EENG 472 Senior Project Proposal
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This is a one semester senior project.

Faculty advisors:

• Roman Kuc, Professor of Electrical Engineering (primary)
• Brian Scassellati, Professor of Computer Science

Background

Robotic wheelchairs have been an active area of research for over two decades. A wheelchair that has the ability to move autonomously or semi-autonomously, in a variety of environments, has the potential to greatly improve the quality of life of the wheelchair user. The utility of such a robot can range from making navigation less tedious to completely controlling the motion of the wheelchair for someone who is not capable of controlling the motion at all.

A robotic wheelchair is an attractive platform for this project for several reasons.

• Yale already owns an electric wheelchair, with inputs for a microcontroller to control the chair’s motion.
• A wheelchair is a stable and low-speed system, compared to other platforms like a flying drone or a car.
• Creating an appropriate technological solution for disabled people requires unique HRI design considerations.

Related work

Different robotic wheelchair projects over the past 20 years have focused on slightly different use cases. In research by Perkowski and Stanton in 1991, a wheelchair was designed that only worked when a complete map of the interior of a building was available. In 1992, Wakaumi et al built a system that only works when a magnetic lane is drawn on the floor. Both of these are useful results, but they are limited by their requirements for knowledge/modification of the environment. In 1996, Simpson et al built the Navchair, which uses a ring of sonar sensors at torso level to navigate indoor environments. People who are unable to drive a standard electric wheelchair were able to drive the Navchair using a combination of voice commands and sonar sensor guidance.
Proposal

The goal of my project is to build a robotic wheelchair that automatically moves next to a person who is walking, to facilitate carrying on a conversation. It should follow next to the walking person autonomously, avoiding obstacles when necessary. It should also react in a reasonable manner to situations where it cannot simply follow next to the person, e.g. when the two people go through a narrow doorway.

The person walking may have to modify their appearance in some way (e.g. attaching a specific color patch to their clothing), but this seems relatively unencumbering compared to the benefit for the wheelchair user of being able to carry on a conversation without worrying about controlling the chair.

There will also be a simple control interface that the wheelchair user will use to activate/deactivate the system, and possibly provide some guidance to the system on how to act in certain cases. But the user should never, or rarely, have to resort to using a joystick for manual control while the wheelchair.

In addition to facilitating conversation, such a robotic wheelchair could be useful when a walking person needs to guide a wheelchair-bound person through a building, perhaps in a hospital or nursing home setting. Rather than have the walking person go in front and be followed from behind with manual control, having the two people move next to each other could create a perception of greater equality.

Implementation

Although this use case is slightly different from (and narrower than) the other use cases mentioned above, it will build on previous solutions that have been explored. Sonar has proven its effectiveness in these navigational tasks and will be one of the sensing components used. Additional sensors may include visual cameras, laser rangefinders, and infrared depth sensors.

For signal processing and computation, I plan to use a platform like the Raspberry Pi which has robust computational power, but also the electronic prototyping capabilities of a microcontroller. I may end up using multiple computation devices, such as a desktop computer and an Arduino, depending on which system is easier to implement.
Timeline

Here is a rough timeline for the project, subject to adjustment:

• February 14: Sensors and computation platform chosen
• March 7: Preliminary sensor mounting complete
• April 1: Hardware finalized, early software prototyping
• April 18: Hardware + software finalized
• April 25: Documentation complete

Deliverables

The deliverables for this project will be:

• The robotic wheelchair system
• A written report describing the final system, the theory behind the system, and the process of creating the system.

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