RoboBrain II

A Test Platform for an Autonomous Robot Controller

by Daniel R. Garalde

William Dunbar
Professor, Computer Engineering, UCSC

Jorge Cortes
Professor, Applied Math & Statistics, UCSC

Noah Wilson
Graduate Researcher, Computer Engineering, UCSC

Daniel Garalde
Undergraduate Researcher, Electrical Engineering, BJU

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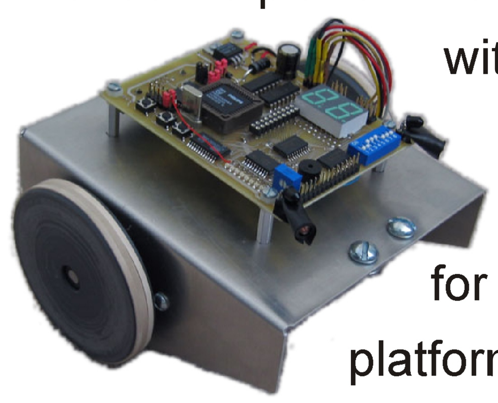
The first RoboBrain came into being as the result of the senior research project of Noah Wilson and Adam Bean while studying at the University of California, Santa Cruz in 2004. RoboBrain is a programmable robot capable of completing autonomous tasks using sensors to retrieve environmental data and two DC motors for locomotion. The goal of the first RoboBrain project was to produce a cost effective platform for high school students to experiment with robotics. This first version of RoboBrain was used by COSMOS - a special summer educational program for exceptional high school students - as a platform for teaching autonomy through feedback control. The COSMOS program involves several UC campuses, and provides advanced instruction in a broad range of sciences. Students are divided into 'clusters' based on their field of interest. 'Cluster 2' is the robotics and nanotechnology cluster - the cluster which uses the RoboBrain robots.



Above: The original RoboBrain prototype

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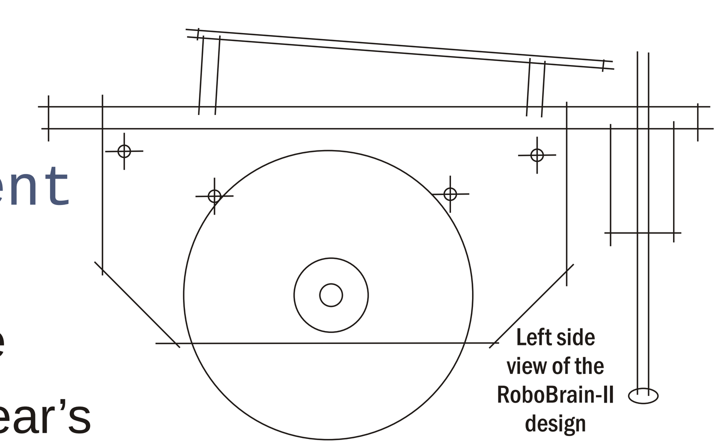
An improvement on the original RoboBrain became desirable for this year's COSMOS program. Dubbed RoboBrain-II, the new version of RoboBrain would have expanded inputs and outputs, as well as a more stable body. It would also feature a new and improved drive train with more powerful motors, better wheels, and a sturdier motor mounting system.



Left side view of the RoboBrain-II design

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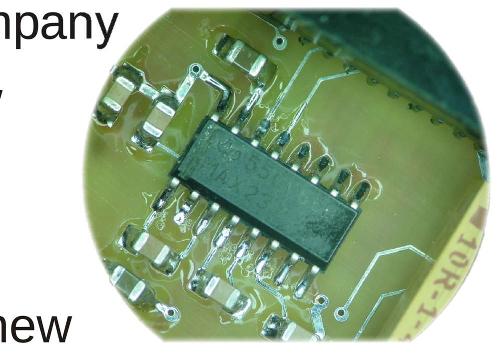
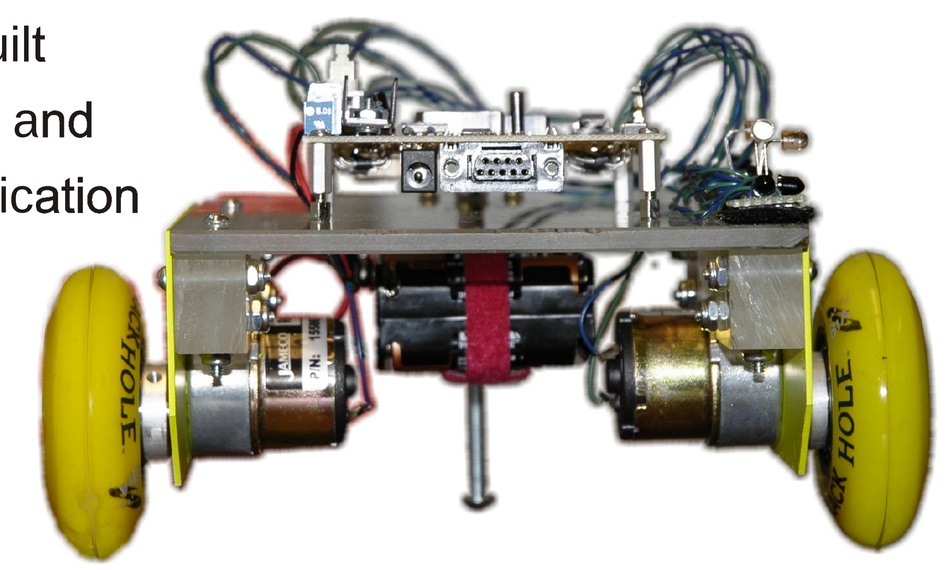
A chassis redesign had to accompany the new circuitry of RoboBrain-II. The new chassis needed to provide more stability, precise alignment, and accommodate the mounting of new motors with integrated gear boxes. Though less important, the new design should also be visually appealing. It, like the old chassis, is built mainly out of Plexi-Glass and sheet metal. All the fabrication was done with standard tools except for the specialized wheel hubs - which were created by machinists at UCSC - to allow the coupling of the wheels to the motor shafts. The new chassis proved to be a great complement to the improved functionality of RoboBrain-II.



A picture through a microscope of one of the surface mount chips on the RoboBrain-II board



Front view of a completed RoboBrain-II

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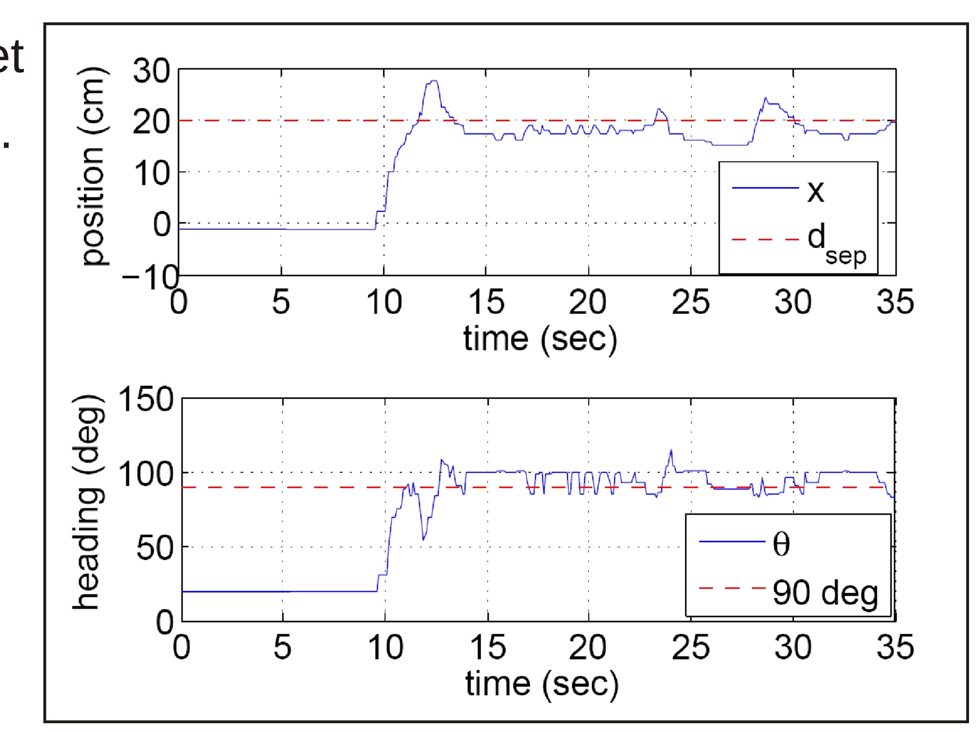
Control theory is good but simulation can only tell you so much. Oftentimes you need to test your controller on the real system. RoboBrain-II provided this test platform for the COSMOS robotics students. After deriving a feedback controller for RoboBrain-II that demonstrated good performance in simulation, the students were able to test the controller on the actual RoboBrain-II hardware. This year's objective was to get the robot to find and track a wall using on-board infrared sensors. As it turned out, some students' theoretical answers worked well, while others learned that simulation isn't always a perfect predictor. One reason simulation may diverge from actual performance is that it often oversimplifies or ignores certain errors that may be introduced into the actual system. For example, RoboBrain-II's infrared sensors were affected by the infrared emissions that are a part of most artificial and natural light sources - a variable the simulation didn't encompass.

Below: Actual position and heading data calculated from the RoboBrain-II sensors



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The finale of the 'Cluster 2' course was for the entire class to calibrate, program, and use the robots. RoboBrain-II provided a great testing platform, and the students loved using the robots. However, it became obvious that the infrared sensors were hard to use if the test environment wasn't free of external infrared sources which oftentimes means the test environment has to be dark. To improve daylight interference rejection, the sensors should be redesigned. That will probably be implemented on another RoboBrain for another day.

COSMOS students pose with their professors and their RoboBrain-IIs

Special thanks to NSF for funding the undergraduate researcher. Photos by Noah Wilson.