An Embedded Robotic Wheelchair Control Architecture with Reactive Navigations

Design by:

Chung-Hsien Kuo, Yao-Sheng Syu, Tsung-Chin Tsai and Ting-Shuo Chen

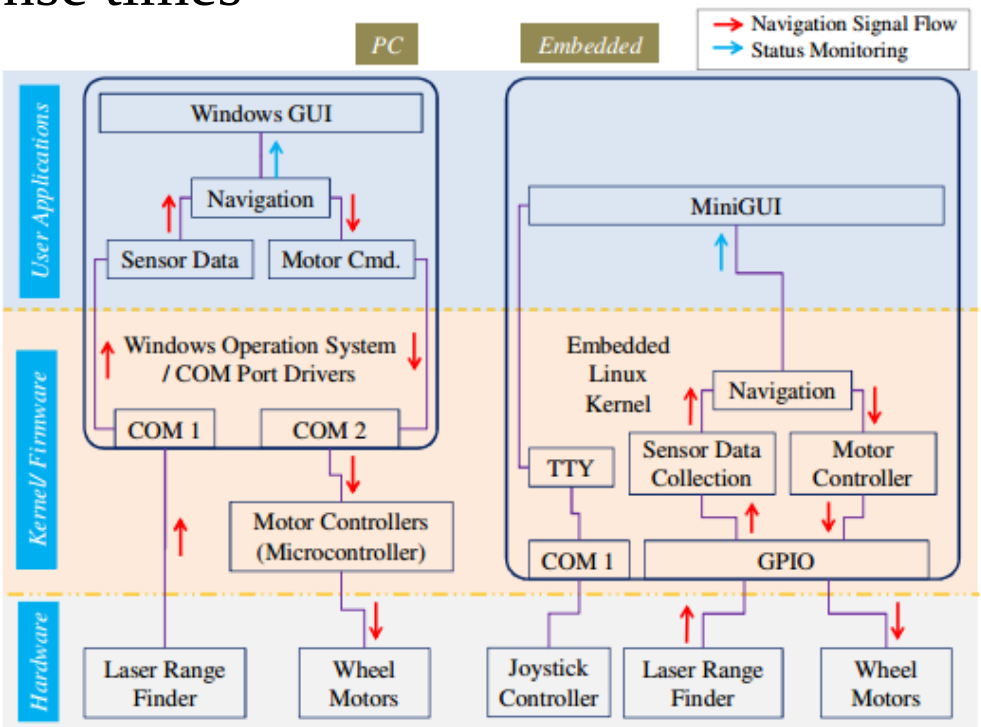
Presentation by:
Joshua Henderson

Motivation

- Lower costs of automated wheelchairs
- Give increased mobility to the handicapped
- Increased safety of the handicapped

Navigation Architectures

- Embedded approach allows faster real-time responses
- Reduces the need for interrupts and polling at the application level
- Allows for faster response times

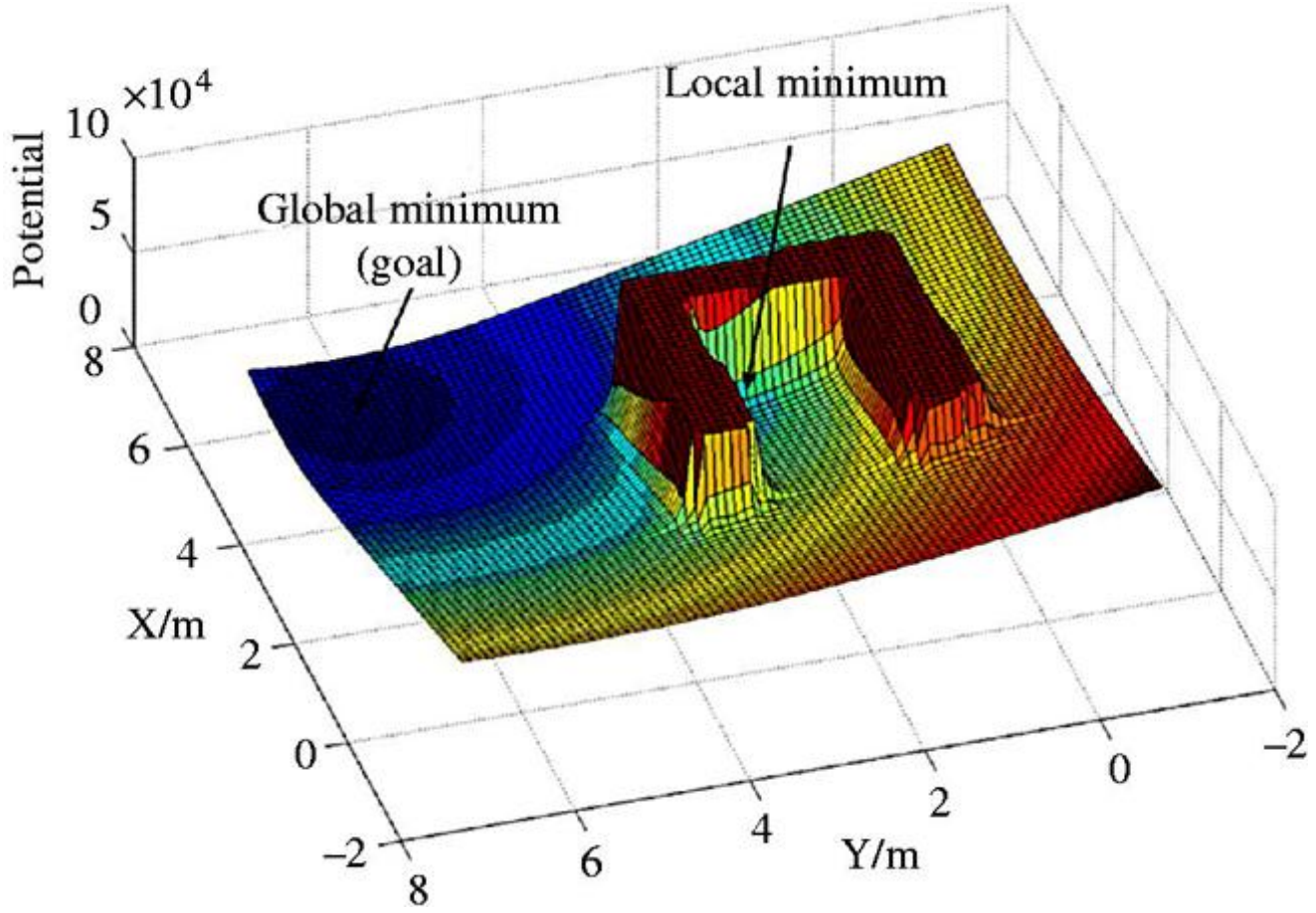


Microcontroller

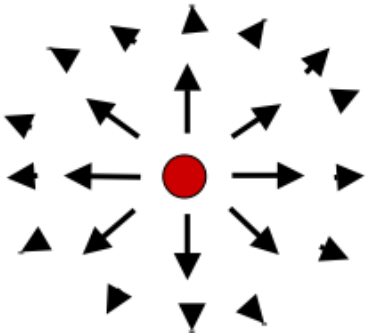
- Xscale PXA270
  - Part of Marvell's implementation of the ARMv5 architecture
  - Embedded Linux with kernel 2.6.15

Artificial Potential Fields (APF)

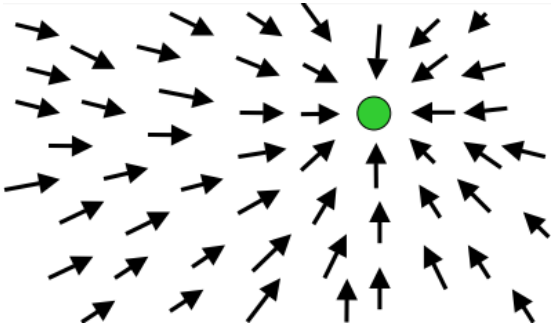
- Desired destination is represented by low points
- High points are objects to be avoided



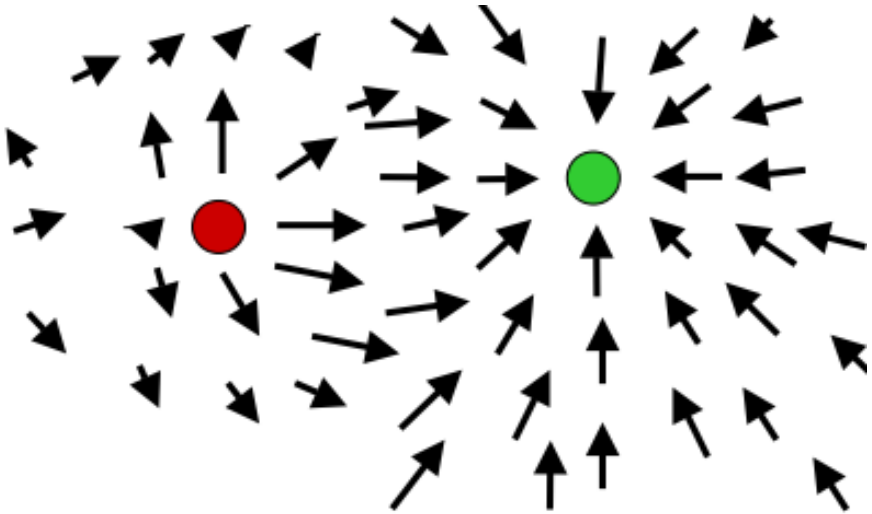
Artificial Potential Fields



Obstacle



Destination



Navigation Flow Chart

- Reactive Navigation is inactive until an obstacle is within 2m
- Applies APF
- Generates Justified Command

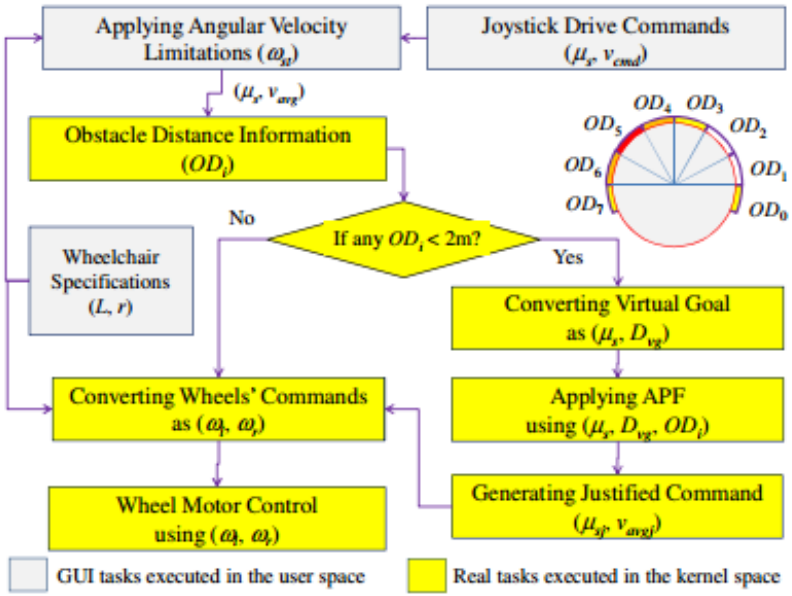
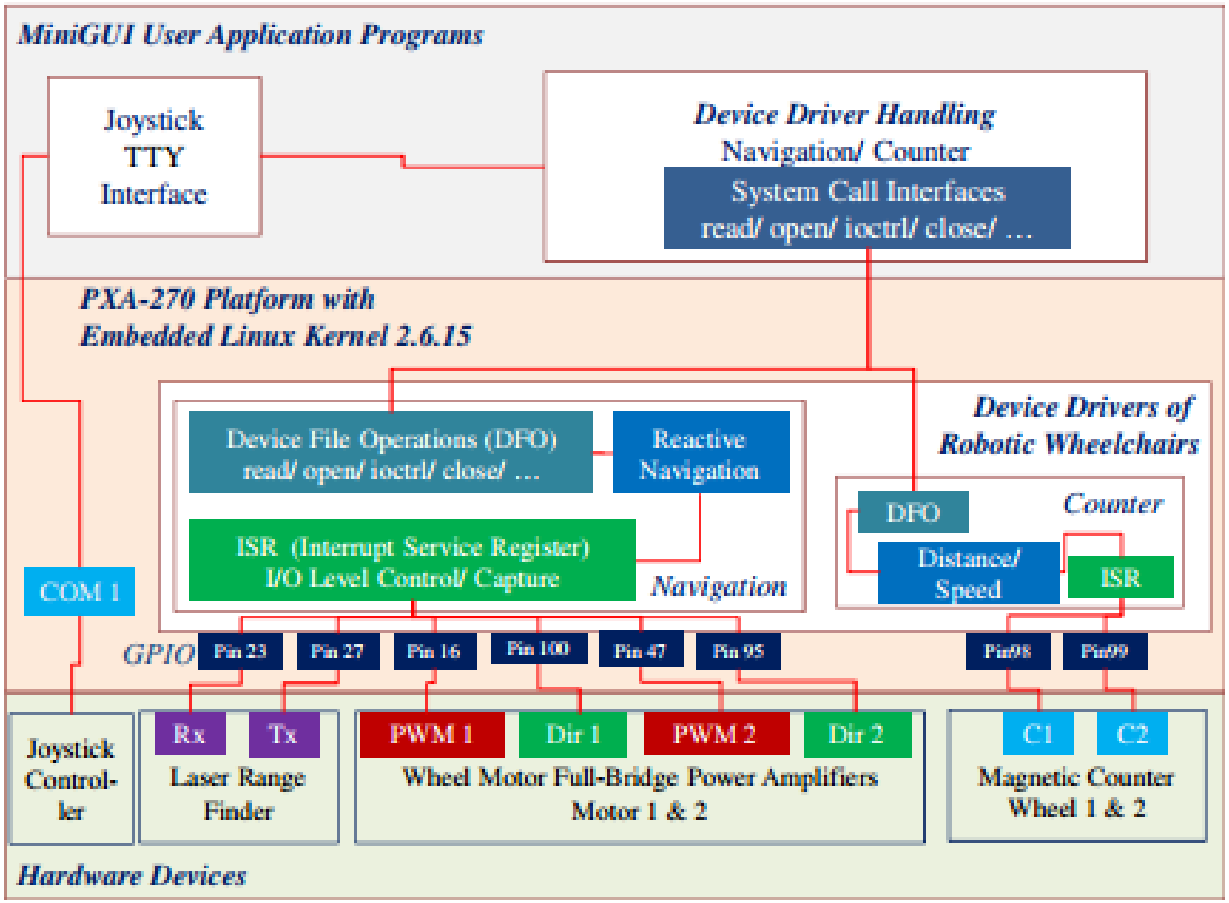
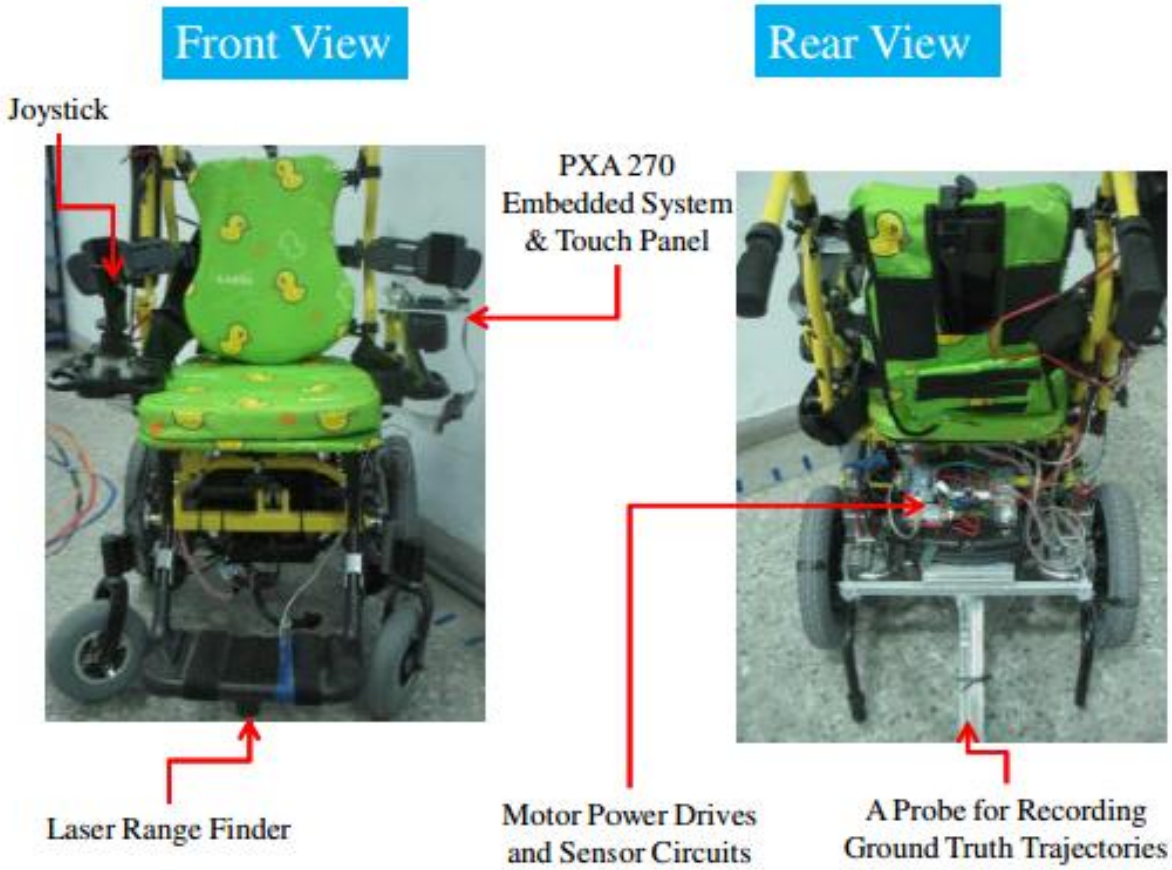


Fig. 2. Reactive navigation architectures.

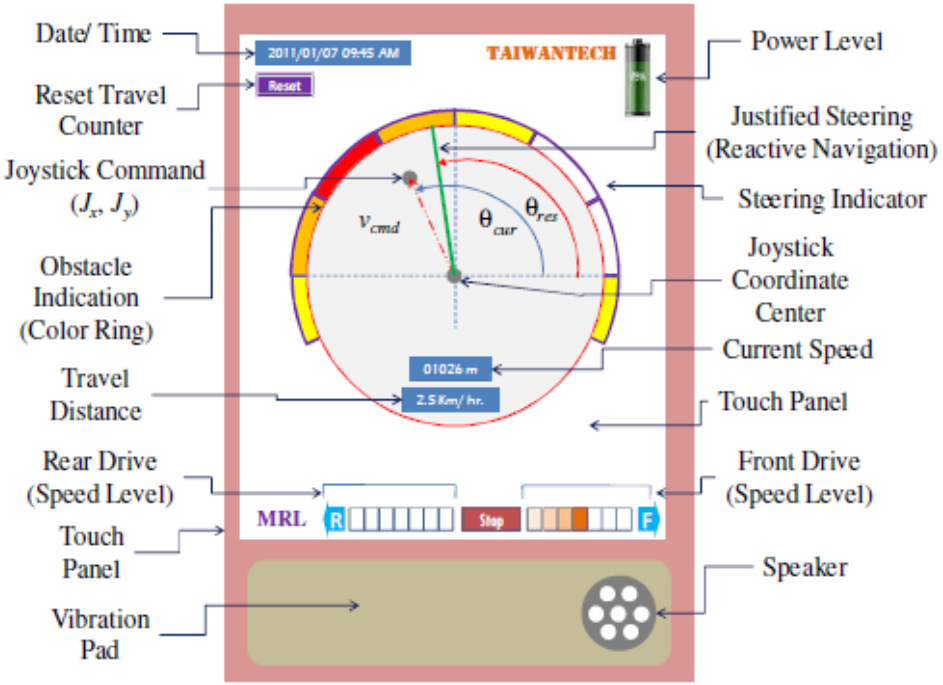
System Architecture and Device Drivers

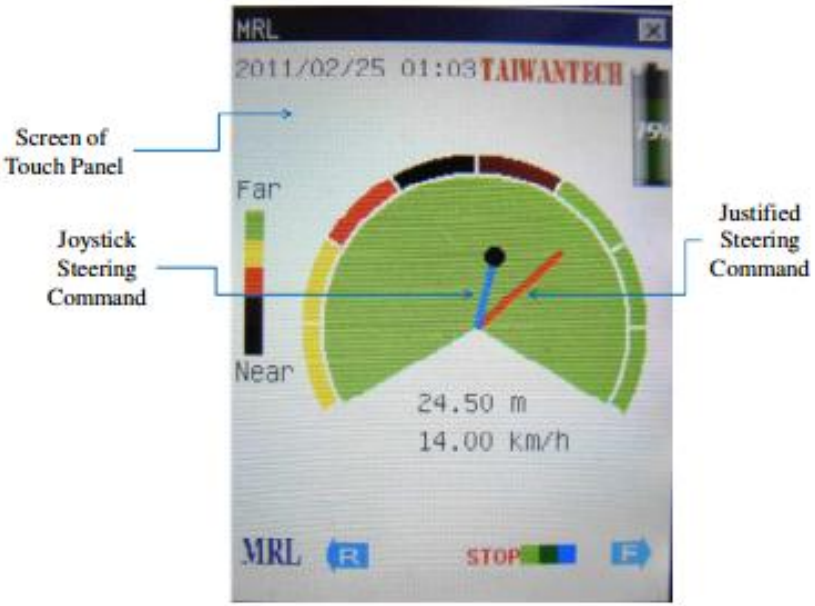


Wheelchair


Front View
Rear View
Joystick
PXA 270
Embedded System
& Touch Panel
Laser Range Finder
Motor Power Drives
and Sensor Circuits
A Probe for Recording
Ground Truth Trajectories

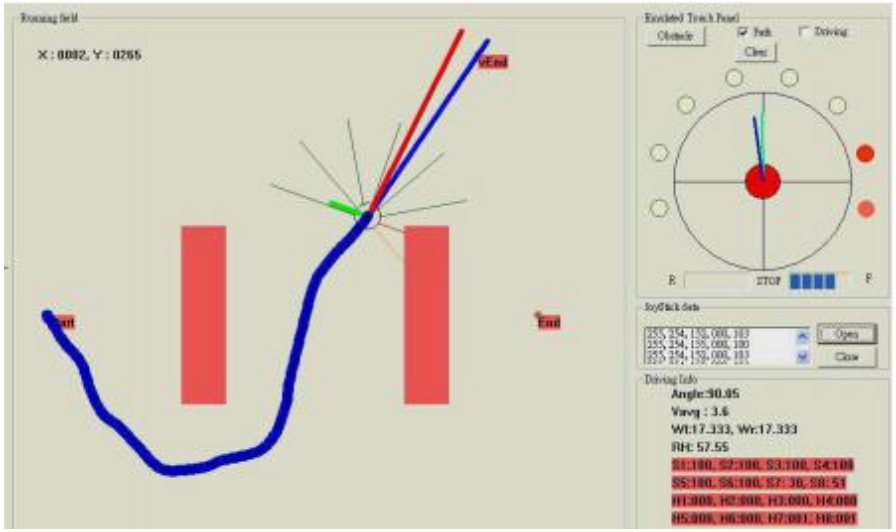
GUI and Information Display



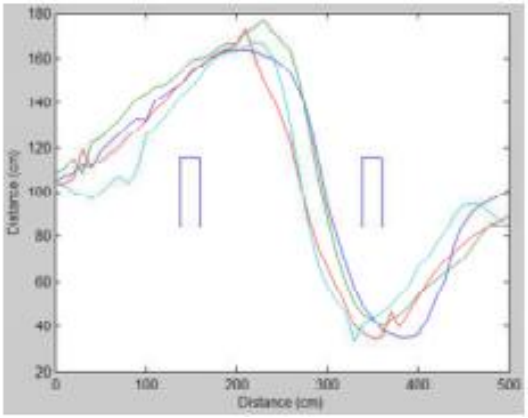


Simulation

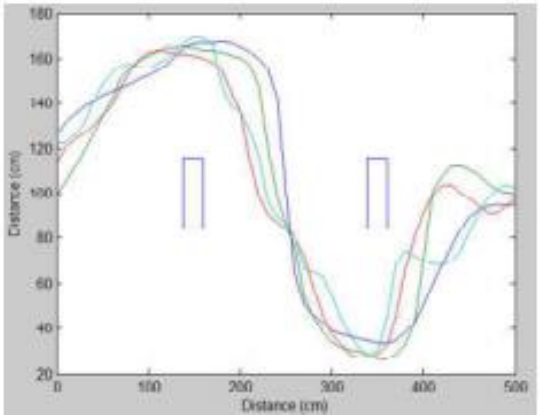
Simulated using Microsoft Visual C++



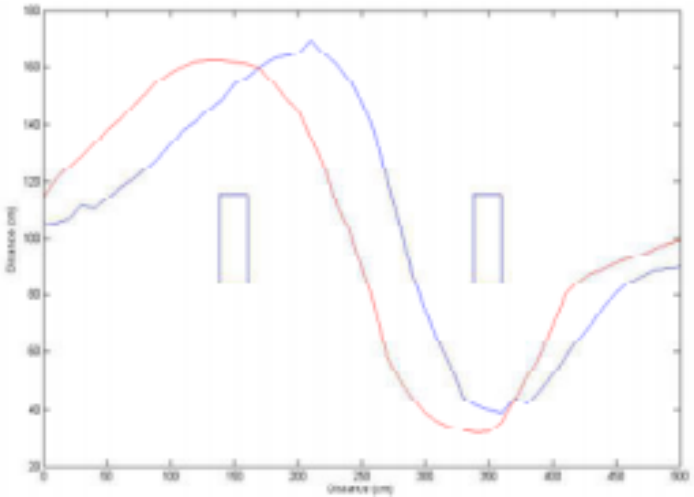
Results



Manual Navigation



Reactive Navigation



Red = Reactive
Blue = Manual

Averaged Results

Conclusion

- Embedded Systems result in lower costs and provide improved reaction times
- Reactive Navigation gives the user a smoother ride and helps prevent collisions
- Future Improvements
  - Voice commands
  - Fully autonomous navigation

References

http://www.youtube.com/watch?v=r9FD7P76zJs

http://web.eecs.utk.edu/~parker/Courses/CS594-fall08/Lectures/Oct-16-Potential-Fields.pdf

http://en.wikipedia.org/wiki/XScale

J. Liu, H. Zhang, B. Fan, G. Wang, and J. Wu, “A Novel Economical Embedded Multi-mode Intelligent Control System for Powered Wheelchair”

Chung-Hsien Kuo, Yao-Sheng Syu, Tsung-Chin Tsai and Ting-Shuo Chen “An Embedded Robotic Wheelchair Control Architecture with Reactive Navigations”