Occupational Therapy Using a Humanoid Robot
Nicholas S. Scannell, Maysam M. Ardehali, M. H. Rahman, Qussai M. Obiedat, Roger O. Smith
Biorobotics Lab, Rehabilitation Research Design & Disability (R2D2) Center

Objectives
The objective of this research study was to program NAO, a humanoid robot with 25 degrees of freedom to complete various therapeutic exercises in a routine for patients to follow. This routine named “NAO Follow Me” will allow the patient to undergo a variety of therapeutic exercises by following the robots verbal directions and physical motions.

Background
NAO is a humanoid robot with 25 degrees of freedom and seven senses to give the most natural patient interaction. This routine includes basic exercises such as raising the arms above the head and turning the head, to more advanced movements such as leaning forward to bow (Figure 3). We created two different programs. In the first, the exercises pace could either be controlled by using the controller buttons on the head of the NAO robot. This allows the therapist to repeat exercises if the patient is having trouble with certain movements or doing them correctly. The other program allows for a pre-set speed of the routine without any controlling needed. This would be beneficial for larger group sessions in which it is desirable for the robot to play through the routine on its own (similar to a yoga session or for a retirement home/senior center morning group routine).

Methodology
NAO can be programmed multiple ways. In this study, we programmed NAO through Choregraphe. Choregraphe is desktop application with a fairly easily navigable user interface (Figure 2). With this desktop program, the user can create behaviors using pre-set options, programming through python, joint coordinate manipulations using a robot simulation or physical adjustments to the robot itself. The major limitation of the application is real-time interaction, all actions for the NAO robot interaction must be pre-programmed through the application. Therefore, NAO cannot assess the patients accuracy or progress through this a future goal in this project. While ensuring the prior is a limitation, using NAO for occupational therapy allows a therapist to tend to other patients while glancing over to ensure the patients productivity.

Approach
While Choregraphe is a desktop application, there are still many ways that NAO can be programmed from this user interface. We started by using “Animation Mode” (allows relaxation of joints) along with “Timeline” which allows us to record the motions of the robot we put it through physically. This approach gave undesirable rough movements due to physical limitations of controlling the relaxed joints. The next approach that was used was to use a robot simulation to adjust joint coordinates and create new saved positions. Using Choregraphe to move from one position to the next while NAOs inertial unit maintained balance.

Results
In this study we created an interactive morning routine for elderly, children, or stroke victims etc. guided by NAO, a humanoid robot with 25 degrees of freedom. This morning routine includes basic exercises such as raising the arms above the head and turning the head, to more advanced movements such as leaning forward to bow (Figure 3). We created two different programs. In the first, the exercises pace could either be controlled by using the controller buttons on the head of the NAO robot. This allows the therapist to repeat exercises if the patient is having trouble with certain movements or doing them correctly. The other program allows for a pre-set speed of the routine without any controlling needed. This would be beneficial for larger group sessions in which it is desirable for the robot to play through the routine on its own (similar to a yoga session or for a retirement home/senior center morning group routine).

Conclusions
In this study we created an interactive morning routine guided by NAO, a humanoid robot with 25 degrees of freedom and 7 senses to allow the most natural patient interaction. This routine included a variety of exercises that varied in difficulty but were targeted towards the capabilities of elderly or injured patients. There are two options: controlled progress routine or pre-set routine speed. This allows the routine to be used in several applications varying from one on one therapy in a physical therapy environment to group morning routines in a retirement home. The future goal of this research topic is to provide real-time interaction between the robot and patient in which NAO can determine if the patient is doing the exercise correctly or not, what they are doing wrong, and give the patient instruction on how to do it correctly. This would allow the physical therapist to be completely out of the room, having multiple patients being treated simultaneously.

Bibliography:

Contact Information:
Nicholas Scannell
Email: scannel3@uwm.edu
Phone: (414) 303 - 9781
Biorobotics Lab:
USR-281 115 E Reyndl Way, Milwaukee, WI 53212
R2D2 Center:
Enderis Hall 135, 2400 E. Hartford Ave Milwaukee, WI 53211