An Intelligent Powered Wheelchair to Enable Mobility in Older Adults with Cognitive Impairments

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Abstract

Mobility has been identified as a key component of physical well-being and happiness, enabling people to interact with their surroundings. Unfortunately, the mobility and independence of many older adults is often reduced due to physical disabilities. Physically disabled older adults with cognitive impairments, such as dementia, lack the skills required to safely manoeuvre powered wheelchairs. Exclusion from the use of powered wheelchairs and the lack of strength needed for manual wheelchair use result in greatly impaired or non-existent mobility for a large number of LTC residents. Reduced mobility often leads to decreased opportunities to socialize, thus leading to social isolation and depression. Loss of mobility also results in increased dependence on care-givers in order to fulfill daily tasks. It is thus imperative to design wheelchairs that enable safe and independent mobility, thereby improving the quality of life of wheelchair users while simultaneously reducing the burden on caregivers.

In this poster, we describe an intelligent powered wheelchair that ensures safe navigation by preventing collisions with obstacles in the user's environment. To date, we have created two prototypes of an anti-collision system that stops the wheelchair if collision with an object is imminent, and provides verbal prompts to help the user navigate around the obstacle. The first prototype used a 3D infrared sensor, however, test results have shown that while the infrared sensor operates with high efficacy in a controlled laboratory environment, it performs poorly in the presence of natural daylight. To address this issue, a newer prototype employs a stereovision camera, creating a system that is more reliable in both controlled and naturalistic environments. We present a comparison of these results along with a discussion of the robotics-based algorithms implemented in the intelligent wheelchair system. Additionally, we propose future work that will include more advanced path planning and decision-making capabilities.

Previously-developed intelligent wheelchairs that help with planning and navigation tasks include Wheelesley, NavChair and PlayBot, however these wheelchairs are designed for autonomous navigation with little or no supervision by the user. A powered wheelchair that moves on its own can lead to confusion and frustration among the targeted user population. On the other hand, wheelchairs that leave the majority of the planning and navigation to the user and assist solely in collision avoidance are also not ideal for users

with cognitive impairment, as their planning capabilities are often quite limited. We thus propose a mixed-initiative control strategy, where the wheelchair relies both on its own intelligence as well as user preferences and abilities. This strategy provides the user with supportive, passive assistance in navigating his/her environment without taking the control away from the user.

The proposed intelligent wheelchair system will be able to assist in navigation by constructing maps of the user's environment using computer vision techniques. The system will also learn locations of interest to the user by using his/her daily schedule (provided to the system as input from a caregiver), observing his/her patterns of daily behaviour, and using any other available information, such as a schedule of special events held at the LTC facility (e.g. a barbeque). Path planning will involve computing the optimal route based on the wheelchair's current and desired locations, obstacles in the wheelchair's path, and other contexts such as user preferences. Guidance will be provided to the user through visual and/or audio prompts. It is anticipated that this feedback will assist wheelchair users in getting to places of interest in a timely fashion, as well as encourage them to explore and interact with their environments in a safe manner. Future work will also involve testing the system in various environments (indoor and outdoor), under different weather conditions, and on different types of floor surfaces (e.g. tiled, carpeted etc.). Subsequently, the system will be tested in LTC facilities with older adults with cognitive impairments, the intended users of this new assistive technology.

Keywords: Mobility, older adults, computer vision, assistive technology, wheelchairs, cognitive impairment, dementia, path planning

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