Reliability and Robustness in a Low-Cost Robot Colony

Jaime Bourne, Abraham Levkoy, Austin Buchan, Christopher Mar, David Schultz, Ryan Cahoon, Evan Mullinix, John Sexton, Brian Coltin, Bradford Neuman, Kevin Woo, Emily Hart, Nicolas Paris, Andrew Yeager, Rich Hong, Benjamin Poole, Bradley Yoo, James Kong, Justin Scheiner

Advisor: George Kantor

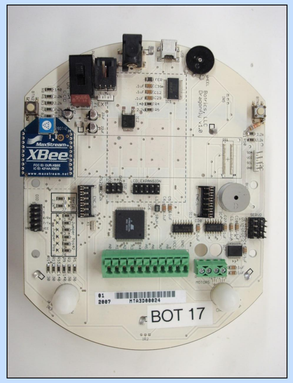
THE ROBOTICS CLUB

Robot Platform

At the core of each Colony robot is the Dragonfly microcontroller board.

Features:

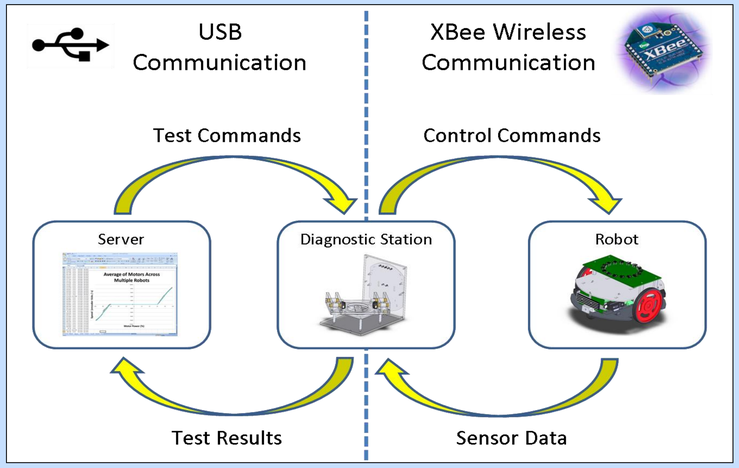
- ATMega128 microcontroller
- XBee wireless module
- USB interface
- 5 Sharp IR rangefinders
- 2 Tri-color LEDs
- Support for encoders and servos



Abstract

The overarching goal of the Colony project is to maintain a flexible yet inexpensive group of robots for researching emergent behavior and cooperative problem solving. The two main obstacles to this goal are an inconsistency in robot I/O capabilities and the inability to recognize and recover from failure. We seek to better understand the capabilities of the robots by quantifying their performance. This benchmarking system provides an incredibly useful tool for debugging and assessing the feasibility of future projects.

Communication Architecture



Motors

Problem

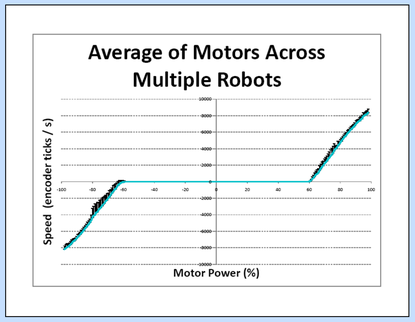
- Motors have different torque constants, bearing frictions
- Leads to inconsistency in power delivered versus actual speed

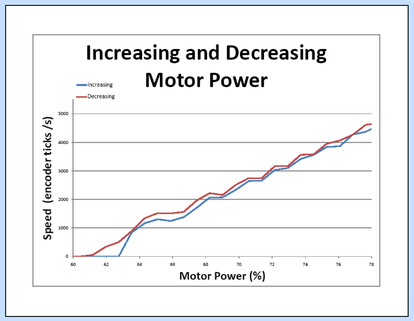
Solution

- Dynamometer pair with more precise encoders than robots
- Run motors in forward and reverse for even power output steps

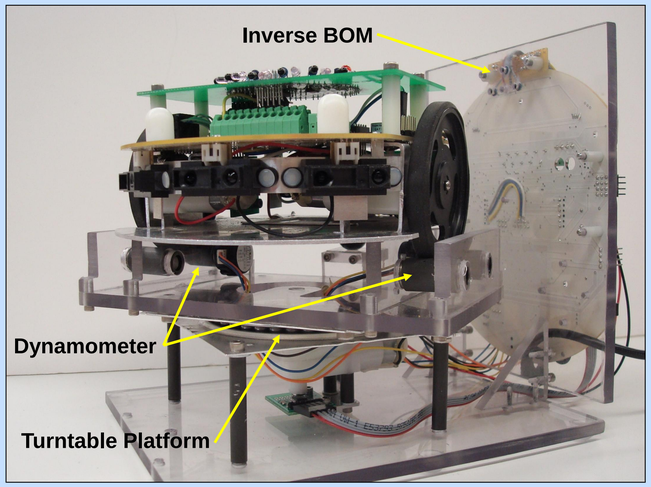
Results

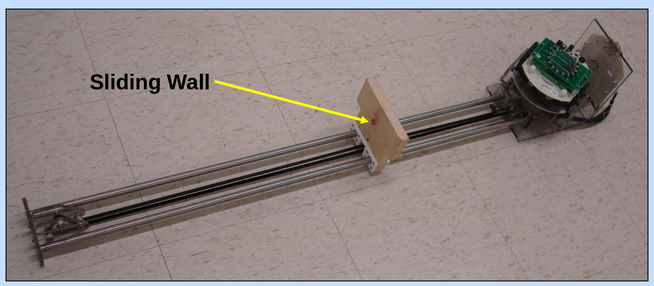
- PWM vs. velocity across robots
- Turn-on vs. Turn-off voltage for each robot





Diagnostic Station





Bearing and Orientation Module

Problem

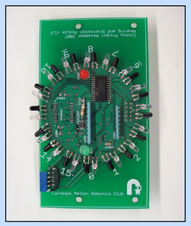
- Emitter and detector signals must be consistent across robots
- The effect of BOM LED misalignment is unknown

Solution

- Use turntable and inverse BOM to test robot emitters and detectors

Expected Results

- Improved consistency after LED realignment



Rangefinders

Problem

- Rangefinders are individually noisy and inconsistent
- Variance over all rangefinders is unknown

Solution

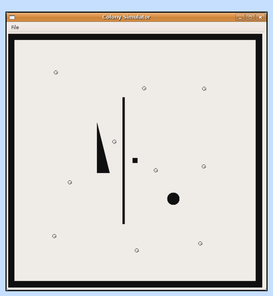
- Use movable wall and turntable to test rangefinders at various distances

Expected Results

- Rangefinder output voltage vs. actual distance
- Variance and noise of individual rangefinders

Simulator

- Allows us to run the same code for our robots on a computer
- Accelerates software development through easier debugging
- Allows us to perform large scale multi-robot tests



Mapping

We have been conducting parallel research in cooperative mapping with the robot colony. The diagnostic station has helped with verifying the accuracy of the on-robot encoders, speed profiles of the motors, and linearity of the rangefinders. We anticipate the diagnostic station will help in a similar manner for all future research.

Acknowledgements

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