RESNA

Student Design Competition

SBS Skill Trainer with Video Feedback (Georgia Institute of Technology)

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SBS Skill Trainer

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Abstract

This project is a clinical rehabilitation tool in a form of an application that provides immediate and easy to understand video feedback to wheelchair users learning functional skills such as wheelies or surface transfers. We focused on three main aspects of implementation: clear UI design, carefully chosen set of features, and the challenges of the target training environment. The application has groups of features revolving around three activities: recording the patient performing a task, playing back the video while providing immediate feedback, and comparing the recording with previous sessions or expert videos. Through these three simple yet powerful features, the clinician will be able to optimize the training sessions. We evaluated the project with real users, ranging from inpatient clinicians to home care therapists, as well as a custom built usage tracker. As a result of all of our work, the application is ready for mainstream release.

Background

The benefits of using video feedback in motor skill learning have been widely documented, particularly for motor skill acquisition in athletics. However, despite its increasing affordability, accessibility and portability, video remains underutilized in rehabilitation settings. Reasons for this under-utilization are the lack of information about the efficacy of the technology, guidance for using the technology and ease of use. In an effort to overcome these barriers, this project developed a system capable of collecting video during the rehabilitation of wheelchair users that must learn many new skills. Some of these include basic wheelchair skills such as propulsion or transfers as well as advanced skills such as performing a wheelie or driving over a curb.

Originally, the project was designed for training wheelchair skills in Shepherd Center (1), one of the best rehabilitation hospitals specializing in spinal cord injuries. The ultimate goal of the center is to move the trainee from a state of dependence to independence by teaching them core wheelchair skills within a compressed training schedule. Side-By-Side (SBS) Skill Trainer was developed to assist patients in understanding what they are doing correctly or incorrectly. The tablet application was designed by a team of Georgia Tech students and directed by Professor Sprigle at the REAR lab(2) at Georgia Tech. Our team worked closely with some of the clinicians at the Shepherd Center, which provided invaluable feedback towards the project. To this day, the hospital continues using the application in their training environment.

Problem Statement

The objective of the project was to design a clinician rehabilitation tool that provides immediate and understandable feedback to wheelchair users learning new functional skills. SBS Skill Trainer is an easy-to-use application on a light-weight tablet, which will manage training videos in a secure and confidential manner, and facilitate immediate feedback for real-time training sessions.

Design Alternatives

Before the implementation of the project, we completed a great deal of research to pick the best tool for the job. Initially, the team considered using Microsoft Kinect technology, which has built-in motion capture capability and supports a group environment. After a few visits to the clinic and several conversations with our director and the clinicians at Shepherd Center, we realized that environments where our application would be used require a portable yet powerful device that is sturdy yet very light. Tablets have a built-in camera, portability, and a level of market availability that enabled us to make this project a success.

Approach

There are three very important aspects of SBS Skill Trainer that we focused on: simple UI that would facilitate our ease of use requirement, the three main features (play, record, compare), and the additional hardware to accommodate the training environment.

UI Design

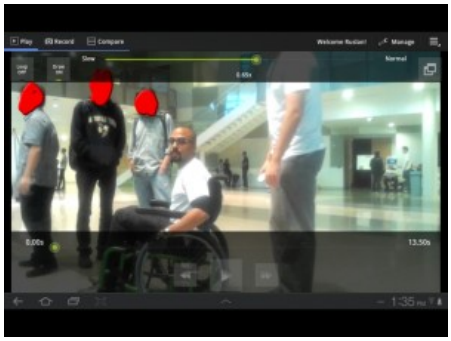
There several solutions already available on the market that can be used to help skill training. Dartfish(3), for example, has a full suite of software that professional coaches can use with their athletes. However, this type of software would not be very useful to clinicians due to its unnecessary complexity and hardware requirements. To achieve better acceptance by clinicians and differentiate ourselves from such products, we decided to focus on simple user interface as our main goal. The application has a very simple tabbed navigation and is free of unnecessary features that would make it confusing. A great deal of research and evaluation has been completed to get the application to a level it is at today. Some of the contributing factors are user feedback and usage tracking. The feedback on the application was gathered from Shepherd Center as well as other independent clinicians and professionals in the assistive technology field. Additionally, the app has a custom built usage tracking capability, which consists of gathering non-personally identifiable information, such as the number of times each feature is used or the time the user was in one mode as opposed to another. These anonymous statistics helped us better understand how the user interacts with the UI and what we needed to do to make it better.

Features

As mentioned previously, the application consists of three modes: play, record, and compare. In play mode, there is a gallery of videos available on the current device as well as smart filters that allow the user to get the training session he has in mind.

Gallery of Video Sessions

Once a video is selected, the playback starts which can be controlled with a specially selected set of controls. The standard play/pause controls are available, as well as loop, draw, frame skipping, and slow motion. Loop keeps the video restarting after getting to the end without user interaction. Draw allows the clinician to finger paint on top of the video to make important highlights for the patient. Frame skipping and slow motion enable the level of granularity that a clinician might need to get to an exact part of the skill motion he wants the patient to see.

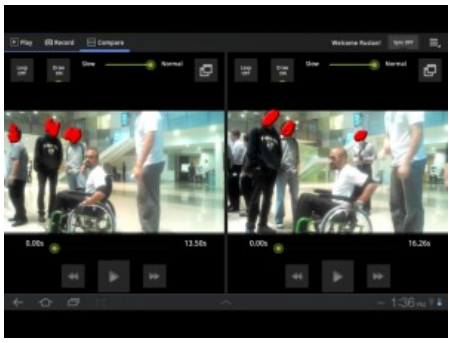


Playback Mode

Record mode enables the user to create new videos of the trainee in a quick and simple way. The application allows you to pick a camera (front or back facing), set a timer, and do a quick restart. A timer is a useful feature that forces the application to wait the specified amount of time after the users click record and the actual recording begins. A countdown is shown on the screen if a timer is specified. This is one of the features that we decided to incorporate into our application based on the environment where the device is used. The quick restart feature resets the recording and deletes the current progress.

Record Mode

Compare mode allows the user to select two videos they would like to see side-by-side. They are able to manipulate the videos with individual set of playback controls mentioned previously or a single set of controls in sync mode. The clinicians are able to show their trainees the correct vs. incorrect way of performing a task or encourage the patient by showing the progress they've made.



Compare Mode

Training Environment

A big part of the project was to accommodate the training environment where the device is to be used. For example, hospitals like Shepherd Center have large gyms with a group of clinicians and trainees working there simultaneously. It is a

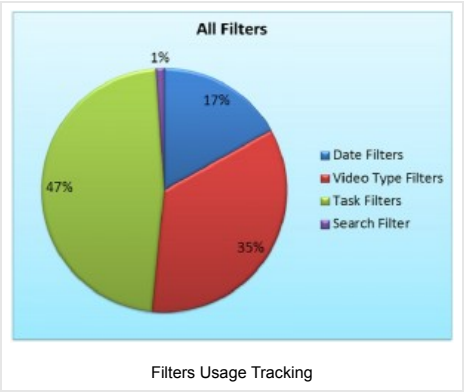
very busy and fast-paced environment with a lot of traffic. We needed to ensure that the tablet can withstand this type of environment and also perform well. Tablets can be rather fragile devices, so we encased them with military-grade cover that protects them from accidental drops or bumps. When the clinician is working with a patient, a lot of times the patient needs to be "spotted." Therefore, the clinician cannot hold the device, and there will not always be a person to hold it for them. Our team went through several iterations of hardware to find an appropriate mount for the tablet that allows it to be placed on most surfaces that are available. In addition to hardware, some of the software functionality is also designed in consideration of the environment. For example, the record timer allows the user to begin the recoding, get into the position for the task, and start the task when the countdown is completed. For the same purpose, the application also supports a Bluetooth remote that can start and stop the recording at the clinician's discretion.

Results

The project went through several feedback-driven development iterations. At the end of every iteration, a device was deployed into clinicians' or therapists' hands to use for several weeks. Additionally, we had a chance to participate in group training sessions and experience the targeted users in action. Surveys were gathered from the clinicians as well as open form written and verbal feedback. Some of the users testing the device were:

1. Inpatient therapists at Shepherd Center.
2. Pediatric PT in home care.
3. Pediatric OT in home care.

In addition to feedback and surveys, the custom built usage tracker provides us with vital information. The tracker focuses on several types of metrics, including period of use per feature, frequency of use, average selections, and some other general information. Period of use would tell us about statistics such as how long the user is in recording mode as opposed to playback. Frequency would bring out the most popular features or tell a story of the features that are not very visible even if they are useful. Using this information we were able to redesign the UI to a more efficient layout. Here is an example of usage extracted about filters. This chart resulted in making the task filter more prominent and the search feature more visible in the UI.



Filters Usage Tracking

Along with functional feedback, we also received a fair amount of praise for the project. Jennith Bernstein at Shepherd Center had this to say:

> *We had a great trial this morning! It was so cool to let the patient evaluate his own skill and "see" feedback...*

Discussion And Conclusion

The SBS Skill Trainer project assists wheelchair users in optimizing their learning of new skills. While designed for training wheelchair users, we believe the app can be used in any functional skill training. In fact, clinician evaluation included

dressing, task sequencing, and gait initiation activities. This Android application is in final stages of release to general audience through the Google Play market. The application targets both clinicians and patients and assists skill training by recording sessions and tracking progress in a simple, clean and efficient manner. We would like to make this project available to everyone interested in building almost any set of skills.

Cost

Extensive research has been dedicated to explore the market availability and price points of compatible tablets. The tablet is the minimum requirement for the project, and its price is the only cost for users. Additional supported gadgets, such as a remote or a sturdy case, are also recommended based on the environment where the device is used. The hardware research shows that there are near a half of dozen of commercially available tablets that are supported by this application that range in prices from $300 to $600. This makes the project a very affordable one already, and given the pace of technology this cost will most likely go down within a year or two.

Acknowledgments

We would like to thank our advisers, Stephen Sprigle and Jim Foley. We worked closely with these two professors throughout the duration of the project and hope to continue doing so. The effort started off in Computing for Good class at Georgia Tech and was developed with the REAR Lab. Special thanks to Jennith Bernstein at Shepherd Center as well as other clinicians that helped with evaluation of the project.

References

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