The Goat

Autonomous Lawnmower

Technical Report

May 13, 2010

Department of Electrical and Computer Engineering
College of Engineering and Computer Science
The University of Michigan-Dearborn

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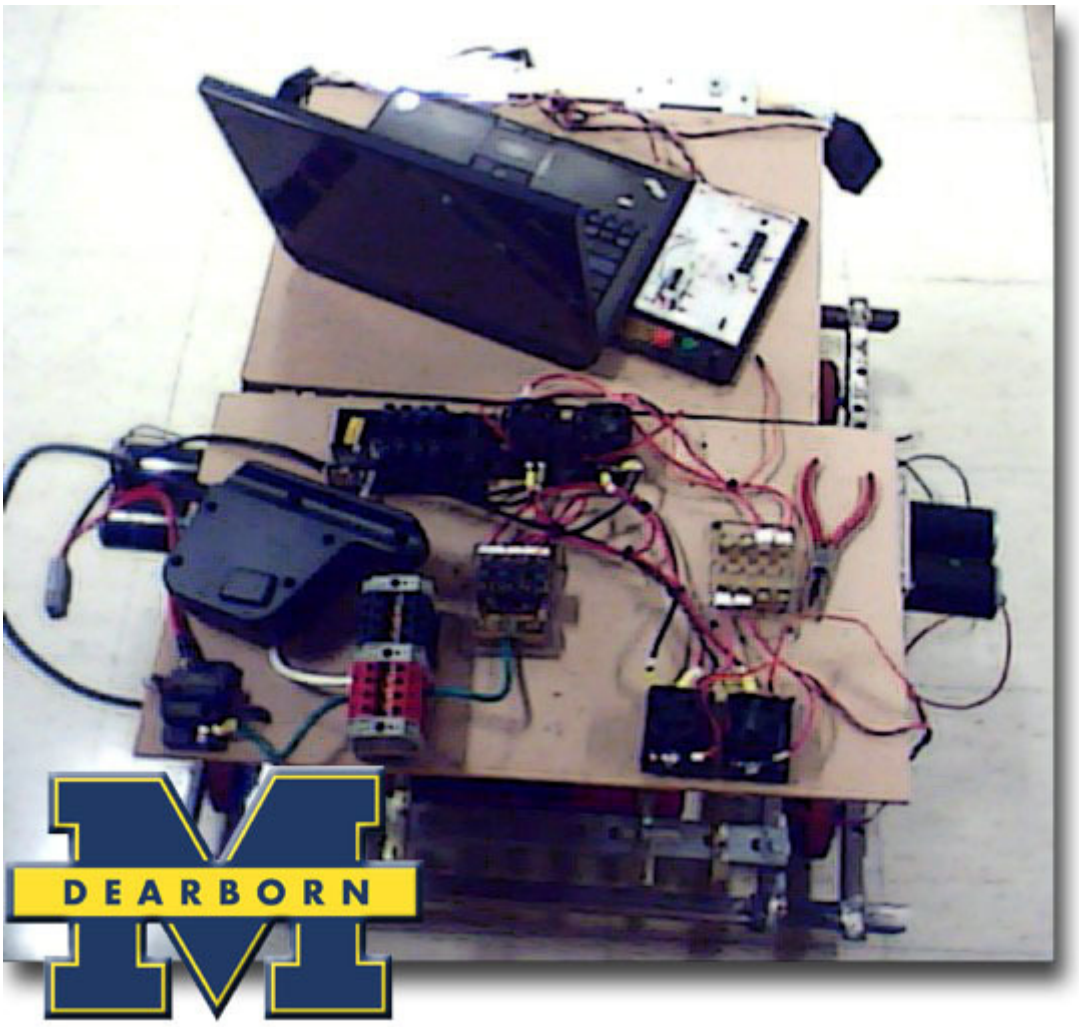

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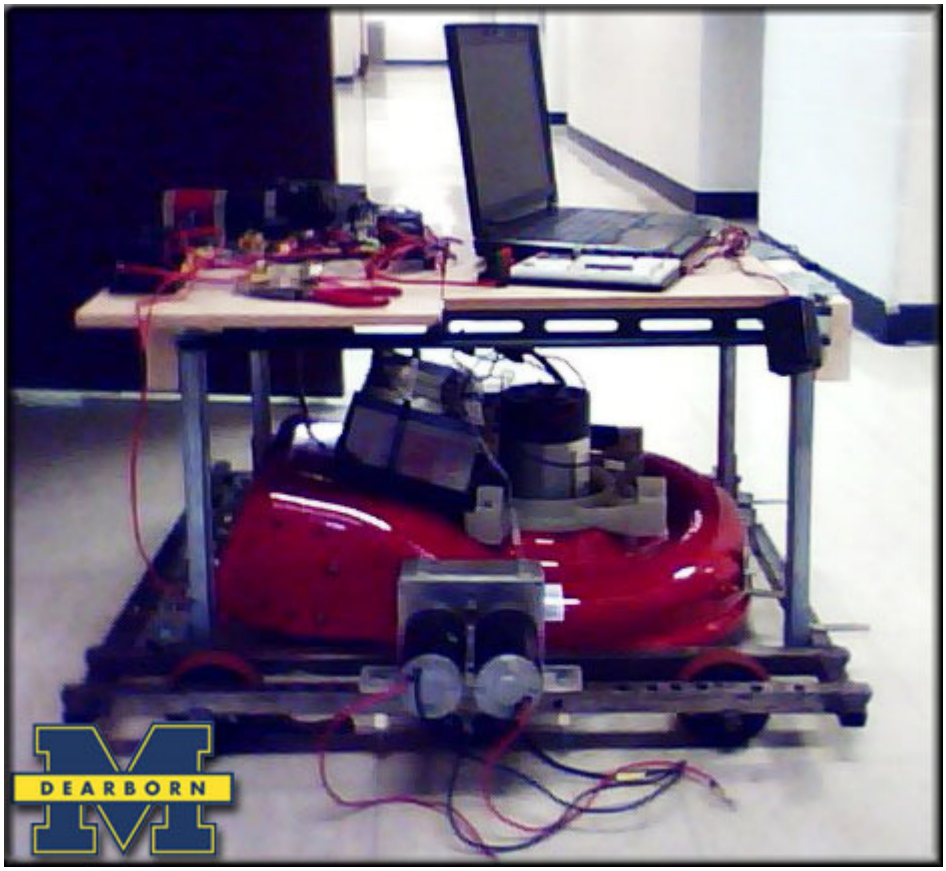

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Team Roster:

-Faculty Advisor:

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-Graduate Students:

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Abstract:

The Goat autonomous lawnmower is being designed by students in the computer, electrical, and mechanical disciplines of engineering at the University of Michigan, Dearborn. To solve the problem of cutting a known dimension of lawn with two randomly placed obstacles the group used a three step approach: electrical, mechanical, and software systems are being incorporated to create one cohesive unit. The initial idea of the group was to keep the lawnmower under budget, easy to operate, and able to be built quickly since we started the project at the beginning of May.

Mechanical System:

The basic platform we're using is a craftsman electric lawnmower. It was disassembled to the basic components of the cutting deck, batteries, and electric motor. To create the drive assembly we used tubular steel for our chassis which incorporates four electric motors and six chain driven wheels. We next constructed a shelving unit out of unistrut to accommodate the electronics needed for operation. The theory we are currently testing is that with the center wheels slightly lower on either side of the lawnmower the unit should be able to go over many different terrain types by utilizing all wheels as drive wheels. This drive assembly should also allow it to turn while stationary to avoid sweeping corners which would miss areas of the lawn required to be mowed.

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Electrical System:

The elements of the electrical system we need are a result of the main problems we are faced with. How the mower will be driven, how to engage the blade, navigation concerns, emergency shutoff requirements, and obstacle avoidance. To run the drive train we've used four electric motors driven by four Victor motor controllers which should allow us the flexibility to drive one side of the mower forward and the other backward to create a facsimile of tank type maneuverability. The project team is still in the drawing board stage of creating a subsystem that will allow the counting of revolutions of the wheels to give precise turning and distance control. The blade engage mechanism has been accomplished by using a simple relay to switch power on and off to the blade motor. The navigation system will be a combination of GPS and a digital compass which should give the pc real time position of the mower. The emergency shutoff is by far the easiest of the subsystems this was accomplished by wiring the Estop and wireless shutoff in series to the coil of an automotive relay that will make or break battery power to the mower. The obstacle avoidance problem is being addressed, we are testing both a webcam for line recognition, and ultrasonic range finders for detection of the trash barrel obstacles. The Operating platform we will be using is a mini laptop in conjunction with a micro processing board for serial interface.

Software System:

The Autonomous Lawnmower subsystems controlled by software consist of the following:

- Sonar obstacle detection
- Visual image detection
- Autonomous Drive Control
- GPS Guidance System
- Electronic Compass Guidance System

Sonar Obstacle Detection:

The audible distance detection system consists of five sonar units dispersed about the perimeter of the lawnmower. Sending analog signals back to a PIC16F690 MCU A2D port for parsing the MCU will forward obstacle presence to the Autonomous Drive Controller on the netbook.

Visual image detection:

This subsystem is handled through a MATLAB visual library. It will input images from a camera and separate contrast areas through filters. The filtering process will separate green and brown areas representing grass and vegetation from white areas representing boundary lines.

Autonomous Drive Control:

The ADC main routine will poll the detection systems for obstruction and boundary lines. Obtaining GPS and compass coordinates the ADC will run routines for traversing the playing field and routines used to navigate around obstacles.

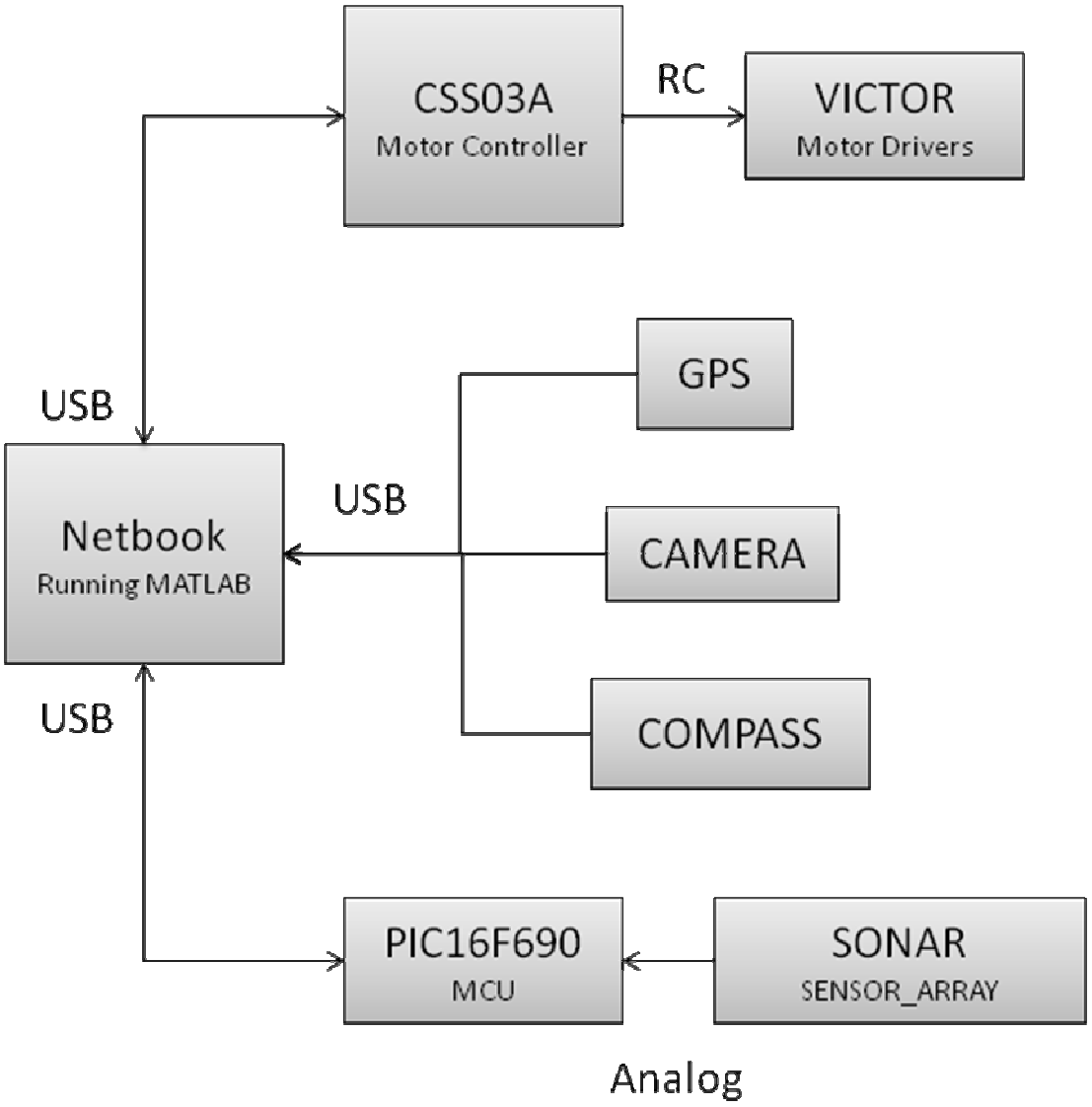
GPS Guidance System:

Using a GPS unit through USB to MATLAB, the NMEA string will be parsed and its results passed to the ADC for navigational assistance. Two units will be used to provide accurate location posture during navigation.

Electronic Compass Guidance System:

Another subsystem of the ADC, the EC coordinates will provide redundant orientation data to verify the data in the NMEA as well as assist will orientation during obstacle avoidance.

DESIGN DIAGRAM:



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Cost:

Total Funds available			$1,000	
item	price	quantity	total	
motor controls/vectors	$90	4	$360	in possession
andy mark tuff boxes w motors	$98	2	$196	in possession
Lawn mower craftsman 48 volt	$398.99	1	$398.99	
laptop	$199	1	$199	
andy mark traction wheels	$26	6	156	
chain 20 ft	$13	2	26	
gps/camera/compus	$85	1	$85	
steel square tubes	$14.00	1	14	
sensors	$22	5	110	
over all total		23	$1,545	
our actual spenditure			$988.99	
Remaining funds			11.01	

Conclusion:

The Basic Cutting Competition presented many problems to work through and our team is attempting to approach the solution to each one independently while trying to maintain the feasibility of constructing a mower that would address them all while remaining under budget. We were given this challenge with very little time to complete the mower but accepted and are currently working hard towards completion. As the majority of us are under classmen this has been a tremendous learning experience in the practical application of our fields of study.

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