END-USERS FEEDBACK ON A HYBRID ASSISTIVE / SOCIALLY ASSISTIVE ROBOTIC PLATFORM FOR PHYSICAL REHABILITATION

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ABSTRACT

Assistive and Socially Assistive Robotics can potentially improve patients' physical rehabilitation. This paper describes a prototype of a robotic platform designed to assist in performing exercises as well as help patients, through a social assist interface, adhere to a home exercise program. The objective of this study was to gather feedback on this prototype from end-users who either are actively recovering from a stroke or neurological incident / disease or who have already completed their rehabilitation. Ten subjects participating in the study interacted with the robot using an arm exercise device that communicated with the robot via Bluetooth. Following their using it they were asked to complete an experience survey. Overall scores were positive where 10 of 12 survey items received median scores of at least 8 on a range from 0 to 10. The feedback from this study will be used to improve future designs of this prototype robotic platform.

BACKGROUND

Physical rehabilitation, traditionally hands-on treatment, has adapted technology to support recovery using assistive robotics that provide assistance in carrying out exercise treatment protocols (Abdullah, Tarry, Lambert, Barreca & Allen, 2011; Conroy, Whitall, Dipietro, Jones-Lush, Zhan, Finley, Wittenberg et al., 2011; Wagner, Lo, Peduzzi, Bravata, Huang, Krebs, et al., 2011). A limitation of these assistive robotic systems is availability in the clinical environment. Socially Assistive Robotics to help patients adhere to home exercise therapy recommendations is at an earlier stage of development (Gadde, Kharrazi, Patel, MacDorman, 2011; Mataric, Eriksson, Feil-Sefer, Winstein, 2011). Due to changing healthcare reimbursement, therapists often are forced to deal with reduced number of patient visits. This requires the patient and therapist to be more effective with less face-to-face time in the clinic. Therapists understand now more than ever that home exercise programs play an important role in a patient's recovery. However, adherence to home exercise programs can often be challenging for the patient to remember and/or perform on their own. Assist and socially assist robot systems can help patients meet therapy requirements at home.

A team of occupational therapists, scientists and engineers developed a prototype robotic system that included features of both assistive and socially assistive robotics; SKOTEE, the **S**ister **K**enny h**O**me **T**h**E**rapy syst**E**m. The design objectives were to keep the system inexpensive while providing for assisted exercise and help with adherence. The first prototype was developed as part of a design project with Mechatronics Engineering students at the Royal Institute of Technology in Stockholm, Sweden and Mechanical Engineering students at the University of Minnesota. Their efforts were coordinated by a graduate student of the Royal Institute of Technology on site at the Sister Kenny Research Center in Minneapolis. Researchers at the Sister Kenny Research Center acted as project advisors. SKOTEE was designed to be used in the home environment to help patients perform their home exercise programs, and provide reminders for appointments and taking medications. The system also included a portal for messaging between patient and therapist and playing audio books for patient entertainment (Oddsson, 2009). The original prototype has been upgraded from the iRobot Create® to the ERA-MOBI platform.

Figure 1: SKOTEE Prototype

We envision SKOTEE being used as both a stand alone device providing verbal instructions to assist patients at home and as an assistive system using multiple exercise device modules that can interact wirelessly. The first exercise module prototype is designed to allow the patient with arm weakness and/or poor motor control to practice reaching motions such as shoulder flexion/extension, elbow flexion/extension, and internal/external rotation. This is accomplished through a height adjustable pole that connects to the base allowing two degrees of rotational freedom (Figure 2). This module converts the position of the arm into a digital signal that is sent to SKOTEE using Bluetooth allowing the patient to perform computer mouse like movements during the exercise games that are seen on the SKOTEE's LCD screen.

Figure 2: Arm Module

The objective of our evaluation study was to obtain end-user feedback on this robotic platform prototype. Evaluation results, comments and recommendations from users will guide future prototype designs of SKOTEE.

APPROACH

We recruited ten current and past patients, eight with stroke and two with neurologic impairments. Due to the non-interventional nature of the study, it was exempt by the Institutional Review Board. Subjects used the SKOTEE and the arm module in a simulated home environment at the Sister Kenny Research Center. SKOTEE approached the subject and asked them if they were ready to perform their home exercises. The subject would confirm their readiness by clicking 'yes' on the touch screen. The patients then followed SKOTEE to another part of the room where the arm exercise module was located. The patients then sat down and SKOTEE positioned itself in front of them. SKOTEE proceeded to show the patients how to position their upper extremity in the handle of the arm module (Figure 2). Subjects were asked to reach as far as possible in order to determine their maximum range of motion. This step allowed SKOTEE to calculate the appropriate challenge level for the exercise. Patients then completed two exercise programs that required them to perform reaching movements.

Subjects had the opportunity to interact with SKOTEE for approximately 15-20 minutes. They then filled out an experience survey consisting of twelve questions. This survey was generated by the SKOTEE team, consisting of engineers, therapists and a scientific advisor. The survey asked questions relating to the patients' experiences using SKOTEE and other potential features. Each of the questions was scored on a scale from 0 to 10 where 0 was the most negative score and 10 the most positive score. The survey also included a comment area for subjects to express their likes and dislikes, and what they would want to see in future versions of SKOTEE.

RESULTS

Many of the patients indicated that they saw the value of SKOTEE for home rehabilitation. Table 1 provides the median, minimum and maximum scores for each of the questions included in the experience survey. Patients responded positively to most questions with median scores of at least 8.0 on a range of 0 to 10. The feedback provided for the arm exercise received the lowest median score at 5.5 (3 to 9) and likeliness to rent received a median score of 6.5 (2 to 10). Figure 3 illustrates the median and range of survey response items.

Table 1: Results of the experience survey for 10 subjects

Experience Survey Question (Scored 0 to 10 where higher is more positive)	Code	Med-ian	Mini-mum	Maxi-mum
Technical-How safe you felt interacting with SKOTEE(Not at all safe to Very safe)	T1	10	8	10
Technical-Appearance (Did not like at all to Like a lot)	T2	8.5	3	10
Technical-Importance of speech capability (Not at all important to Very important)	T3	8.5	3	10
Technical-Use on-line environment to exercise (Not likely to Very likely)	T4	9	3	10
Arm Exercise-Motivate to exercise (Not at all to A lot)	A1	9	2	10
Arm Exercise-How easy to set yourself up (Very difficult to Very easy)	A2	8	1	9
Arm Exercise-Level of workout(Very poor to Very good)	A3	8	5	10
Arm Exercise-Feedback (Not at all helpful to Very helpful)	A4	5.5	3	9
Experience-Use at home? (Not at all likely to Very likely)	E1	9.5	4	10
Experience-Beneficial to rehab (Not at all beneficial to Very beneficial)	E2	8.5	4	10
Experience-Likely to rent? (Not at all likely to Very likely)	E3	6.5	2	10
Experience-Use on a daily basis (Not at all likely to Very likely)	E4	9	2	10

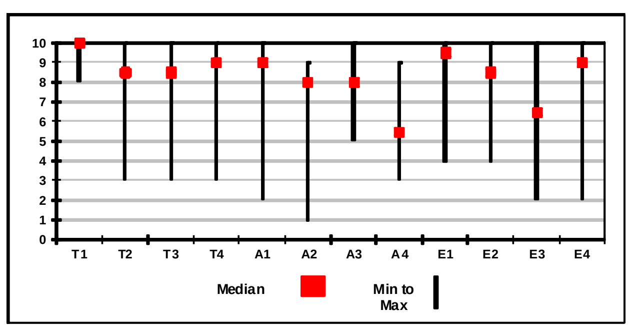

Figure 3: Experience survey results. Refer to item codes in Table 1.

Although we have gained some valuable insights and comments about SKOTEE from this study, there is still much more to learn about patients' wants and needs for robotic rehabilitation. We have asked the ten subjects to participate in a follow up focus group. We will ask them to reflect back on what they think would have been beneficial to them when they left the hospital and started their recovery at home. For example, "What reminder or social needs did you have as you recovered?" Following these probes we will reflect with these subjects on how the SKOTEE might be adapted to meet these needs. This exercise will provide guidance in exploring potentially new features to be included in the SKOTEE robotic platform.

CONCLUSION

It appears that patients' initial perceptions of using a socially assistive robot device, such as SKOTEE, are positive. Many of the participants indicated that they could see benefits to their recovery using SKOTEE. However, questions remain as to why responses were relatively low regarding a willingness to pay out-of-pocket for renting such a device. We believe that by using a focus group we will be able to further explore this question as well as new features that meet the needs of patients in rehabilitation. We look forward to improving the design of the SKOTEE as it effects patient adherence to exercise and recovery.

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