MASTER'S THESIS
PROJECT PLAN

August 2014

Robot control by user tracking with a laser range scanner

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1 Project Description

1.1 Overview

`SmartWalker` is a high-tech extension of a walker that aids people of reduced mobility in moving around. The walker is equipped with sensors and actuators and is designed to function both *autonomously* and *non-autonomously*. This project addresses the challenges in the non-autonomous mode, in particular, controlling the walker's velocity according to its user's movement. The goal of this project is to develop a human detection and tracking algorithm and use the information to control the walker. The work will involve processing laser data to detect and track the user's leg movement, writing a control loop for the walker to move accordingly, and testing the algorithms with real people in various environment.

1.2 Scope of the work

Non-autonomous-Mode (primary)

- Description of different leg shapes
- Leg movement/walking characteristics, especially of older persons
- Leg detection behind the walker
- Walking detection
- `SmartWalker` wheel control in coordination with leg movement/walking

Autonomous-Mode (secondary)

- Leg detection in front of the walker (automatic mode)
- Walking detection
- `SmartWalker` follows the walker

1.3 Intended results

A person behind the walker is detected by its legs. The moving of the `SmartWalker` is controlled by following the leg movement.

2 Background Material

2.1 Reading list

- A novel system for tracking pedestrians using multiple single-row laser-range scanners [8]
- Detection and tracking of multiple pedestrians by using laser range scanners [6]
- People Tracking Using a Robot in Motion with Laser Range Finder [5]
- ...
- Multisensor-Based Human Detection and Tracking for Mobile Service Robots [1]
- Detection and tracking of human legs for a mobile service robot [4]
- Fast line, arc/circle and leg detection from laser scan data in a player driver [7]
- Detection, motion planning and control of human tracking mobile robots [3]
- Detection of Human Pairs of Legs in 2D Laserscans [2]

3 Project Management

3.1 Objectives and priorities

1. collect laser scanner data from different situations *(high)*
2. human leg and walking detection by two legs, eg. wearing shorts or pants *(high)*
3. human leg and walking detection when wearing a skirt *(mid)*
4. find a model to translate the walking detection into `SmartWalker` movement (Non-autonomous-Mode) *(high)*
5. include the environment into the movement control, eg. obstacle avoidance *(mid)*
6. report *(high)*

3.2 Criteria for success

The `SmartWalker`'s movement can be controlled by the person behind the walker just by walking.

3.3 Method of work

- Use well know Software Engineering concepts, like Design Patters, Testing Suites
- Continuously write down a log book (makes writing the thesis simpler at the end)

3.4 Quality management

- Permanent testing of the source code
- Tests with real people

4 Plan with Milestones

4.1 Project steps

1. leg detection
2. walking detection
3. SmarkWa

4.2 Deadline

February 2015

4.3 Tentative schedule

5 References

[1] N. Bellotto and Huosheng Hu. "Multisensor-Based Human Detection and Tracking for Mobile Service Robots". In: *Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on* 39.1 (Feb. 2009), pp. 167–181. ISSN: 1083-4419. DOI: `10.1109/TSMCB.2008.2004050`.

[2] Applied Informatics Group, ed. *Detection of Human Pairs of Legs in 2D Laserscans*. URL: https://aiweb.techfak.uni-bielefeld.de/node/667.

[3] Dong-Hyung Kim et al. "Detection, motion planning and control of human tracking mobile robots". In: *Ubiquitous Robots and Ambient Intelligence (URAI), 2011 8th International Conference on*. Nov. 2011, pp. 113–118. DOI: 10.1109/URAI.2011.6145943.

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[6] Xiaowei Shao et al. "Detection and tracking of multiple pedestrians by using laser range scanners". In: *Intelligent Robots and Systems, 2007. IROS 2007. IEEE/RSJ International Conference on*. Oct. 2007, pp. 2174–2179. DOI: 10.1109/IROS.2007.4399152.

[7] J. Xavier et al. "Fast Line, Arc/Circle and Leg Detection from Laser Scan Data in a Player Driver". In: *Robotics and Automation, 2005. ICRA 2005. Proceedings of the 2005 IEEE International Conference on*. Apr. 2005, pp. 3930–3935. DOI: 10.1109/ROBOT.2005.1570721.

[8] Huijing Zhao and R. Shibasaki. "A novel system for tracking pedestrians using multiple single-row laser-range scanners". In: *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on* 35.2 (Mar. 2005), pp. 283–291. ISSN: 1083-4427. DOI: 10.1109/TSMCA.2005.843396.