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Telerehabilitation Service with a Robot for Autism Intervention

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Abstract

Though studies on robot-mediated intervention for children with autism have gained momentum in recent years, not much work has been done to help therapists to have on-line access to robot programs. Telerehabilitation is an efficient solution to overcome barriers of access, remote locations, lack of autism therapists and cost in the delivery of rehabilitation services. In this study, a telerehabilitation system is developed to help therapists to concentrate fully on the intervention and not in robot programming. Robot scenarios are created based on consultation with clinicians and therapists and are available in the system via a website, with user-friendly graphical user interface (GUI). A survey with 15 therapists was carried out to get feedback on the system's usability. 80% of therapists agree that their overall first-time experience in using the telerehabilitation website was good.

1. Background

Robots offer motivation, accuracy, repetition and adaptability to individual's needs. On the other hand, telecommunication technology eliminates distance barriers in healthcare services, allowing storage and access of treatment resources and patients' information. These factors combined enables care for people at different locations.

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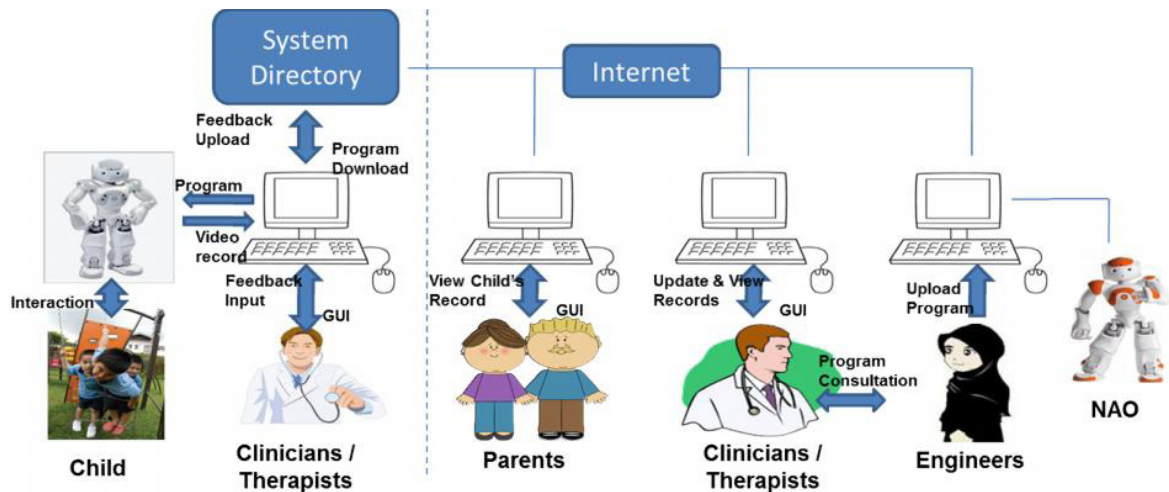*E-mail address:* syamimi@ieee.org

Fig. 1. The telerehabilitation system with a humanoid robot to 'transfer' the learning content to the children with autism

Such system will be able to break the barrier between the engineering and clinical world. This is where the telerehabilitation platform takes place. To date, much attention has been given to telerehabilitation as a plausible effort to overcome barriers of distance, time and cost in providing rehabilitation services [1]. This is supported by advances in Internet technology, speed of data transmission and affordability of computer systems.

Telerehabilitation simply refers to the delivery of rehabilitation services using the means of telecommunication technologies [2]. Such services include assessment, intervention, education and also therapeutic interventions for disabled people [3]. Children with autism are oftentimes subjected to limited participation in age-appropriate activities at home, school and community [4]. Hence, telerehabilitation offers the solution where these children will have more chances to learn at not only schools and clinics but at home with the presence of a robot companion.

1.1. Telerehabilitation for the autism community

Telerehabilitation as a solution to deliver robot-based services to the autism community was first reported in 2010 by the researchers at the Eindhoven University of Technology. Their project is aptly named 'WikiTherapist', accessible at the web address http://www.wikitherapist.nl/. WikiTherapist is an on-line platform where a community shares robot-based training scenarios for autistic children. Therapy programs are created using TiViPE software and are kept in WikiTherapist on-line database but only available to the community members with access to the website. Current work on WikiTherapist mainly focuses on developing end-user programming to help therapists to control a robot for therapy purposes. As for the WikiTherapist website itself, it is inaccessible to the public and was only discussed in a short publication [5].

Next, another similar project is the Ask NAO initiative by Aldebaran Robotics. It is an interactive and educational implemented tool to engage kids through customized robot applications for special education. The website link is https://asknao.aldebaran.com/. To gain access to the robot programs, users need to purchase the Ask NAO package. Though Ask NAO claims that all robot applications are inspired by commonly practiced teaching methods in autism (i.e. Applied Behavioural Analysis (ABA), Picture Exchange Communication System (PECS)), no publications has been found to support this.

The NAO-base project at the Laboratory For Understanding Neurodevelopment (F.U.N), University of Notre Dame also puts forward a similar idea on compiling and sharing robot behaviours. These programs have been used and tested in therapy sessions incorporating the humanoid robot NAO. Fully accessible to the public at

http://funlab.nd.edu/the-nao-base/, users may view the robot movements by playing the YouTube clip or download the actual behaviour files. However, no information is provided on what is the learning outcome of each behaviour or whether the behaviours were developed based on inputs from clinicians or teachers.

Based on the review on existing telerehabilitation sites for autism, there is a need for an on-line platform that can be accessed by parents and therapists at different locations. Robot scenarios that are available on-line need to be created or co-developed with input from clinicians. The usability of such system has to be established before it can be fully utilized to store robotic scenarios and collect information on children with autism.

2. Telerehabilitation Website Features and Functions

The website presented in this study is a telerehabilitation database that connects experts in engineering and medical field (Fig. 1). The system hopes to break the barrier between the technical and clinical world. Both parties collaborate to explore the application of a robot as a useful intervention tool. Through the website, engineers can upload robot programs for clinicians, therapists and parents to access and keep track on child's progress in robotic intervention. Users are able to choose suitable programs based on the child's diagnosis and development.

A robot in human form (humanoid) is the chosen ready-made platform for the system. It is the humanoid robot NAO, manufactured by Aldebaran Robotics. NAO has been designed to be similar with the size of a human toddler and moderate facial likeness to human. Children with autism have shown preferences to robots with simplified features. NAO has flexible arms and legs, allowing it to perform complex movements in imitation therapy. Currently it is the preferred research platform in rehabilitation including pilot robotic programs for hospitalized children [6], to comfort children with chronic diseases [7] and create engagement with autistic children [8-10]. NAO comes with an-to-use GUI; Choregraphe. This intuitive and available interface allows users to create, save and re-run sequence of behaviours for the robot. With 25 degrees of freedom, NAO has the mobility to adopt various human-like postures needed in therapeutic interventions.

2.1. GUI (Graphical User Interface) design

The GUIs in the website act as a communication medium between users and the system. The GUIs were designed using facilities available in the WordPress 3.5 package. All GUIs that function inside the telerehabilitation website are summarized in the conceptual diagram shown in Figure 2. Ten GUIs excluding the Admin Dashboard were designed to perform various functions. General users (without login ID and password) are only able to access certain pages from the menu on the Home page: '*Research Collaborators*', '*Publications*', '*Testimonials*', '*User Manual*' and '*Join Us*'. These pages contain general information about the robot-based intervention project. New users can download the user manual (in pdf) or watch the demo video provided. These facilities are meant to help them navigate better through the website. Future users may contact the administrator to apply for access into the site.
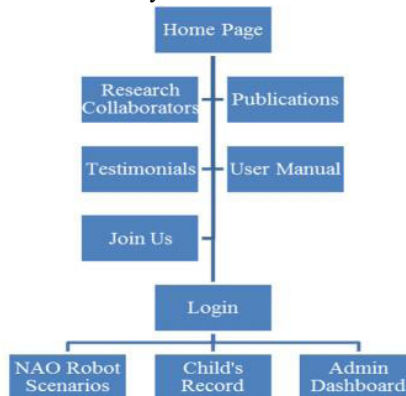

Fig.2. Layout of the different GUIs in the website

Following is a brief description of the most important website features and functions:

- Record of each child involved in the robotic intervention program
- Robot program for each scenario with specific learning outcome are compiled (after consulting experts) and uploaded to the telerehabilitation database by engineers. These developments are presented in [11]
- An appointed administrator is responsible to endorse new members to the on-line system and sets the level of authority/access
- Even though all users are allowed access to robot scenarios, only clinicians and therapists can modify children's demographic data and record
- Programs can be downloaded and learning sessions can be carried out in therapy centres and at home
- Clinicians and therapists who monitor child-robot interaction using the robot scenarios are able to post observation records for future references, especially to track child's progress
- Parents are able to carry out learning activities at home using the robot. Video record of each session can be uploaded to be viewed by clinicians and as part of child's archive
- Parents can also access, track and monitor their child's progress based on the feedback record from clinicians stored in the database
- Each parent is only allowed to access data of his/her own child
- Under the 'NAO Robot Scenarios' GUI, All robot programs that are currently available will be displayed here and are available for downloading. Using the 'Download' button on any of the program descriptions, users may start downloading into their own computers. A short description on the robot program is provided together with a short video example on the robot's behaviour for each scenario
- Once a program is completely downloaded into user's computer, transferring it into a robot is only a step away. By double-clicking on the program icon, Choregraphe software will launch and the robot behaviour will be loaded. Next, users need to click the '*Connect to*' button that is green in colour and select an available NAO robot to execute the behaviour. Then, selecting the '*Play*' button will send the behaviour to the robot. The humanoid robot NAO is ready for use with the specified program

3. Pilot Stage Implementation with Therapists

The telerehabilitation website was launched for on-line access in January 2014. The next step is for the system to be evaluated in terms of its usability. As mentioned by John Brooke in [12], the usability of any tool or system needs to be assessed in the context of its application. Therefore, it is apt that for a first-time study on the website usability that a group of therapists were the survey respondents. This group of allied clinicians will be the first users of the telerehabilitation site and their feedback is important to gauge the implementation of this on-line system in the clinical field and at autism rehabilitation centres.

3.1. Method: survey on user experience and website content

A group of therapists were inquired, through a questionnaire-base survey whether they agree or disagree with 20 statements regarding the usability and experience after using the telerehabilitation website. The questionnaire consists of 10 questions where users ranked their preferences from one to five on a Likert scale ranging from 1: strongly disagree to 5: strongly agree. The survey involved 15 therapists from the Faculty of Health Sciences, Universiti Teknologi MARA (UiTM) Puncak Alam. For the therapists to take part, the requirements are to have formal qualifications, have undergone training and have experience in autism therapy. Overall, the respondents have professional experience ranging from one to seven years as therapists.

Prior to the survey, a short briefing was given to all respondents to give information on the aim of the study. After a short demonstration, the therapists had the experience to navigate through the website on their own and try to download robot programs from the website into the computers provided. In this survey, the therapists need to answer ten questions. The questions cover statements regarding the user's design experience and website content which were inspired from a study by Cyr, Ilsever, Bonanni and Bowes in 2004 [13]. Respondents need to score on a

5-point Likert scale to indicate their level of agreement for each statement. All statements are positively worded items. The questions are:

1. The user menus are clearly categorized and are well laid out on the screen.
2. I can easily recognize and find where the NAO robot scenarios and their information are located.
3. The website looks professionally designed and well presented.
4. The product information (NAO robot scenarios) provided on the website is presented consistently and logically.
5. The screen design on the website (i.e. colours, boxes, menus, navigation tools etc.) is harmonious and well presented.
6. The website can be easily navigated.
7. The organization, sequencing and overall arrangements of the site are understandable and easy to use.
8. All robot scenario's options, attributes and information are well designed and presented.
9. Site product (NAO robot scenarios) availability and product variety are well explained.

The tenth question is a general question to determine if a word or phrase could be associated with the website's overall usability.

10. How would you rate your overall first-time experience in using the telerehabilitation site? (On a scale from 1: Very bad to 5: Very good)

4. Results

Survey results for the 10 questions are presented in the form of radar charts. The first chart shows the responses for questions 1 to 4 (Figure 3 (a)). From the chart, 87% or 13 out of 15 the therapists agreed that the user menus are categorized clearly and nicely laid out on the screen. In addition, 67% agree that they can easily recognize and find where the NAO robot scenarios and their information are located while 97% agree and strongly agree that the website looks professionally designed and well presented. For Question 4, 87% supported that product information (which is on NAO robot scenarios) provided on the website is presented consistently and logically.

The second radar chart shows results for questions 5 to 9 (Figure 3 (b)). All 15 therapists (100%) agree and strongly agree that the screen design of the website (i.e. colours, boxes, menus, navigation tools etc.) is harmonious and well presented. Additionally, 93% of the respondents supported that the website can be easily navigated, 87% agree that the organization, sequencing and overall arrangements of the site are understandable and easy to use, 73% agreed that all robot scenario's options, attributes and information are well designed and presented and 87% supported that the availability and variety of the robot programs are well explained.
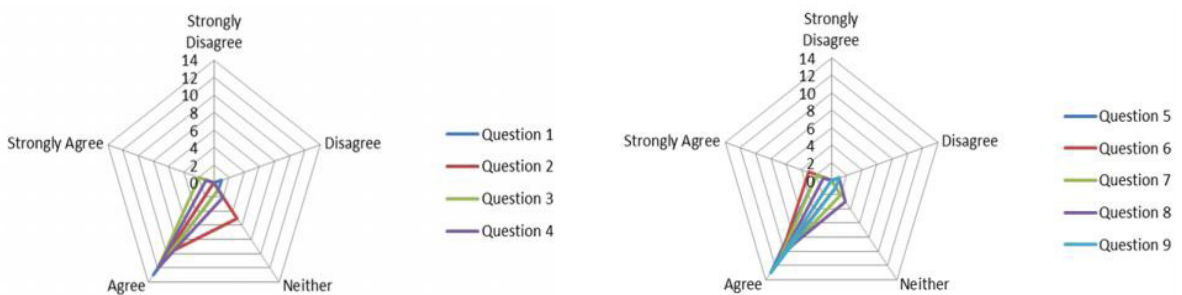

Fig. 3. (a) Therapists' response to questions #1 to #4 and (b) therapists' response to questions #5 to #9

The third radar chart shows results for question number 10, which concerns the general opinion from respondents (Figure 4). For this, 80% of the therapists gave opinion that their overall first-time experience in using the website was good.
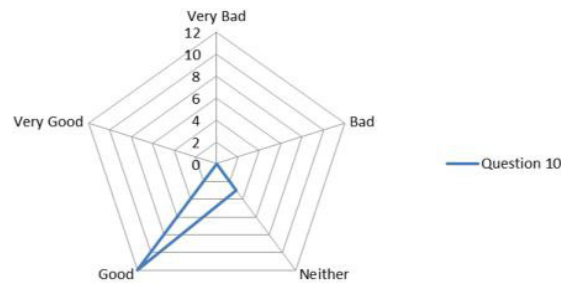
Fig. 4. Therapists' Responses to Question #10: How would you Rate your Overall First-time Experience in using the Telerehabilitation Site?

5. Discussion and Conclusion

The survey on the pilot implementation of the telerehabilitation system aims to investigate the user's feedback on the website's design experience and content. Overall, most therapists found that their on-line experience with the website design to be good and content of the telerehabilitation website was presented well. This study was the first of its kind in Malaysia regarding the development of telerehabilitation involving robots in aid of the autism population. When this system is fully realized, the step forward is to create software solutions that empower non-technical persons (i.e. therapists) to easily create robot behaviours by themselves.

Acknowledgements

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