DOING THINGS WITH THE NAO : LIKE LASERS AND STUFF

THESIS

Submitted in Partial Fulfillment of

the Requirements for

the Degree of

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by

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July 2015

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ACKNOWLEDGEMENTS

Thank Khorrami

Thank PK, Brian, and Agraj.

Dedicate to Mom and Dad. I totally wouldn't have even gone to this school if not for my Dad.

ABSTRACT

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Griswald Brooks

Advisor: Dr. Farshad Khorrami

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This thesis shows what I did over the course of two years. I did something with the Nao robot and made it move and look at things and stuff. You'll see.

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CHAPTER I

Introduction

1.1 Concept and Motivation

A common task for robotic systems is for a mobile platform to transport itself from one location to another in the presence of environmental obstacles. Within this general task there are many subproblems. The system must have some sort of awareness of the destination objective and usually some notion of where it is relative to that destination. The destination location and the location of the robot can be encoded in a map that the mobile platform or some off board system is responsible for maintaining. Within the environment there may be obstacles that prevent the robot from moving through that space which can also be encoded into the map. Given these notions of robot, goal, and obstacle locations often an initial path is planned to allow the robot to reach the goal location. In addition to these higher level concepts, the robot must have a scheme by which it transports itself through the environment be rolling, walking, flying and controls for each of those methods. Solutions to these subproblems, map building, robot localization, obstacle localization, path planning, locomoting and others work together to accomplish the overall goal. Each of these subproblems can be expanded upon and this thesis works on three of these components: local navigation, obstacle detection and characterization, and gaiting. Used to work on these problems was the Nao Humanoid Platform by Aldebaran Robotics.

1.2 Platform Overview

The broader task of moving an agent from one location to another is applicable to a wide range of robots but each platform will have details that change the scope of the problem and the method used to approach it. The three problems focused on (local navigation, obstacle detection, and gaiting) for a flying robot with a global camera system will require different solutions than a wheeled robot with only rangefinders. For this thesis, the Nao Humanoid Platform by Aldebaran Robotics was chosen to act as

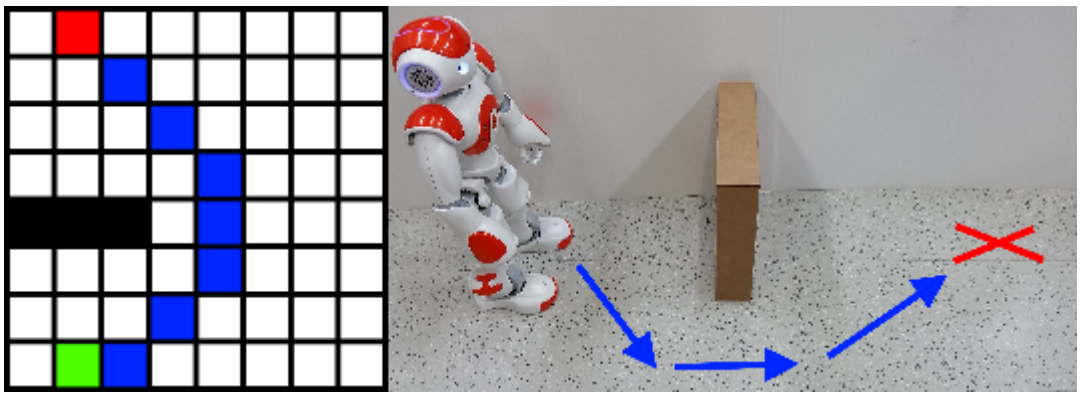

Figure 1: Example illustration of the Nao humanoid robot in an environment with an obstacle. The red X represents a goal location with the blue arrows showing an possible path. On the left side is one possible representation of the environment as a 2D grid.

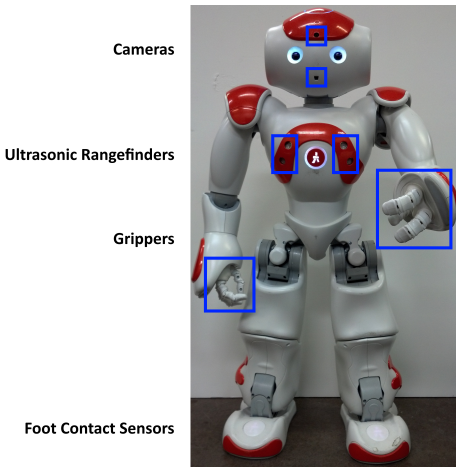

Figure 2: Coronal view of the Nao humanoid with a few pertinent features highlighted.

the mobile base. It is a 1.9 ft tall humanoid weighing 9.5 lbs with 25 degrees of freedom including two legs, two arms, and two grippers. Figure 2 shows a cursory illustration of the humanoid configuration. This lightweight but capable configuration enables research into mobile manipulation, humanoid gaiting, and terrain adaptation without the need for specialized support equipment such as belays or dedicated experimentation areas as the robot is safe for humans to interact with.

(the robot may be small but it allows us to try all the things we want but we can handle it easily and it won't hurt us.)

Such as? Why and what experiments? small

Nao comes with a suite of sensors including two cameras, two ultrasonic rangefind-

ers, a 3-axis accelerometer and 2-axis gyro, foot contact sensors, and angular position encoders on every joint. Such a complement of sensors aids the robot in creating an estimate of a number of variables including the robot state and environment characteristics. While some mobile robots are operated in controlled environments utilizing global sensors there are many situations where outfitting the environment with such sensors is infeasible making local sensing a more attractive option.

One sentence on global vs local sensing.

It has a built-in WiFi radio and 1.6 GHz Intel Atom processor running a version of the Linux operating system allowing the robot to be programmed in C++ or Python using standard libraries that can be remotely uploaded. With these features the Nao ...

1.3 Problem Domain

1.4 Implemented Components

1.4.1 Navigation

1.4.2 Crawlspace Detector

1.4.3 Crawl Gait

1.5 Thesis Structure

This thesis is organized as follows:

REFERENCES

[1] G. Brooks, P. Krishnamurthy, and F. Khorrami, "Humanoid robot navigation and obstacle avoidance in unknown environments," in *Control Conference (ASCC), 2013 9th Asian*, June 2013, pp. 1–6.