



Technical note

Evaluating the usability of a smartphone virtual seating coach application for powered wheelchair users



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ABSTRACT

The aim of the smartphone virtual seating coach (SVSC) was to provide a personalized reminder/warning system to encourage powered wheelchair users to use their powered seating functions (PSFs) as clinically recommended. This study evaluated the usability of the SVSC system by gathering feedback from five powered wheelchair users and five rehabilitation professionals through questionnaires and interviews. The results indicated that clear and understandable instructions to adjust the PSFs are the most important requirement for SVSC application. The instructions must be intuitive, could benefit from animations or indications of PSFs control buttons so powered wheelchair users can adjust their PSFs immediately and appropriately.

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1. Powered seating functions

Powered seating functions (PSFs), which include tilt in space, backrest recline, and legrest elevation, are critical functions for people who stay in their powered wheelchairs for long periods [1]. Through altering tilt and recline angles, positioning mechanisms help people with limited trunk control maintain seating stability and to re-position their body [2]. Adjusting posture dynamically and maintaining proper postural alignment by using PSFs is important for managing complications such as orthostatic hypotension, autonomic dysreflexia, spasticity, and edema [1]. frequent and well-performed repositioning exercises can redistribute skin pressure, thus reducing the risk of developing pressure ulcers [3]. Appropriate seating adjustments may also improve driving safety. For example, using the tilt function to compensate for the changes in the center of gravity while driving on a slope may prevent the wheelchair from tipping over or the user from sliding out of the wheelchair [1,4].

The Virtual Seating Coach (VSC) provides a personalized system which can promote proper utilization of PSFs based on clinical recommendations [5,6]. By comparing the seating function usage data with the clinical recommendations, the system provides tailored reminders to the users [5]. The VSC includes safety warnings, such as tilt angle adjustments while driving on slopes and repositioning reminders. Clinicians can customize the coaching program based on individual conditions, hence training can be extended beyond the clinical setting. Through individualized reminders proper usage of powered seating functions can be facilitated in their daily environment.

The Smartphone VSC (SVSC) was designed as an easily installed add-on system to be applied to powered wheelchairs with PSFs. In SVSC, accelerometers were connected to a microcontroller which converted the analog sensor signals into digital data and sent them to an Android smartphone [7,8]. A Kalman filter was applied to decrease the noise. A smartphone cradle was designed to be easily mounted on the armrest of powered wheelchairs. The cradle allowed the users to position the smartphone based on their individual preferences to view the information displayed on the smartphone and operate their smartphones with greater ease. Our SVSC app has the ability to analyze the seating angle data and give users recommendations (Fig. 1). For example, when users are driving downhill on a steep ramp, the app will remind the users to tilt the seat backward to improve sitting stability. The app shows the angle information as well as the target angle so the users can understand how to adjust their seating angles. The reminder display effects will change depending on how the users set up their

Abbreviations: SVSC, Smartphone Virtual Seating Coach; PSFs, Powered Seating Functions.

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Fig. 1. Screenshots of the Smartphone Virtual Seating Coach application.

1. Main Menu: Showing the angles of the powered wheelchair, including seat tilt, backrest recline, legrest elevation and wheelchair base inclination.
 2. Statistics display of powered seating functions usage: Users can review their progress of using seating functions. The goal is to increase the compliance with performing repositioning and decrease the number of seating function usage warnings.
 3. Instruction Menu: Instructing the users to adjust their wheelchair. The angle bars highlight the target angles in green based on the clinical recommendations. The white indicators point out the current seating angles and move as the user adjusts the seating angles.
 4. Clinician Setting: Clinicians can customize reminder and warning parameters for users.
- The screenshots of repositioning exercise and safety warning reminders.
- (A) Repositioning exercise reminder which pop out on the top of the screen.
- (B) Safety warning reminder which shows like a text message.
- (C) The users need to scroll down the navigation bar to click the message to read the instruction of changing PSF.

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