PAPER

Personal Mobility

A. AGUIRREZABAL, D. ASHLEY, R. ALQASEMI, S. CAREY, S. SUNDARRAO, R. DUBEY. Enhanced control to improve navigation and manipulation of power wheelchairs. Gerontechnology 2018;17(Suppl):91s; https://doi.org/10.4017/gt.2018.17.s.089.00 **Purpose** Power wheelchairs are used by individuals with a broad array of disabilities including myopathy, spinal cord injury (SCI) with tetraplegia, head injury, stroke, degenerative diseases (e.g., MS, MD), cerebral palsy, poliomyelitis, amputations and age-related disability. Approximately 6.8 million non-institutionalized Americans utilize mobility devices, including wheelchairs, scooters, walkers and canes[1]. Numerous power wheelchair control interfaces have been developed which aim to be universal in nature, suit many types of disabilities[2]. However, some require cumbersome EEG signals[3] are slow to react[4] or require many pieces of custom hardware additions[5]. Additionally, some users may suffer from unilateral neglect or other spatial awareness issues and might find it difficult to navigate in certain directions while using a wheelchair[6]. The power wheelchairs motion may not always adequately represent the users' intended motion. Additionally, sometimes the architectural layout of a building or home may not appropriately accompany individuals who use wheelchairs[7]. **Method** Our team developed a mobile wheelchair control kit designed to allow power wheelchair users the ability to manoeuvre their wheelchair without the need to manipulate a joystick with their hands. We use a smartphone and its internal accelerometer sensor to detect the vector of gravity, and thus detecting the pitch and roll. These values are converted into motor commands and sent via Bluetooth to the custom wheelchair controller. Collision avoidance was implemented into the control kit to allow for remote operation, collision avoidance, and navigation assistance. To determine the viability of using this kit as well as which features to further develop, a customer discovery was completed. Over a hundred interviews of power wheelchairs users, therapists, care takers, manufacturers, dealers, and assistive technology professionals were conducted at clinics, tradeshows, disabilities support groups, and rehabilitation organizations. The goal of these interviews was to meet power wheelchair users, ask about their lives in a power wheelchair and identify pain points of wheelchair use. After the customer discovery, data were collected while ten able bodied non-wheelchair users completed eight tasks with and without the use of the obstacle avoidance feature. **Results & Discussion** The conducted surveys show that most power wheelchair users were content with joystick control methods. The sub-features of the control kit, such as remote operation and collision avoidance, had more value than the control method itself. Some power wheelchair users were aware of back up cameras to help with wheelchair navigation. The able-bodied user study showed that the system could avoid collisions. Future work will concentrate on removing excess weight from the control kit as well as improving the ease of installation of the kit to any power wheelchair.

References
1. Kaye HS. National Institute of Disability and Rehabilitation Research, U.S. Dept. of Education, 2000
2. Cruz CD, Bastos TF, Cheein FA, Carelli R. SLAM-based robotic wheelchair navigation system designed for confined spaces 2010
3. Li J, Liang J, Zhao Q, Hong K, Zhang L. International Journal of Neural Systems 2013; 23(03)
4. Craig DA, Nguyen HT. IEEE Engineering in Medicine and Biology Society 2005; 6:6235–6238
5. Mitzlaff P, Niznik R, Alqasemi R, Dubey R. International Mechanical Engineering Congress & Exposition 2014
6. Webster JS, McFarland PT, Rapport LJ, Morrill B, Roades LA, Abadee PS. Arch. Phys. Med. Rehabil 2001; 82(6):769–775
7. RodriÂguez AG, Herrera RM, Batlle VF, Sanjuan PP. Industrial Robot: International Journal of Robotics Research and Applications; 34(2):110–115

Figure 1. Power wheelchair driven by an Android smartphone attached to a hat