Semi-Autonomous Wheelchair

Sponsors: Team Gleason, WSU Intelligent Robot Learning Laboratory and Microsoft

Mentors: Dr. Matt Taylor and Jon Campbell

Robin Hartshorn, Ryan Huard, Kait Johnson, Greg Nelson, Ruofei Xu

Motivation

Improve the lives of ALS patients by providing them an affordable tool for greater autonomy in navigating their home. We have created software which controls a motorized wheelchair enabling semi-autonomous navigation. Our prototype semi-autonomous wheelchair simplifies the navigation process, allowing different levels of control depending on users ability.

Background

Amyotrophic Lateral Sclerosis (ALS):
- Progressive neurodegenerative disease impairs motor skills
- Many patients, even in late stages, can still move their eyes
- Affected typically confined to bed or specialized wheelchair

Previous work:
- Utilizing controls for the chair, obstacle detection and software architecture

Design

UI: Accepts input and displays feedback
Navigator: Plans route using map and sensor input
Door Detection: Localizes door and traverses door
Vision: Identifies obstacles based on Kinect output

Implementation

Door Detection

- Color-based detection: Finds objects matching the known size and color of a door
- Infrared-based detection: Uses Kinect infrared stream to identify reflective tape on door frame
- Depth-based detection: Uses Kinect depth stream to identify regions of contrasting depth

These three techniques, used in combination, improve overall door detection accuracy

Mapping

- Caregiver uses our MapMaker tool to generate map
  - Identify rooms, connections and objects
  - Relates real world to internal
  - Finds safest path around obstacles
  - Dijkstra’s algorithm finds best path

Requirements

- Build on existing code
- Safe autonomous navigation using a map
- Recognize and traverse doorways using Kinect v2
- Track wheelchair position using an IPS
- Avoid obstacles

Hardware

Kinect: Microsoft Kinect v2
IPS: Marvelmind Robotics Indoor Navigation System
IMU: Bosch BNO055 Intelligent 9-axis orientation sensor
Sonar: HC-SR04 Ultrasonic sensors

Impact and Future Work

Impact
- Increased awareness and community involvement with ALS
- Greater autonomy for ALS patients

Future Work
- Improve localization
- Replace outdated hardware

Workshop Paper
- Submitted a workshop paper
- Includes results from three different tests:
  - Door navigation
  - Point-to-point navigation
  - Avoid obstacles

Acknowledgements

Special thanks to Gail Gleason and the Sprenger family and Team Gleason for all the support they have given us. For their help and guidance, thanks to Dr. Sakire Arslan Aya, Dr. Matt Taylor and Jon Campbell. Thank you to James Irwin, Team Aaryn, the WSU Mechanical Engineering team and the Sports Management Fundraising Teams.

Team Mormont

Glossary

EyeTribe: Eye tracking sensor
IMU: Inertial Measurement Unit (Indoor Compass)
IPS: Indoor Positioning System (Indoor GPS)

Special thanks to Robin Hartshorn, Ryan Huard, Kait Johnson, Greg Nelson, Ruofei Xu and Team Mormont for their contributions.