Software Control of an Electric Wheelchair

Degree programme: BSc in Micro- and Medical Technology
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The Bern University of Applied Sciences is developing an assistive robotic arm to enhance the independence of wheelchair users with upper limb impairments. The arm can help pick up objects from the floor or grab them from the table. However, more complex tasks, like opening a door, require coordinated motion of the wheelchair and robot arm. With this as the ultimate goal, this thesis develops software control for the electric wheelchair.

Introduction

Currently, the user must position the wheelchair manually to bring objects within reach of the robot arm. For more complex tasks, such as opening a door, the wheelchair and arm motion must also be coordinated by the user. To improve usability, the wheelchair and robot motions could be synchronised, which requires them to be controlled by the same software. Therefore, the goal of this thesis is to develop a method that enables software-controlled wheelchair steering while preserving the user's ability to control it as usual.

The user control unit of the wheelchair has two modes: one for adjusting the seat and another for driving. When in driving mode, a joystick controls both the speed and direction of movement. Additionally, to better adapt to different environments, the user can select between various speed profiles that determine the maximum velocity.

Method

The user control unit, used to control the wheelchair manually, is connected via an R-Net to the master module, which controls the entire wheelchair. At first, software-generated messages were fed into the bus to take control. This did not work because the additional data resulted in a bus error. Hence, the communication bus is bypassed by directly manipulating the electrical signals inside the user control unit.

Figure 1: The assistive robot used at home to pick up an item from the floor.

Result

The implemented solution uses analogue signals to simulate the use of the joystick. To ensure that the joystick remains functional, additional components (Fig. 2) are used to enable switching between the two steering methods. To increase safety, the signal from the joystick is constantly monitored. In the event it is used, the automatic steering is stopped and control is returned to the user. When the dip-switches (Fig.2) are turned on, the wheelchair can be used without starting the robot software.

Future Work

Currently, the wheelchair is controlled in an open loop. To use it like a differential drive mobile robot, additional sensors will be needed to measure the actual velocity of each wheel, the direction of travel and the distance to surrounding obstacles. In a closed-loop system, the sensor data will be used to calculate the real position of the wheelchair and synchronise any motions with those of the robot arm.

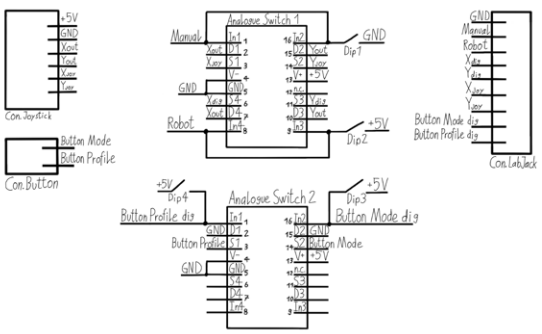

Figure 2: Curcuit diagramm to switch between steering methods and changing the wheelchairs mode and profile.


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