Hardware and Software Computing Architecture for Robotics Applications of Neuroscience-inspired Vision and Navigation Algorithms

Chin-Kai Chang, Christian Siagian, and Laurent Itti

Computer Science Department, University of Southern California, Los Angeles, California USA

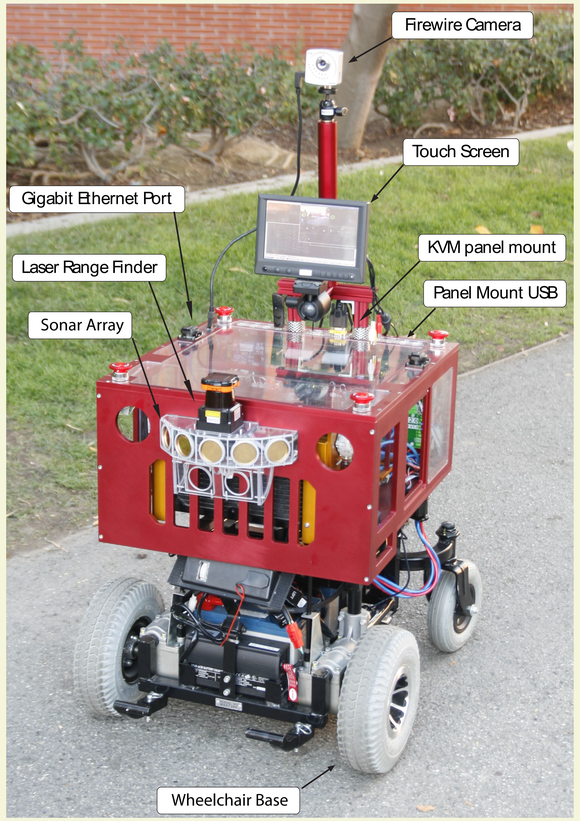
http://ilab.usc.edu/publications/doc/Chang_etal10vss.pdf

Introduction

We present a biologically-inspired visual navigation and localization system, which is implemented in real-time using a cloud computing framework. Our work involves both a new design of cluster computer hardware and software for real-time vision.

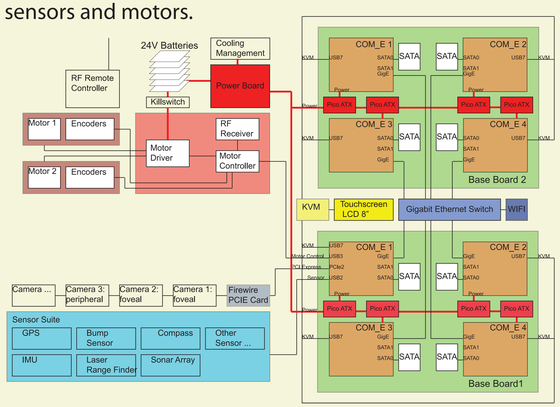
Beobot2.0 Hardware Overview

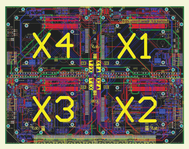
Beobot 2.0 carries a high performance computing cluster of 16 processor cores, 2.2GHz each. The robot is equipped with various sensors such as camera, Laser Range Finder, sonar suite, IMU, compass, and GPS.

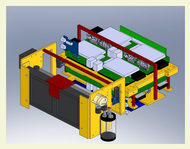


Electrical System

The vision hardware consists of two custom-built carrier boards that host eight computer modules connected to sensors and motors.

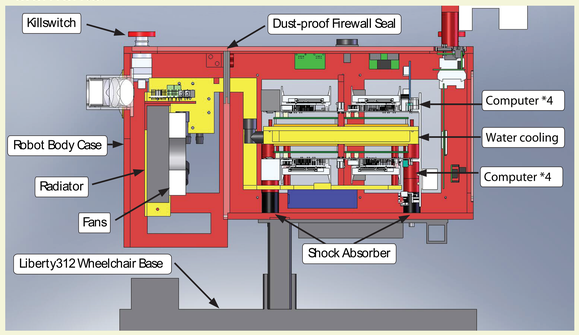






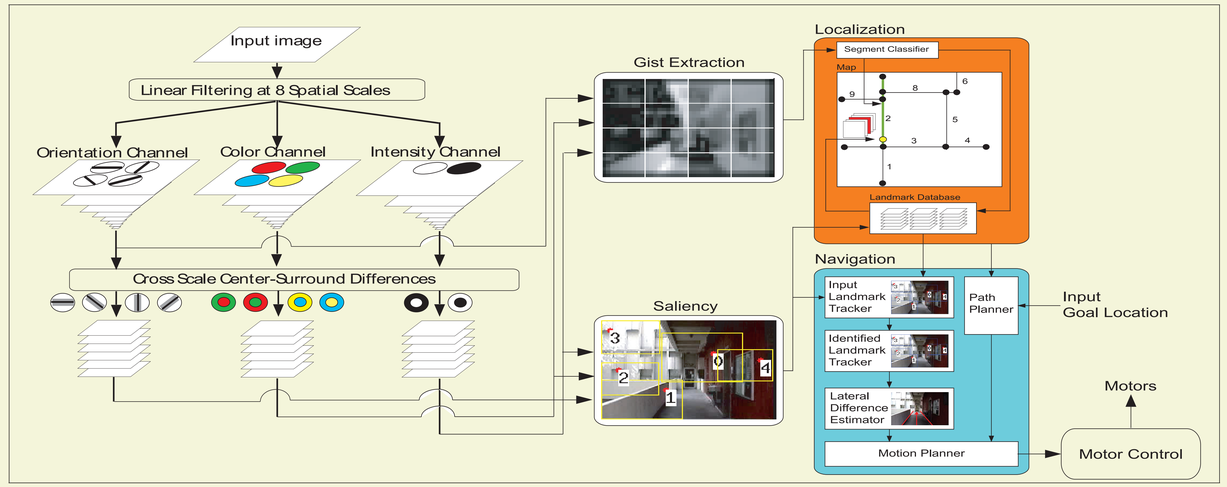
Mechanical System

The robot is divided into two chambers by a dust-proof firewall. The open front allows for the heat to dissipate and the sealed back chamber shields the electronics from the elements.

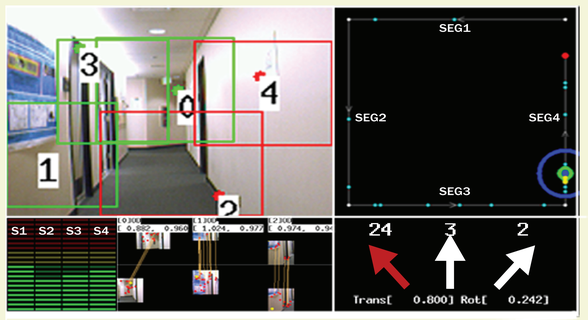


Visual Navigation & Localization System Overview

Our biologically-inspired system models two extensively studied human visual capabilities: (1) extracting the "gist" of a scene (a holistic statistical signature of the image, yielding abstract scene classification and layout) to produce a coarse localization hypothesis, and (2) refining it by locating salient regions in the scene to triangulate the current position of the robot.



Runtime Screenshot



Indoor & Outdoor Environment

Testing & Results

Site	Site Dimensions	Traversal Length	Nav. Error	Loc. Error
HNB	27.13 x 27.13m	36.67m	3.68cm	1.15m
Equad	69.49 x 18.29m	138.27m	8.78cm	5.31m

Discussions & Conclusions

We have created an affordable research-level mobile robot platform which allows for a class of computationally intensive vision algorithms. The robot is able to navigate using salient landmarks that are identified by the localizer in real-time.

The hardware design and source code are available at: http://ilab.usc.edu/wiki/index.php/Beobot_2.0

Acknowledgement

The authors gratefully acknowledge the contribution of NSF, HFSP, ARO, DARPA, and the Okawa Foundation.