SCRIPT: Motivational User Experience for Robotic Tele-Rehabilitation

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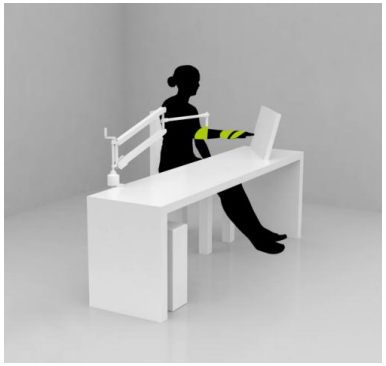
Abstract
We present the overall user experience designed for supporting rehabilitation of stroke patients at home. Patients use a robotic hand (orthosis) to control therapeutic games and a touch screen for the UI. They are supervised remotely by a therapist who uses a similar interface from their desk. The system includes therapeutic games and user interfaces (UIs) for both patients and therapists. The concept and design of these UIs were implemented during the first year of the SCRIPT project.

Author Keywords
Tele-Rehabilitation; Stroke; Usability; Motivation; Gamification; Feedback

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces ---*Graphical user interfaces (GUI), Haptic I/O*; I.2.9 [Artificial Intelligence]: Robotics---*Sensors;* J.3 [Computer Applications]: Life and Medical Sciences---*Health*

General Terms
Design; Human Factors



Possible setting of the SCRIPT system for robotic tele-rehabili–tation at home at home (3D volume model) including: Touch display for UI control; Robotic support for hand and wrist movements; Arm support (use of an available system).

Introduction

Due to the high costs of clinical neuro-rehabilitation, post stroke treatments are generally limited to some weeks to a few months after the (stroke) event, with a restricted amount of training due to therapist/healthcare professionals (HCPs) availability. Recent developments in robot-mediated rehabilitation have shown the potential of robotic devices for delivering repetitive training and thus offering more patients a post-stroke training.

Patients need to engage in such a tele-robotic rehabilitation for therapy success. The system must be motivating and accessible as well as fast and easy to use. Thus the user experience (UX) of the system is crucial. For the SCRIPT project[1] such a user interface (UI) for patients and HCPs has been conceived. These UIs provide access to training, feedback and communication between patient and HCP as well as access to the patient's progress (game outcome, sensory data, etc). The HCP can adapt the training plan according to therapeutic progress and goals. Patients can use this tele-rehabilitation platform in their homes. It will be supervised and managed remotely. It is innovative in addressing wrist and hand rehabilitation which has been mostly neglected in research to date.

This paper aims at shortly presenting the status of the ongoing work on the SCRIPT project. It introduces the UIs for the patient and HCPs while giving a more detailed picture about the therapeutic games. We will conclude this paper by mentioning current and future evaluations of the system.

[1] SCRIPT (Supervised Care & Rehabilitation Involving Personal Tele-robotics) is partially funded by the European Commission (FP7-ICT-2011-07; grant 288698).

Overview of SCRIPT

The SCRIPT project follows a User-centred design (UCD) process (ISO 9241-210), which iteratively progresses through the phases of Analysis, Design, Implementation and Evaluation.

During analysis the project partners integrated their expertise from different backgrounds [1-9] to make sure all aspects are covered. Additional research engaged potential stake-holders of the SCRIPT system (patients, HCPs, family members) to identify their requirements through understanding their experiences of stroke and technology use as a co-producer of the prototype system.

The design phase iterated quickly from hand-drawn sketches to wireframes and finally high-end visual design. For these quick cycles feedback from clinical and technical partners and end-users was elicited and integrated into a concise UI specification. The following sections describe the elements of the overall user experience for the SCRIPT system in more detail.

For implementation the consortium followed an agile approach favouring direct communication over extensive documentation (specs and assets were provided as needed). Each partner worked on a part of the system—e.g. games or robot hand. The overall architecture builds on previous work of the partners, e.g. tele-health-care and real-time robotics.

The platform has now been integrated: The robot, backend, communication components, UIs, games and hardware now form a cohesive system.

Motivating User Interface and Games

From the outset motivating elements played an important part during UI design. In early sketches engaging UI elements were conceived together with possibilities for feedback about game performance and therapeutic progress. See figure 1.

First ideas for the Patient's home screen

Motivational elements were included from the outset and first sketches, e.g.

Stars to indicate training progress (statistics): These later became "Progress" as a detailed means for feedback.

A "mood image" to foster engagement (flowers grow): This later became the SCRIPT rectangles filling from transparent to shades of green.

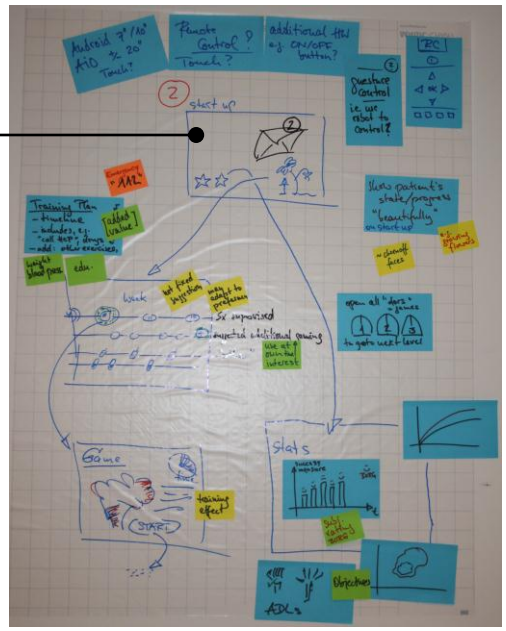


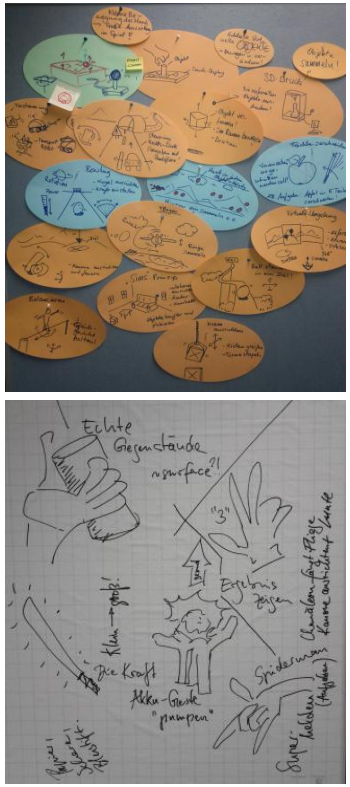
Figure 1. Early design ideas for the SCRIPT user interface.

Patient UI

The main motivation for the patient is to improve hand and wrist function. This means playing therapeutic games while training their impaired hand. After start-up one game is presented as "Suggested Game". The patient can directly start the game by pressing "Play". The training plan is set up by a therapist and determines which game and level of game is appropriate for each individual. Patients control the UI with the non-impaired hand via a touch screen. The patient wears an individualized robotic hand (orthosis) which is used for game play while training of hand and wrist function.

Figure 2 shows the visual design for the patient's home screen. The main navigation is placed at the bottom of the screen to accommodate usage independent of the side of the impairment. This interface was kept very simple and straightforward: Patients may be less computer-literate and might also have impairments associated with their stroke, such as visual neglect which can influence their use of screens.

Figure 2. The patient's home screen.



Many game ideas were explored early in the project. This led to discussion and refinement of the requirements.

After calibration of the robotic hand the game is viewed on the full screen and the patient performs gestures with the impaired hand. The sensors in the orthosis transfer the data to the game and thus allow real-time control of the games. See figure 3.

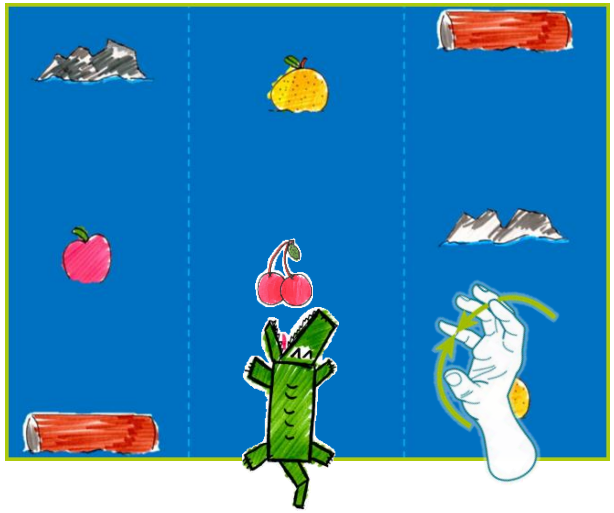


Figure 3. Therapeutic game "Super Crocco": Sensor data from the robotic hand controls the game play. To eat a fruit the patient opens and closes the impaired hand (grasping gesture).

Different games address different functional movements which are important for activities of daily living (ADLs). In the Crocco game collecting fruit serves to train a grasping gesture like reaching for a glass. Other movements are: Diving below wooden logs using wrist flexion or jumping over rocks using wrist extension. Lanes can be added for lateral arm movements. Other games address pinch grasping (involved in movements like picking up a pencil), pronation and supination (like turning a door handle), and arm movements. The therapist can adapt the training plan to make the game easier or more difficult. So far three games have been implemented.

Patients receive immediate feedback about their performance after the game finishes.

Patients are then free to turn the system off and return later which may be the most common case. They may also continue to the next prescribed game or level or explore their training progress and plan. Within "Messages" they can contact their therapist by text, voice or video message (offline).

Therapist UI

This UI is more complex than the patient's which fits the user group and their tasks. Therapists supervise multiple patients and need access to their detailed training progress and medical condition. Despite this the UI is very similar to the patient's but optimized for mouse usage in a desktop setting.

Figure 4 shows the HCP's planning screen. The main task for HCPs is to monitor the patient's progress and adapt the training plan accordingly. First they need to inspect the detailed "Progress" about the patient's performance. This includes not only gaming scores and achievements but also parameters derived from the orthosis sensor data during calibration and game play. Then the HCP selects the most appropriate games that the patient can play. Games are added or removed either by drag-and-drop or by using the arrows on the left hand side of the list. Basic game settings are

directly available in this screen as well as relevant information about the patient. Detailed descriptions for the games are also available. For the future developments of the interface a bigger pool of games may be filtered by criteria as e.g. which gestures and movements the game requires.

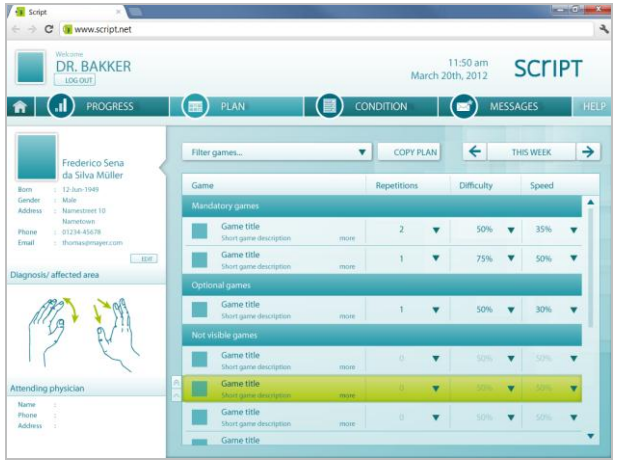
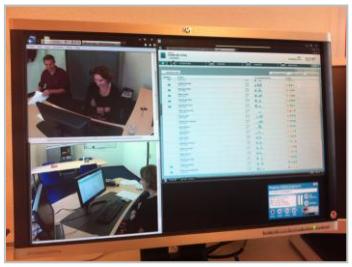


Figure 4. Therapist/HCP screen to set up the training plan.

The home screen contains an overview of the current list of supervised patients using the system with the most important information up-front. "Messages" mirrors the functionality for the patients; "Condition" contains results from surveys regularly administered to the patients.

Evaluation

During the development of the system focus groups, home visits including the application of cultural probes were used to gather and refine requirements. The results of these activities are not yet available at the time of when this manuscript is prepared.



Recording one of the tests in Enschede (Therapist UI).

A usability test of the UIs was conducted with an early prototype in late October 2012 (in the UK, Italy and the Netherlands, each testing 3 patients and 3 HCPs). These tests were qualitative in nature, i.e. meant to improve the UI. The results are not fully available at the time of this writing but indicate that the overall UIs were well-received by patients and HCPs. Findings point into the direction of further simplifying screens (e.g. patient's progress) and giving more supportive information, e.g. on (detailed) game descriptions. Some of the findings are due to preliminary content of the screens.

First feedback about the whole system including the orthosis comes from a co-operative evaluation in progress intending 5 home visits by three clinical sites and will be subject to future publications.

Currently (November 2012 till January 2013) we are performing an in-depth participatory evaluation with all the components of the SCRIPT system. Summative medical evaluation with 30 patients will be conducted using the system in their own homes. Results are expected in early Spring 2014.

Conclusion

The SCRIPT project has produced a working platform with a motivating user interface to support stroke patients in rehabilitation at home.

The system has now entered intensive evaluation that will continue in the following year with patients in real-use situations at home. The system will be improved and enhanced in parallel and subdued to further evaluation in the third year.

We believe that this system will be beneficial to patient recovery and for improving overall quality of life and that it may reduce hospital and home visits for patients and caregivers.

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