

Mappino - Open Source Robot for Learning about IR Range Scan Matching

Albert Diosi

www.diosirobotics.net/mappino.html

Independent, self sponsored research

albert.diosi@gmail.com

Samorin

Slovakia

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Introduction / Motivation

- Around the world many people build mobile robots for fun.
- More and more schools include robotics into their curriculum.
- Localization can make many tasks for mobile robots easier.
- There seems to be a lack of attention on localization on hobby / mid level education level.

Introduction - 2D Scan Matching

- Range scanner: Collects range readings at given bearings.
- Range scan: Set of range readings and corresponding bearings.
- Scan matching: Finding the rotation and translation between two scans maximizing overlap.
- Applications: Localization and mapping.

Overview

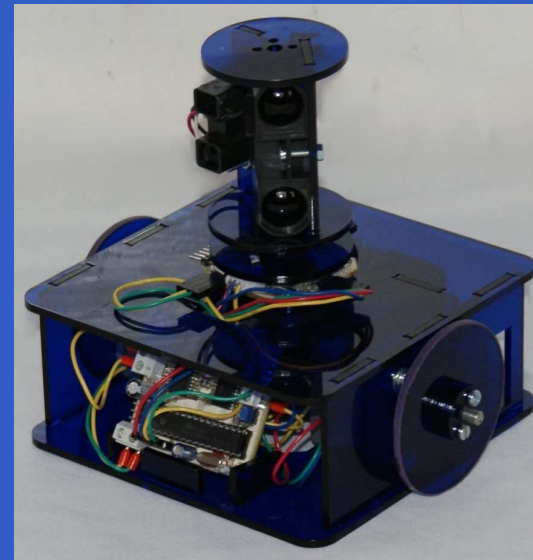
- Robot requirements.
- Mappino v0.1.
- Experimental results.
- Applications.
- Conclusions.

Robot Requirements

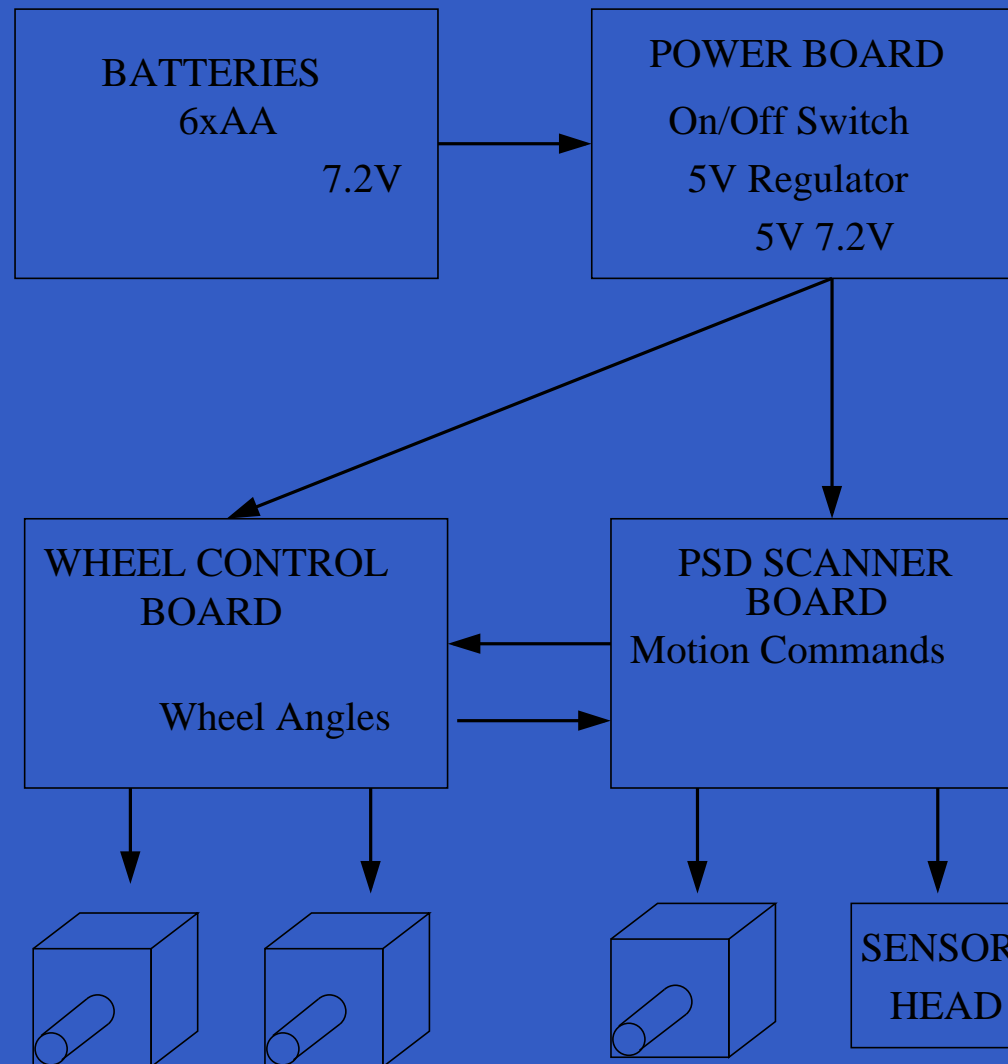
- As simple and cheap as possible.
- Open source software and hardware using open source tools (Arduino IDE, gEda,...).
- Small size.
- At least 2 hours of run time.
- Should be usable for localization, mapping, occupancy map generation, path planning, obstacle avoidance.
- Should work under laboratory conditions (reasonable lighting, flat and hard floor...).

Mappino v0.1

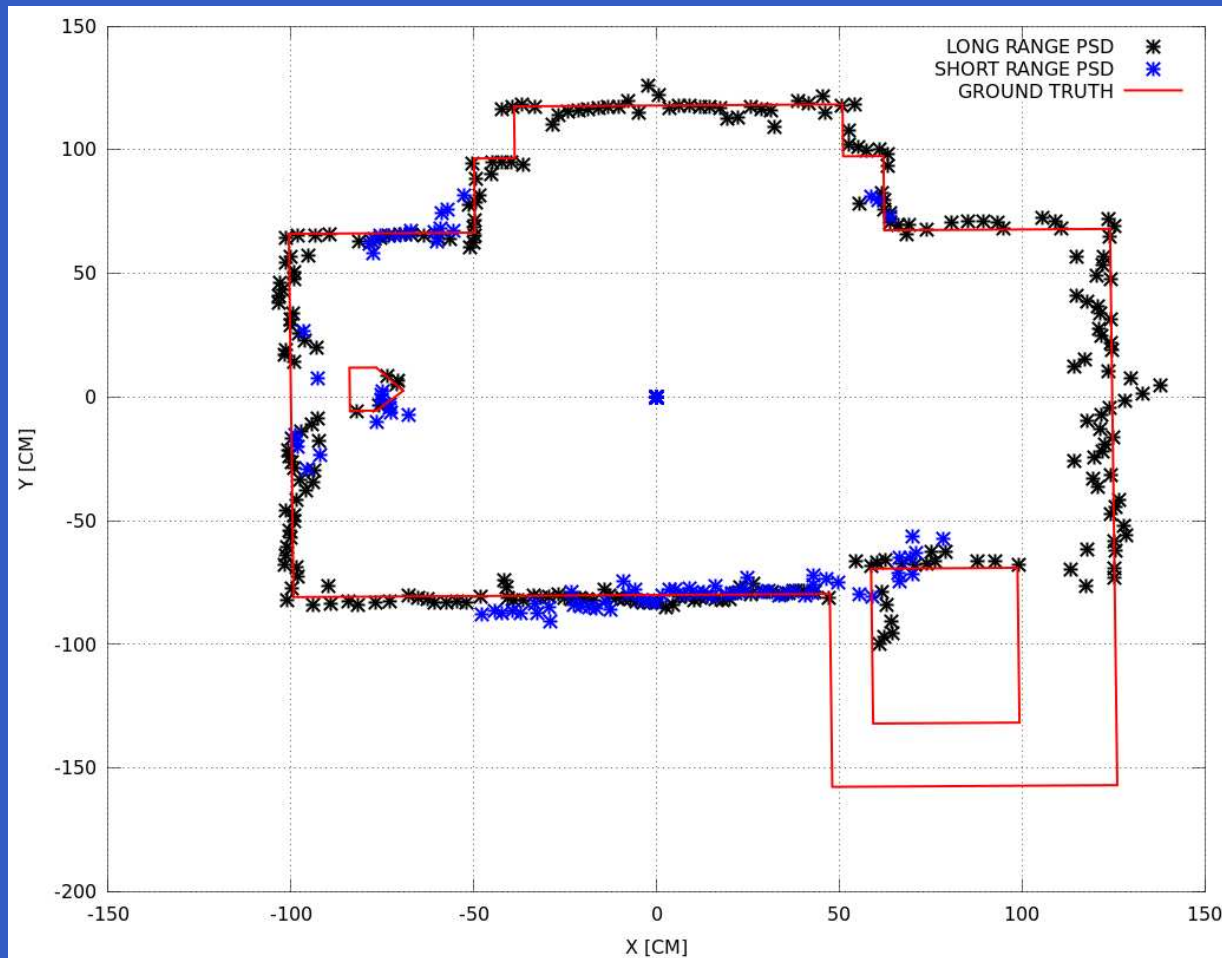
Size (WxDxH)	168x144x148mm
Weight	1100g
Motors	3 x Stepper
Sensors	2 x Sharp PSD
Batteries	6xAA NiMh
Runtime	Stationary: ≥ 20 h Moving: ≥ 2 h
Speed	≥ 10 cm/s
Cost	cca 220 euro



Mappino v0.1 - Electronics

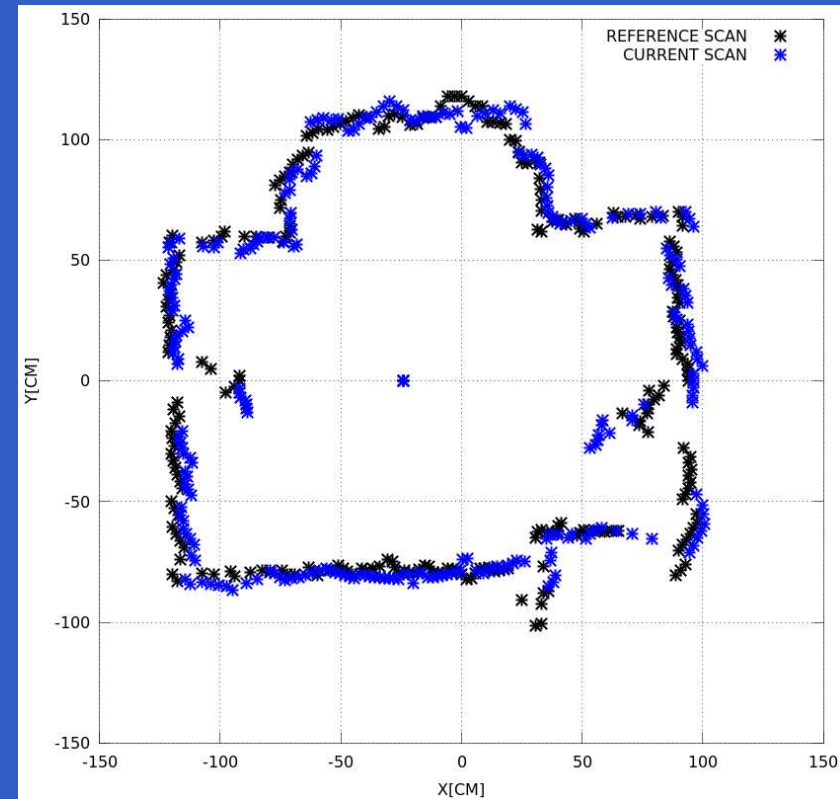
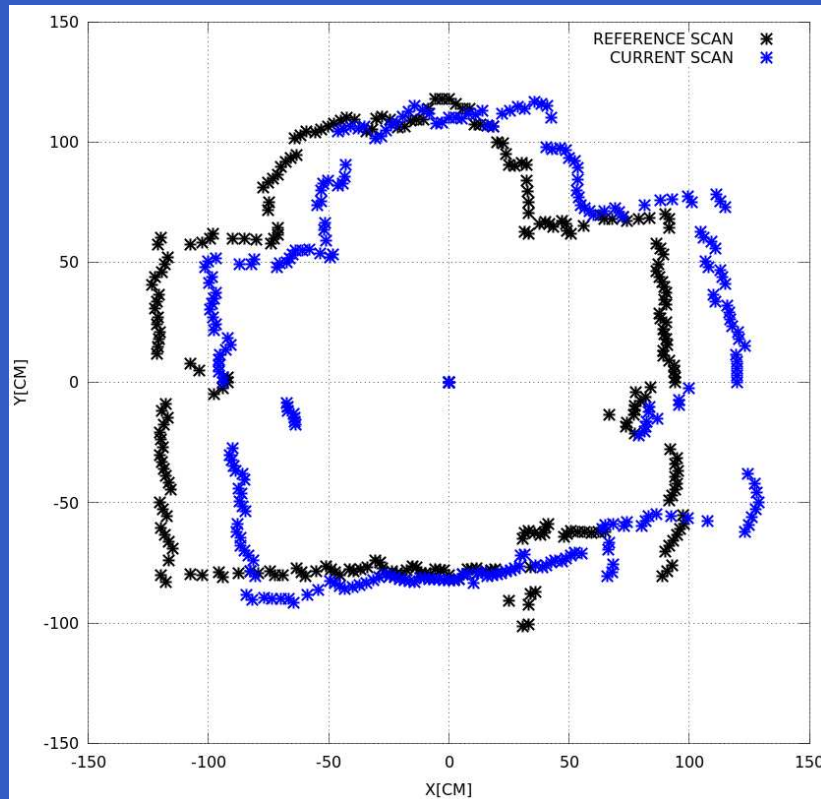


Result: Ground Truth



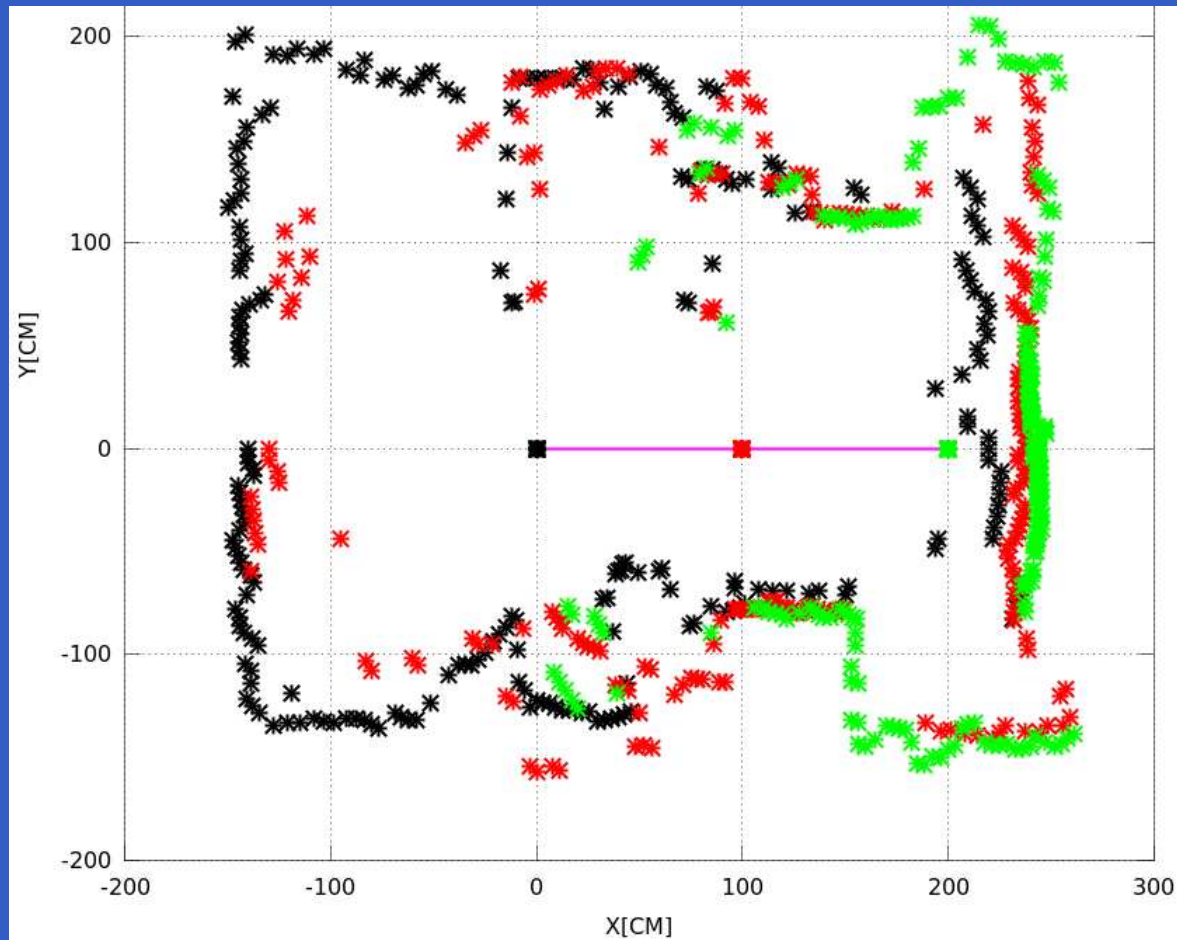
Scan of a bathroom (black - long range, blue - short range PSD) overlaid over ground truth (red). Room width: 230cm.

Result: Scan Matching



Scans prior matching (left) and after matching (right) using a Polar scan matching (PSM) implementation for Arduinos.

Reality check: Kitchen using Odometry



Three scans with 1m separation in a cluttered kitchen with horizontal range discontinuities in the height of the PSDs.

Potential Applications

The following topics can be investigated by programming Mappino v0.1:

- Scan matching.
- Localization.
- Mapping.
- Odometry and scan matching fusion.
- Path planning.
- Person following.
- Occupancy grid generation.
- Obstacle avoidance.
- Motion control.

Conclusion

- Open source robot for learning basic concepts under laboratory conditions as localization, mapping, path planning, obstacle avoidance.
- Likely first time demonstration of scan matching on an 8-bit microcontroller.
- Match time: 154ms @ 256 points, 5 iterations.

Future work

- Increase memory, fix one pin mis-assignment, iron out minor mechanical issues, perform proper testing and write proper documentation.

The Mappino project can be downloaded from:
www.diosirobotics.net/mappino.html