

SHRUG: Stroke Haptic Rehabilitation Using Gaming

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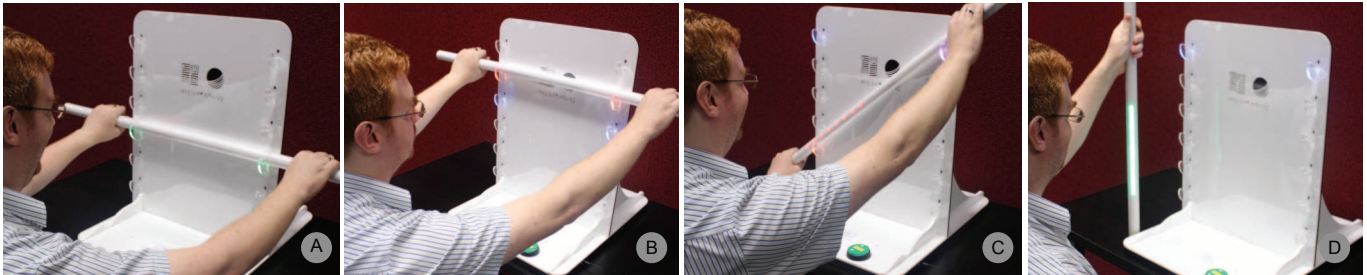


Figure 1. The SHRUG’s interactive and gamified elements (a) Green hooks indicates the correct placement of the pole on the platform (b) Red hooks indicate an incorrect placement of the pole on the platform. Blue hooks indicate the target hooks (c) The pole lights up if not held horizontally (d) Holding the pole vertical displays the progress/game score of the patient

ABSTRACT

This demonstration paper describes SHRUG, an interactive shoulder exerciser for rehabilitation. Firstly, the system’s interactive and responsive elements provide just-in-time feedback to the patients and can also be used by the therapists to observe and personalise the rehabilitation program. Secondly, it has a gamified element, which is expected to engage and motivate the patient throughout the rehabilitation process. With this demonstration, the participants will be able to use the system and play the games introduced by SHRUG and observe the feedback.

ACM Classification Keywords

K.4 Computers and Society: Social Issues—*Assistive technologies for persons with disabilities*

Author Keywords

Serious Games, Stroke Rehabilitation, Responsive Objects

INTRODUCTION

Exercise programs focusing on the rehabilitation of the shoulder are a common occurrence in post-stroke rehabilitation. These programs, commonly feature exercises that utilize both shoulders together such that the ‘strong’ shoulder is able to guide the ‘weak’ shoulder through the proper movements. One such activity involves the placing of a wooden pole into a pair of horizontal hooks while keeping the pole horizontal throughout the activity¹.

¹<http://goo.gl/7XdjHE>

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Our observations and discussions at a rehabilitation ward of a local hospital indicated that with the existing systems therapists need to constantly observe the patients to detect incorrect actions. This could be a challenging task when a few therapists observe multiple patients. In addition, it was indicated that current method of accurately recording and storing specific activity information (patients’ hand movement patterns and speed) was an arduous task. However, collecting these data is very desirable so that the therapists can analyze and personalize the rehabilitation programs effectively.

Therefore, with SHRUG (Figure 1), our main objective is to address the above limitations and provide an interactive and gamified experience to the patients and therapists. Existing research has discussed the usefulness of rehabilitation devices with features such as interactivity and adaptable game-play, in which difficulty is tailored to patient performance in real-time [2, 3]. We built on these research and SHRUG system was modelled the SHRUG system such that it follows the same physical specifications and affordances of the existing platform. The approach of SHRUG is two pronged. Firstly, enhance the effectiveness of rehabilitation process for the therapists by converting the existing shoulder rehabilitation exercise platform into an interactive object that monitor, record and provide timely alerts. Secondly, enhance the experience of the rehabilitation process for the patients by providing immediate feedback of their actions and introducing serious gaming aspects [1, 4] to motivate patients during sessions and encourage them to practice continuously.

IMPLEMENTATION

The SHRUG system mainly consists of the SHRUG Pole and the SHRUG Platform (Figure 2). Patient is required to hold the SHRUG pole horizontally and place it on the SHRUG platform as per the usual shoulder rehabilitation exercise.

SHRUG Pole: The SHRUG Pole consists of a Teensy 3.1 as the main microcontroller. An orientation sensor (ArduIMU

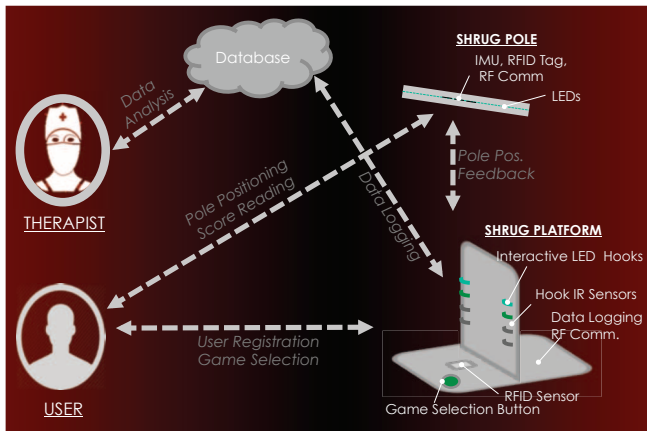


Figure 2. Overall System Diagram of SHRUG

V3) is used to detect the orientation. A strip of 26 RGB LEDs is spread throughout the pole in a single profile to provide just-in-time feedback when the pole is not horizontal or indicate progress results (score) when the pole is held vertically during a game. An RFID (Radio Frequency Identification) tag embedded in the pole gives each pole a unique ID.

SHRUG Platform: The SHRUG Platform uses an Arduino Due as its main controller. A RFID reader on the platform is used to identify the RFID tag of the pole and register the patient. Each hook of the platform is embedded with a RGB LED which makes the hook light up in different colors. Infrared (IR) proximity sensors placed just behind the hook are used to detect the pole positioning. The game selection button on the platform allows the users to select various games of the exercise program.

Communication: The platform communicates with the pole using RF (radio frequency). RF transceiver modules are used both at the pole and the platform. This communication channel is initially used to pair the pole and the platform. During the exercise, the pole transmits orientation data to the platform. Then the position of the hooks, orientation data, task start time, duration, speed, target hook positions are stored in a SD card integrated in the Platform. After each usage session, the Platform sends data to a cloud server via Wifi. This data can then be accessed by the therapists for post review.

INTERACTION EXPERIENCE WITH SHRUG (DEMO)



Figure 3. Typical usage of SHRUG (a) Place the pole on the platform for identification (b) Select the game using the selection button on the platform (c) Place the pole on the platform hooks as required by the game

During the demonstration of the SHRUG device, participants will be able to experience and compare the existing platform at the local rehabilitation ward and SHRUG platform with

interactive and gamified elements. ‘Mode 1’ (listed below) is similar to the existing passive exerciser whereas ‘Mode 2 through 4 introduce various interactive and gamified elements. The interaction process is as follows (indicated in Figure 3).

First the participant has to register himself or herself with the platform by placing the pole on the platform. All hooks on the platform light up and blink to indicate successful identification and pairing. Next, the participant may select a mode out of the following four modes.

- Mode 1: In this mode, the platform and the pole does not provide any form of feedback to the patient (Similar to the existing passive exerciser).
- Mode 2: Patients follow their own pace with the exercise but are provided with immediate feedback through the platform (lighted up hooks) and the pole.
- Mode 3: In this mode, a set of hooks light up sequentially on the platform. The patient has to follow these moving lights with the pole. As the patient keeps up, the game increases the challenge by speeding up the process.
- Mode 4: In this mode, the difficulty is furthered by having the hooks light up at random locations.

CONCLUSION

In this demonstration we present SHRUG, an interactive shoulder rehabilitation exerciser. With this system, users are expected to explore the effectiveness of providing interactive and gamified feedback which helps rehabilitation patients to correct their movements and guide through the exercise session.

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