Therapeutic Play with a Storytelling Robot

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ABSTRACT
We are developing a prototype storytelling robot for use with children in rehabilitation. Children can remotely control a furry robot by using a variety of body sensors adapted to their disability or rehabilitation goal. We believe this robot can motivate children and help them reach their therapy goals through therapeutic play, either by exercising muscles or joints (e.g. for physically challenged children) or by reflecting on the stories (e.g. for children with developmental disabilities). To develop this technology we use an innovative design methodology involving children as design partners.

Keywords: Therapeutic play, robot, children, user interface, design process, rehabilitation

INTRODUCTION
Over the past three years, the Human-Computer Interaction Laboratory (HCIL) has developed a unique program focusing on the process of designing children's technology. This has demonstrated the benefits of including children as active partners in the design of new technology rather than just as testers or informants in the design [1]. One of the better known examples from this partnership is the design of a robot for storytelling called PETS: A Personal Electronic Teller of Stories. Using the storytelling software, children can write stories and include actions or emotions selected from a list of pre-programmed options [2]. The story can then be "played" by the remote controlled robot, which acts out the story and the emotions. The collaboration between HCIL and AnthroTronix - a startup company focusing on robotics and adaptive technology - has expanded the scope of the research to focus on the design of toy robots for the purpose of children's rehabilitation.

Previous work
Video games have been used in the past in a variety of therapeutic and rehabilitation situations [3]. Studies have shown that games can be used as a means to achieve desired functional goals. The literature also describes the use of puppetry as a therapeutic, educational, and social tool (e.g.,[4]). Technology can be used by a child to confront what may be too difficult to express otherwise. By telling a "story" children can "act out" their feelings just as an adult may "talk out" their difficulties with a therapist. To control a robot, otherwise passive children might become active and use their body. Our work is motivated in part by the promising results of a case study using AnthroTronix assistive technology with an off-the-shelf video game [5]. Family interviews suggested that using the video game broke the routine therapy exercises but also suggested that the initial excitement might fade after a few weeks. We conjecture that the repetitiveness and the lack of creativity in most video games might be a hurdle in any attempt to alleviate the boredom of daily therapeutic exercise. This leads us to believe that a creative storytelling robot might provide a long-term motivational tool to help children in rehabilitation. We have introduced the robot technology with the hope that 1) the robot will provide an engaging environment usable by children with a variety of physical or cognitive challenges, and 2) that the creative storytelling will provide the long term motivation needed to reach therapeutic goals. Early tests of a robot doll [6] suggest that autistic children can enjoy interacting with a mimicking robot.

Initial designs and tests
Our team is comprised of engineers, computer scientists, rehabilitation specialists, education specialists, artists and children. The early phases of the design have been conducted with our existing team of child design partners (6 to 11 y.o.). Children with disabilities are now joining the team as informants during the refinement of the design and of course as testers of the refined prototypes. We conducted our first design sessions with commercial remote-controlled toys. Then we used the existing HCIL PETS robot instrumented with AnthroTronix assistive technology. Sensors (accelerometers) were imbedded in two armbands - to control the 2 arms of the robot- and in a hat to control the head (figure 1)[7] Additional sensors, typically placed on the legs, are used to control the robot moves on the floor. The controls can be recalibrated by software to match the amplitude of the child's movements.

The control mapping is flexible. For example, the arm bands can be interchanged to control either arm - kid left arm to robot left arm, or in a mirror fashion, kid left arm to robot right arm. Of course the sensors can also be used on other body parts to match specific rehabilitation needs (e.g., a sensor can be placed on a foot to exercise an ankle while controlling the robot.) Finally it is our hope that the story creative and collaborative storytelling component of the system will provide the long-term motivation to use the robot for rehabilitation.

Ideas proposed by the team included the need for wireless control, embedding sensors in pleasant soft accessories such as bracelets or hair bands, and the need for decorating accessories with elements that resembled the robot part being controlled in order to clarify the mapping between sensors and actuators. We saw the importance for a direct correspondence between body motion and the motion of the robot for the children to understand what was happening.

From the design sessions with our child design partners, it was clear that the robot was a very powerful tool to engage children in physical activities. Our tests suggest that the children were able to control the robot and that they were motivated to play continuously. Many children would literally dance around, or with, the robot. After adjustments and corrections of the control system, children were able to control individual movements of the robot, while the imprecise movements of the robot gave it a compelling liveliness.

The new prototype

Based on these ideas, a new prototype was built. It is smaller, wireless, more robust and responsive to children body actions. Our goal is to design a system that will have potential both as a commercial toy for all children and a rehabilitation tool for children with special challenges through the addition of special sensors and the development of a rehabilitation methodology.

Figure 1 : Sensors mounted in arm bands and hats allow users to directly control the robot. The movements can be recorded and saved to be used later in stories. Here the controls are actually shared between two children.

We are now working with professional rehabilitation experts to develop strategies and games that make the best use of this technology. Examples of strategies vary from having children mimicking the robot (as a "Simon Says" game), teaching the robot moves that can be replayed - with or without a story, or "powering" a story by having the execution of exercises trigger the continuation of a multi-step story told by the robot. Complementary objects such as floor maps or other active objects (balls, other robots) whose location could be sensed by the robot are envisioned as well. Finally, we will conduct field studies to measure the hypothesized benefits in long-term rehabilitation.

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