a humanoid robot equipped with a touchscreen that allows interaction with patients through our application. The system is connected to a server that sends various exercises to the patient in the form of games for therapeutic purposes.

The humanoid robot used is Pepper. It is a humanoid robot designed by the SoftBank Robotics [5] company to interact with humans.

During the therapeutic session, the therapist starts the system via his PC so that the application is launched on Pepper's touchscreen, and the child can face the first exercise. During the exercise, the child will (unknowingly) be supervised by the humanoid robot's video camera, which will periodically capture frames. It was decided to carry out a sampling in order to reduce the computational load of the system. The captured frames will be analyzed by a model of classification of emotions so that an estimate of the child's emotionality can be made.

The classification of the frames obtained will be combined with the results of the exercise. This combination will be processed by the server, which, through ad hoc metrics and algorithms, will return the evaluation of the patient's therapy day. The combination of data is essential as we cannot rely solely on the outcome of the exercise but also on the specific emotional state of the patient, which may be influenced by several factors (such as boredom, hyperactivity, anger).

The architecture of our work is presented in Figure 1. For each therapy session, data is collected that helps to characterize the patient's profile to monitor improvements or regressions; this helps the psychologist to identify the right therapeutic path and the right behavioral measures to be adopted. The therapist can view the patient's progress on his PC and therefore understand in real-time how to continue the training session.

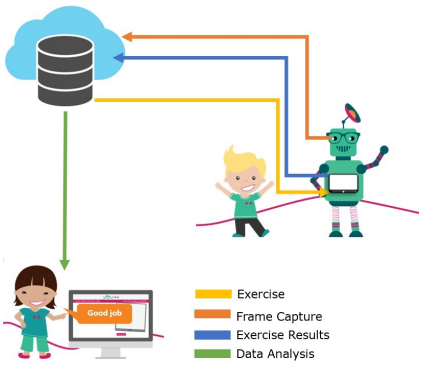

Figure 1: System Workflow.

3 Prototype Evaluation

An initial experimental phase was performed through the observation of a group therapy session to evaluate the degree of acceptance. A group of children (N=5) was followed by the psychologist, who interacted with them through games and exercises. Group therapy allows children to manage their emotions through social relationships as they collaborate with other children [15]. During the experimental session, the psychologist introduced Pepper to the children by explaining how to interact with the humanoid robot. Children immediately accepted the humanoid robot's presence, starting to collaborate and showing a high degree of attention regarding the exercise they had to carry out. The introduction of the humanoid robot in the therapeutic session was aimed at obtaining feedback regarding its acceptance in these contexts. After the session, we adopted a UTAUT questionnaire [16] to measure their acceptance of the system. The participants could indicate their level of agreement on a five-point Likert scale including verbal anchors: totally disagree (1)–disagree (2)– neither agree nor disagree (3)–agree (4)–totally agree (5).

The results obtained were encouraging, obtaining an average of about 4.3, confirming the acceptance and intention of using a humanoid robot for therapeutic use in children with behavioral disorders. Also, the psychologist found a favorable reaction regarding this type of experiment.

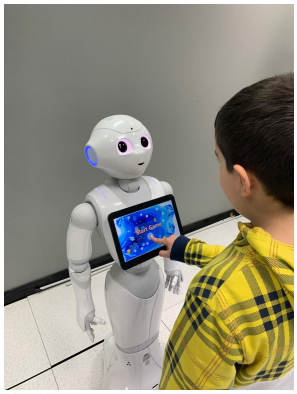

Figure 2: A child while experimenting with the system.

4 Conclusion and Future Work

In conclusion, the addition of a humanoid in the therapeutic context has had a very satisfactory response, the psychologists are enthusiastic, and the children are more involved. Children in general love playing with robots and previous research has shown that children with autism respond positively to therapies performed with the humanoid robot [17].

It may seem counterintuitive, but a robot could help children manage social and emotional relationships.

Our system will be able to offer different therapeutic paths based on the patient's pathology. An important aspect we will consider in our future work is the concept of *explainability*. Particularly for medical therapeutic applications it is of utmost (future) importance for automatic and adaptive intelligence such as in use in (future) therapeutic robots, that the robot can explain why a certain therapy e.g. has been selected, or at least make it interpretable, re-traceable to the therapist [21].

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