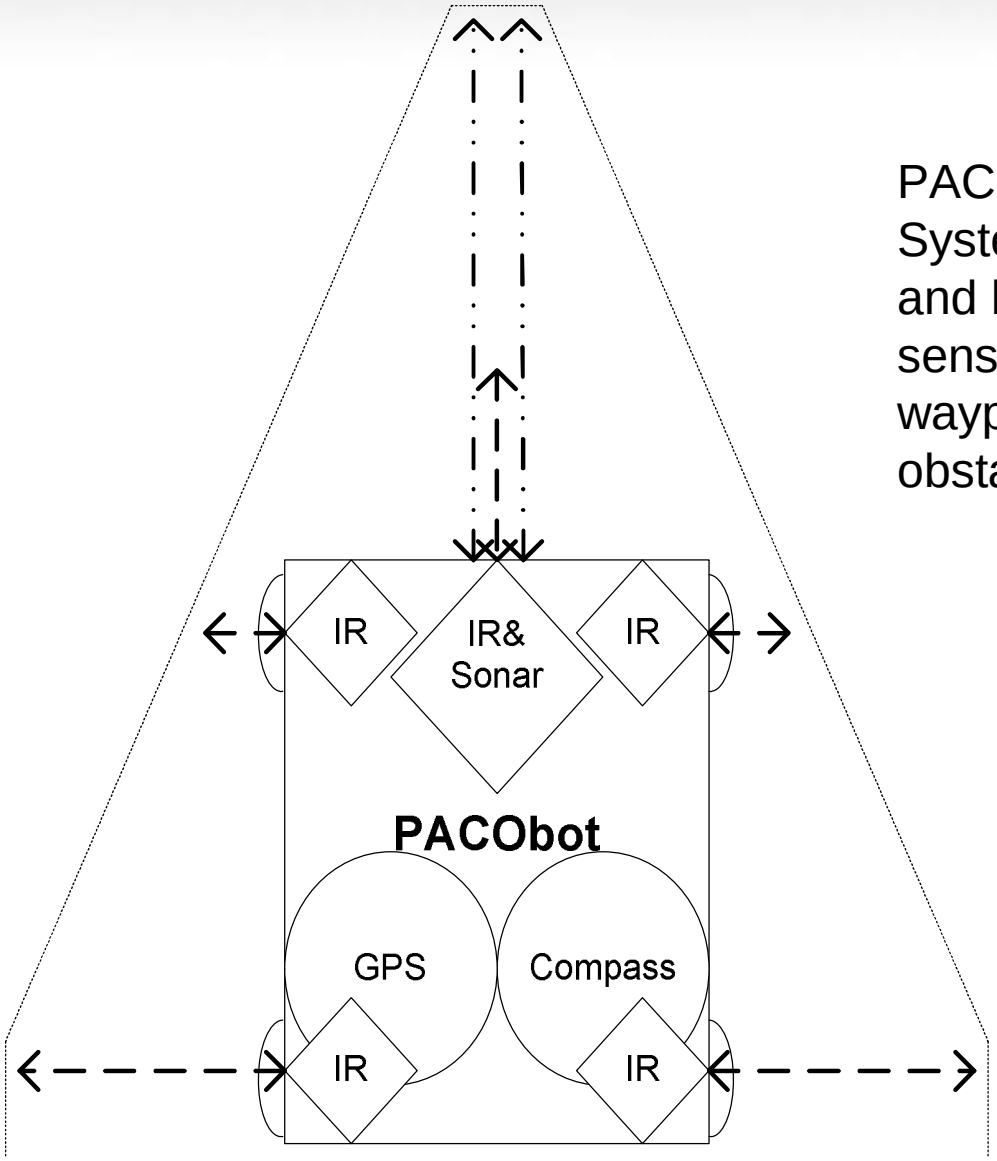
Point-to-point Autonomous Collision and Obstacle-avoidance Robot

Arthur Rudnick
Dan Dosch
Derek Spadaro
Nhat Le

Professor John Johnson
ECE 189A-B 2004-2005

http://www.AtotheR.com/robotics/pacobot

Product Description



PACObot utilizes Global Positioning System technology, a digital compass, and both infrared and ultrasonic sensors to travel to preprogrammed waypoints while avoiding unplanned obstacles in its way.

Consumer Applications

Scientific: Topological mapping, mapping of other planets, regular distance soil and water sampling.

Military: Automated reconnaissance, unmanned convoy control, robotic sentry, mine field charting.

Public Utility: Automated lane line painting, lot line adjustment, spill clean up, parking lot layout.

Homeland Security: Automated border patrol, airport parking lot and loading area monitoring.

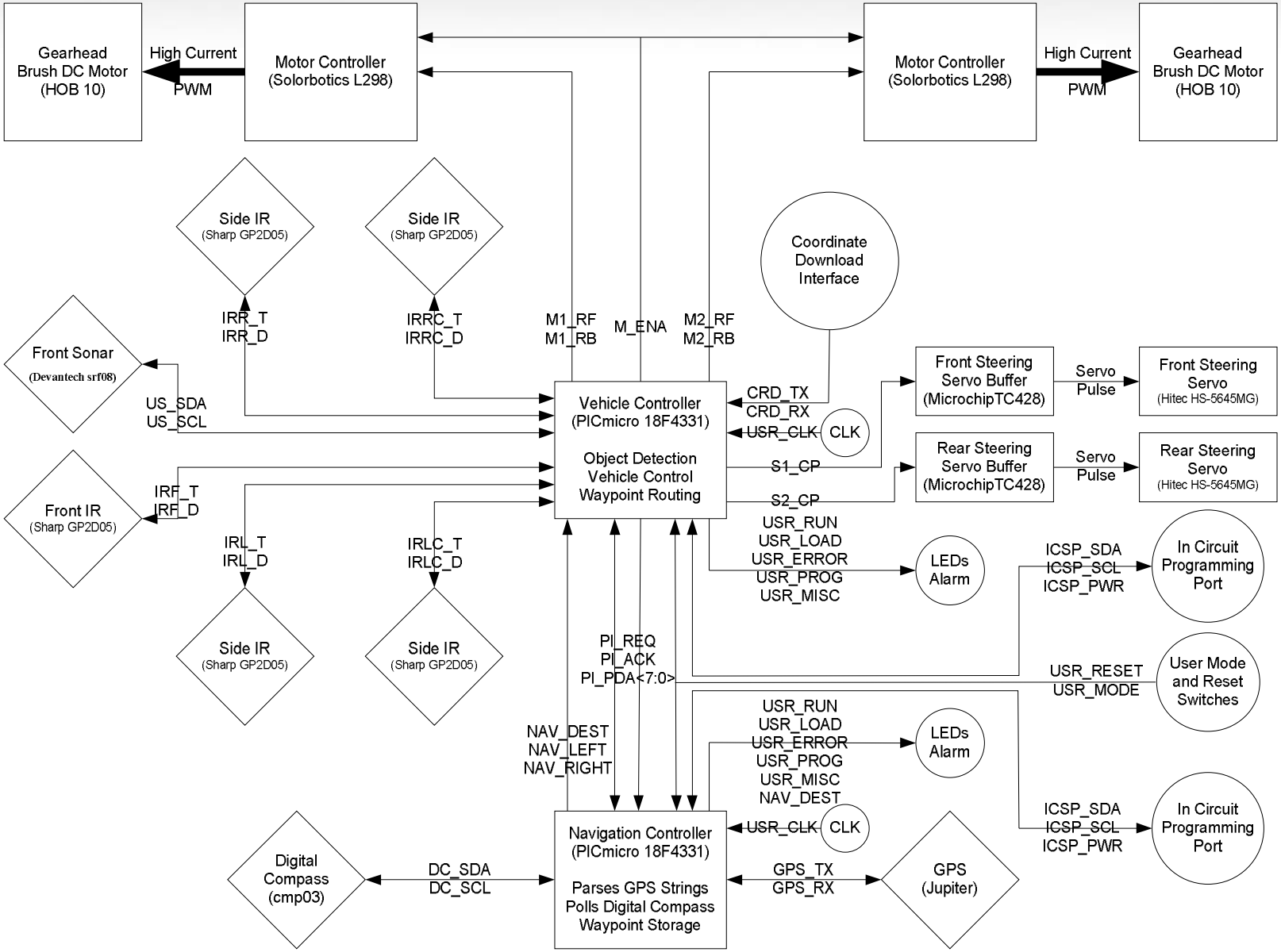
Household Consumer: Automated dog walking, intelligent large area lawn mower.

High Level Block Diagram

Project PACObot

No Risk Systems

Version 4



Subsystem Ownership

Arthur Rudnick: Group Leader
- Inter-Processor Communication
- Power Management and Distribution
- System Level Design and Integration
- Control Processor Software
- Crisis Management

Dan Dosch: Object Detection
- Infrared Sensors
- Ultrasonic Sensor
- Digital Compass
- Navigation Processor Software

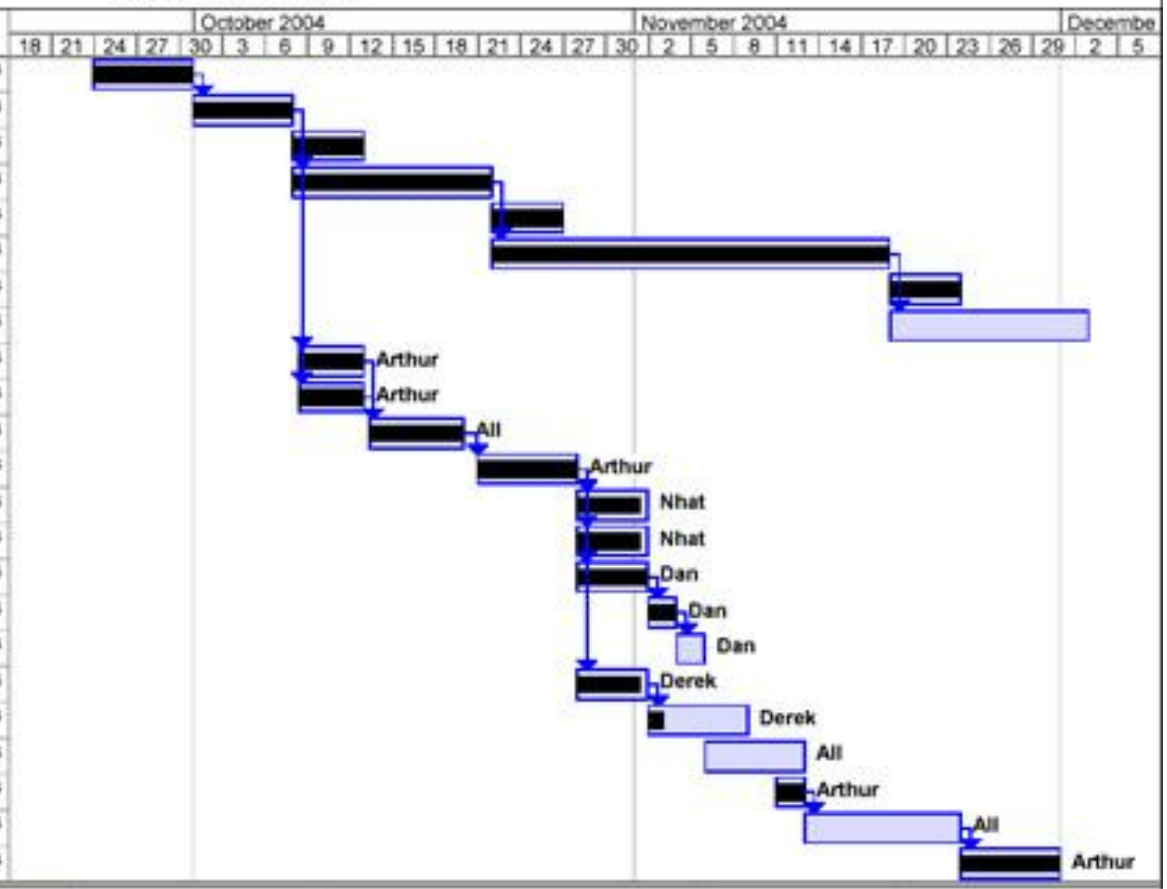
Derek Spadaro: Navigation
- Global Position Satellite Module
- PC User Interface
- Navigation Processor Software

Nhat Le: Vehicle Control
- Motor and Servo Control
- Chassis Design and Fabrication

Design Plan (Fall)

PACObot — Proposed Project Schedule

ID	Task Name	Duration
1	Project Idea and Team Formation	5 days
2	Refined Project	5 days
3	Initial Design Review	3 days
4	System Level Design	10 days
5	Preliminary Design Review	3 days
6	Detailed Design	20 days
7	Critical Design Review	3 days
8	Implementation of Hardware Design	10 days
9	Establish Purchase Orders	3 days
10	Contact Free Part Contacts	3 days
11	Obtain Parts	5 days
12	Basic Microcontroller Unit Test	5 days
13	Servo Control Unit Test	3 days
14	Motor Control Unit Test	3 days
15	IR Sensor Unit Test	3 days
16	Sonic Sensor Unit Test	2 days
17	Digital Compass Unit Test	2 days
18	RS-232 Unit Test	3 days
19	GPS Unit Test	5 days
20	Integration Testing	5 days
21	Schematic Layout	2 days
22	System Prototype	7 days
23	PCB Layout	5 days

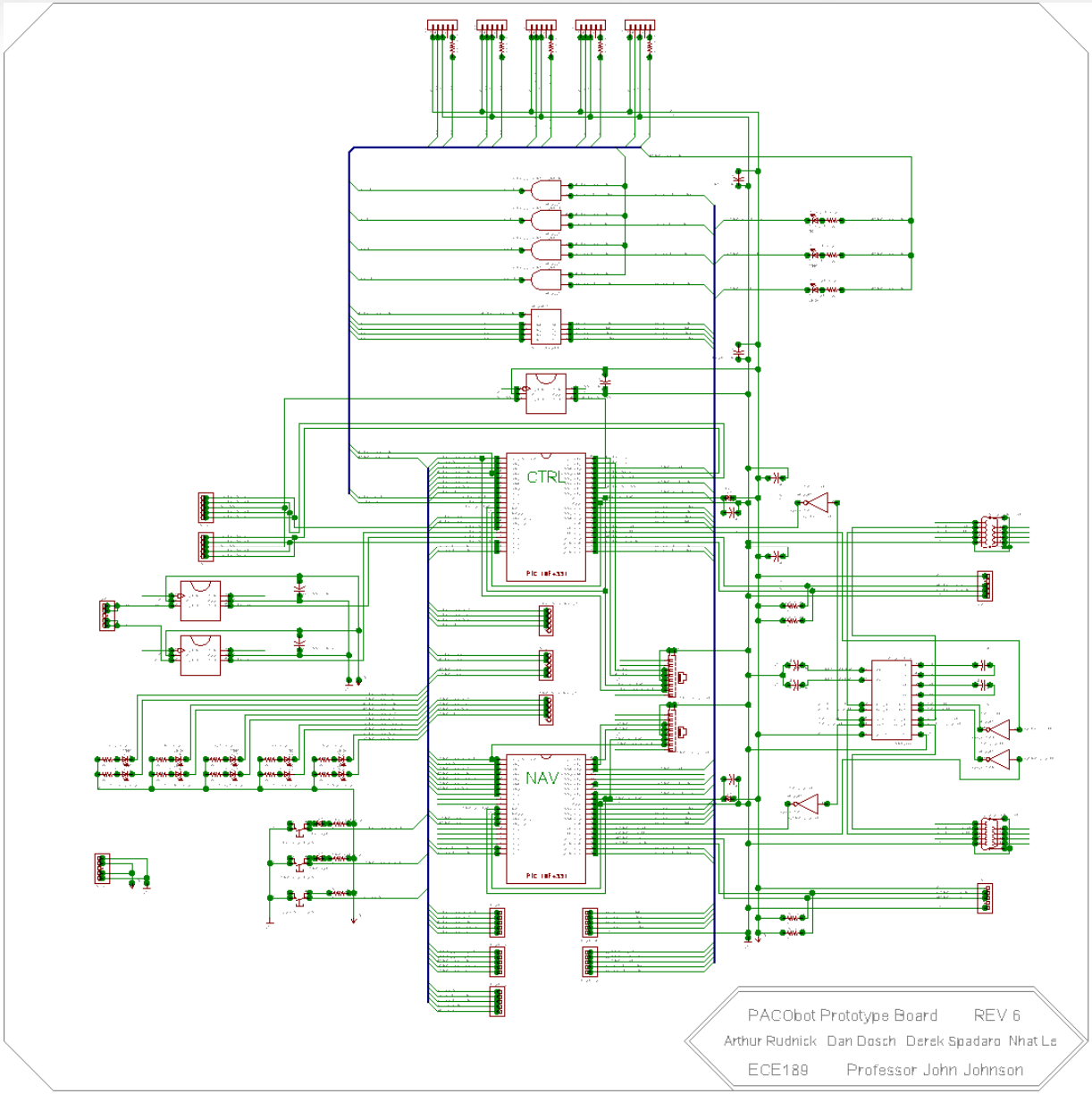


Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

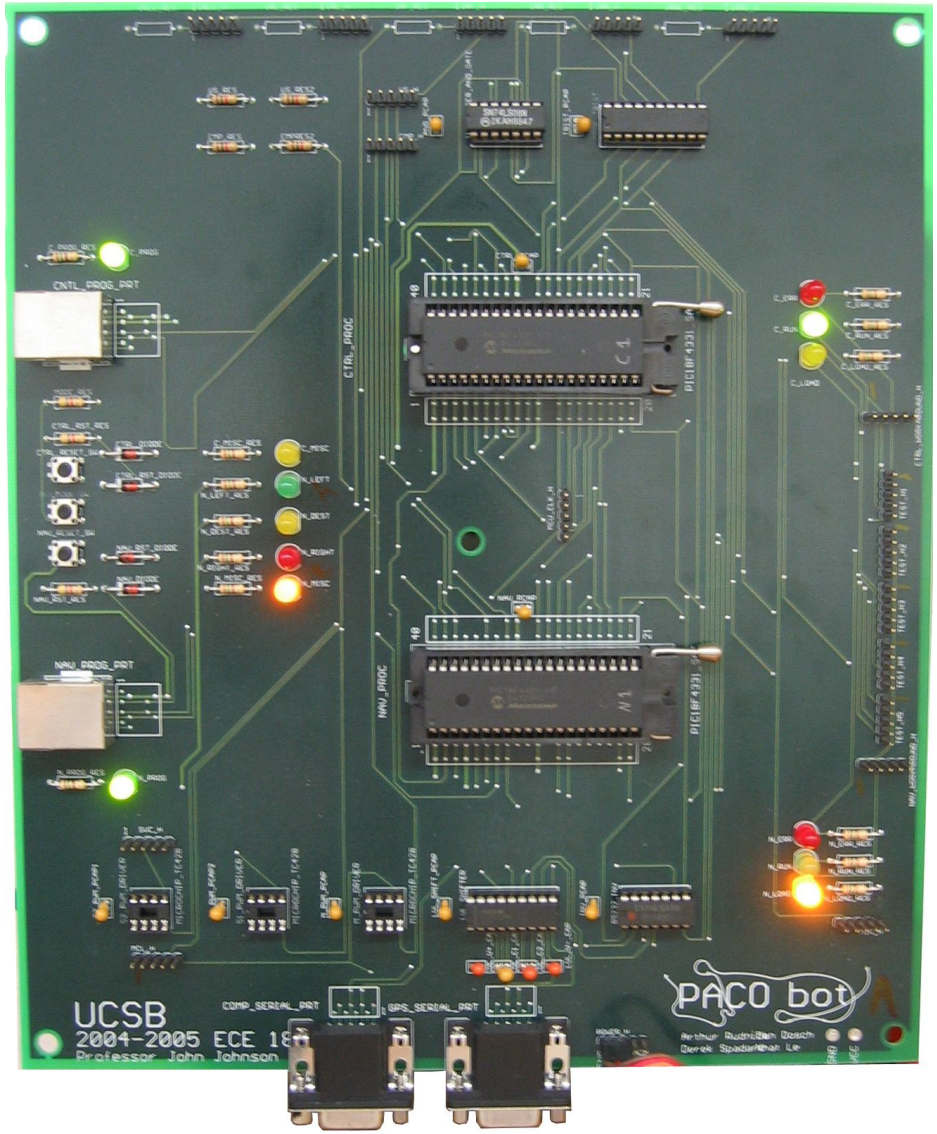
Testing and Development Plan (Spring)

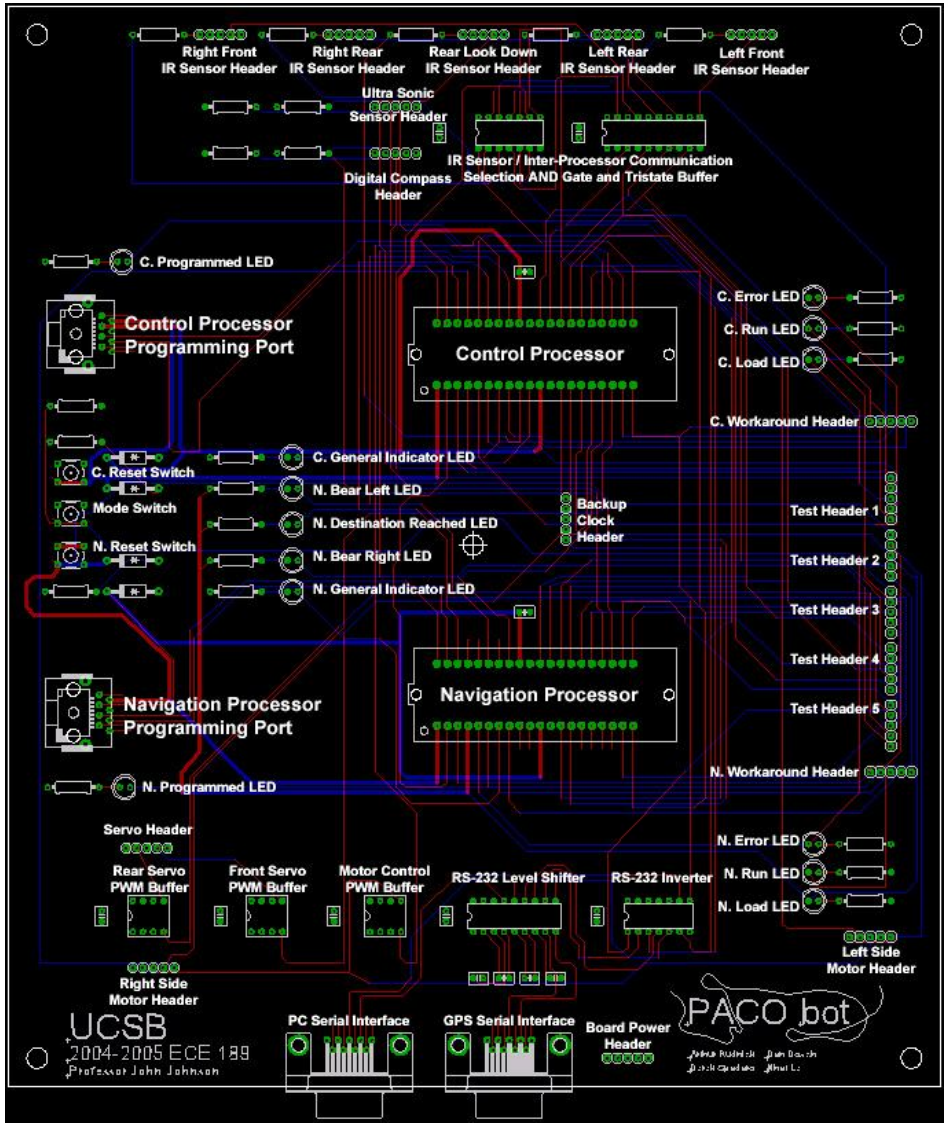
ID		Task Name
1	✓	**Mechanical Development**
2	✓	Finish Chassis
3	✓	**Hardware Verification**
4	✓	Ohm Out Board
5	✓	Power Up Empty Board
6	✓	Check All Chip Power Supplies
7	✓	Power Up Processor
8	✓	Program And Test Power Up LED Externally
9	✓	Program And Test Power Up LED In Circuit
10	✓	Program And Test LED Blink
11	✓	Debounce Switches
12	✓	Program And Test Switch Controlled LED Toggle
13	✓	**Parallel Unit Testing And Development**
14	✓	Motor Control Unit Test
15	✓	Servo Control Unit Test
16	✓	IR Sensor Unit Test
17	✓	Ultrasonic Sensor Unit Test
18	✓	Digital Compass Unit Test
19	✓	RS-232 Unit Test
20	✓	GPS Unit Test
21	✓	Processor Interconnect Unit Test
22	✓	**System Integration**
23	✓	RS-232 to Ctrl Proc to Nav Proc Integration
24	✓	Sensor to Ctrl Proc to Motor and Servo Integration (Obstacle Avoidance Mode)
25	✓	Digital Compass and GPS to Nav Proc Integration
26	✓	Nav Proc to Ctrl Proc to Motor and Servo Integration (Navigation Mode)
27	✓	**Project Finalization**
28	✓	Obstacle Avoidance Mode and Navigation Mode Incorporation
29	✓	Final Shakedown and Testing

Schematic Diagram

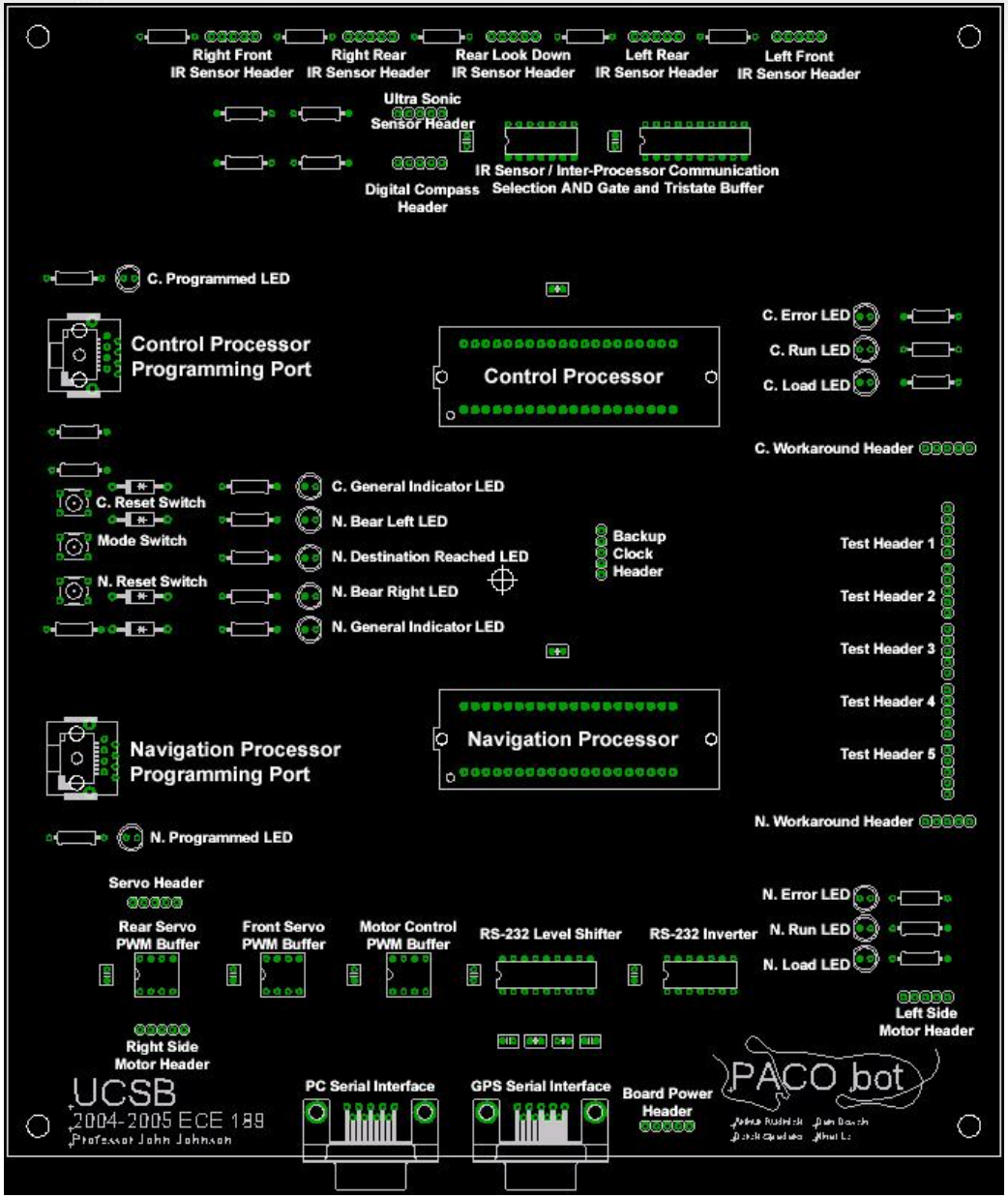


Board Layout



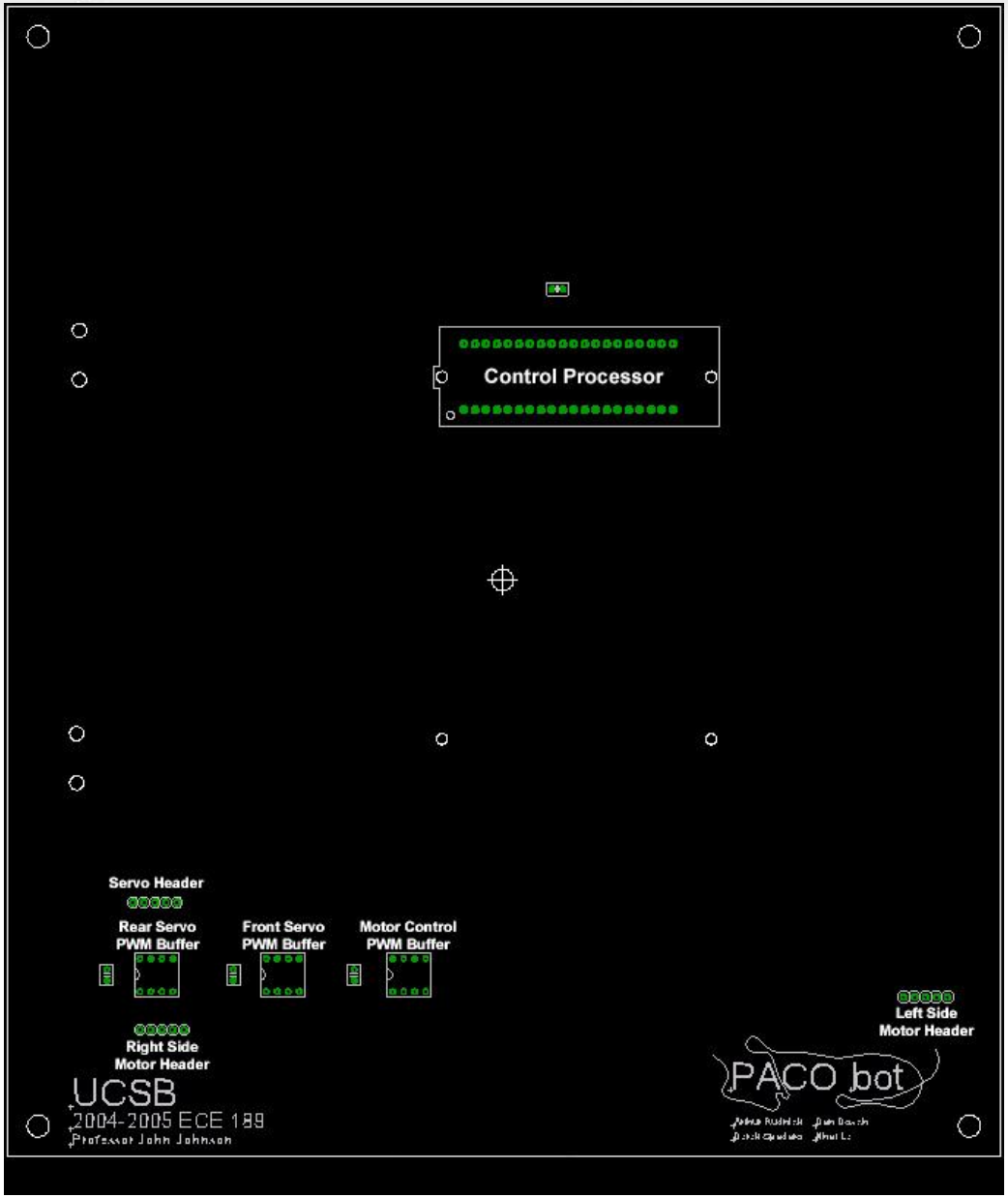


System Overview



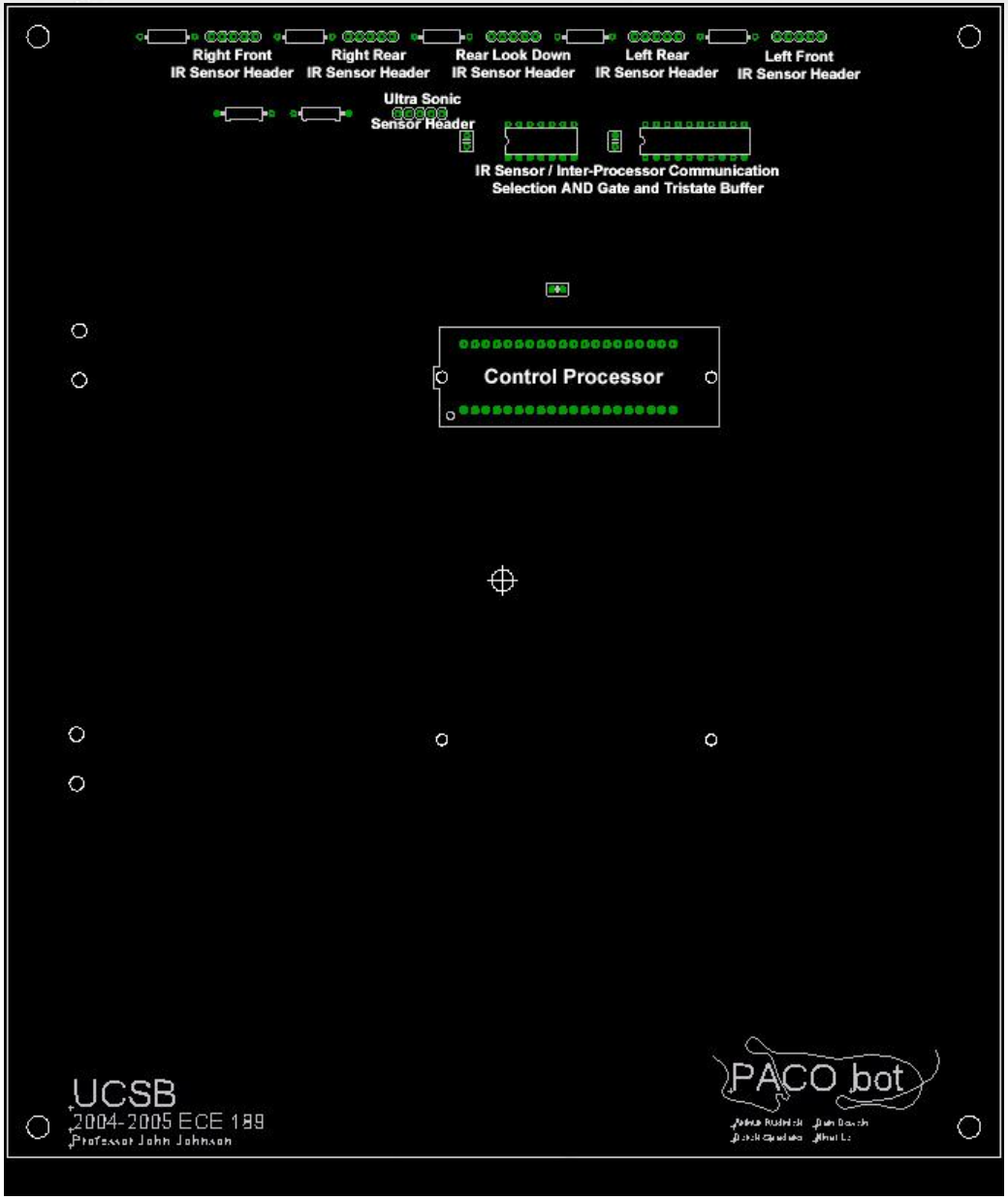
- Microchip PIC18F4331
  - Running on 8MHz Internal Clock
  - 40 MHz Capable with External Clock
  - 40 I/O Pins
  - 2 PWM Modules (8 & 2 Channel)
- Dual Processors
  - Faster Response Times
  - Task Modularization
  - Parallel Development Process
- Robust and Testable Design
  - Highly Modular
    - Pin Headers
    - Socket Mount Components
    - Off Board Modules
  - Diagnostic LEDs
  - Test Points

Vehicle Control (Motor & Servo Subsystems)



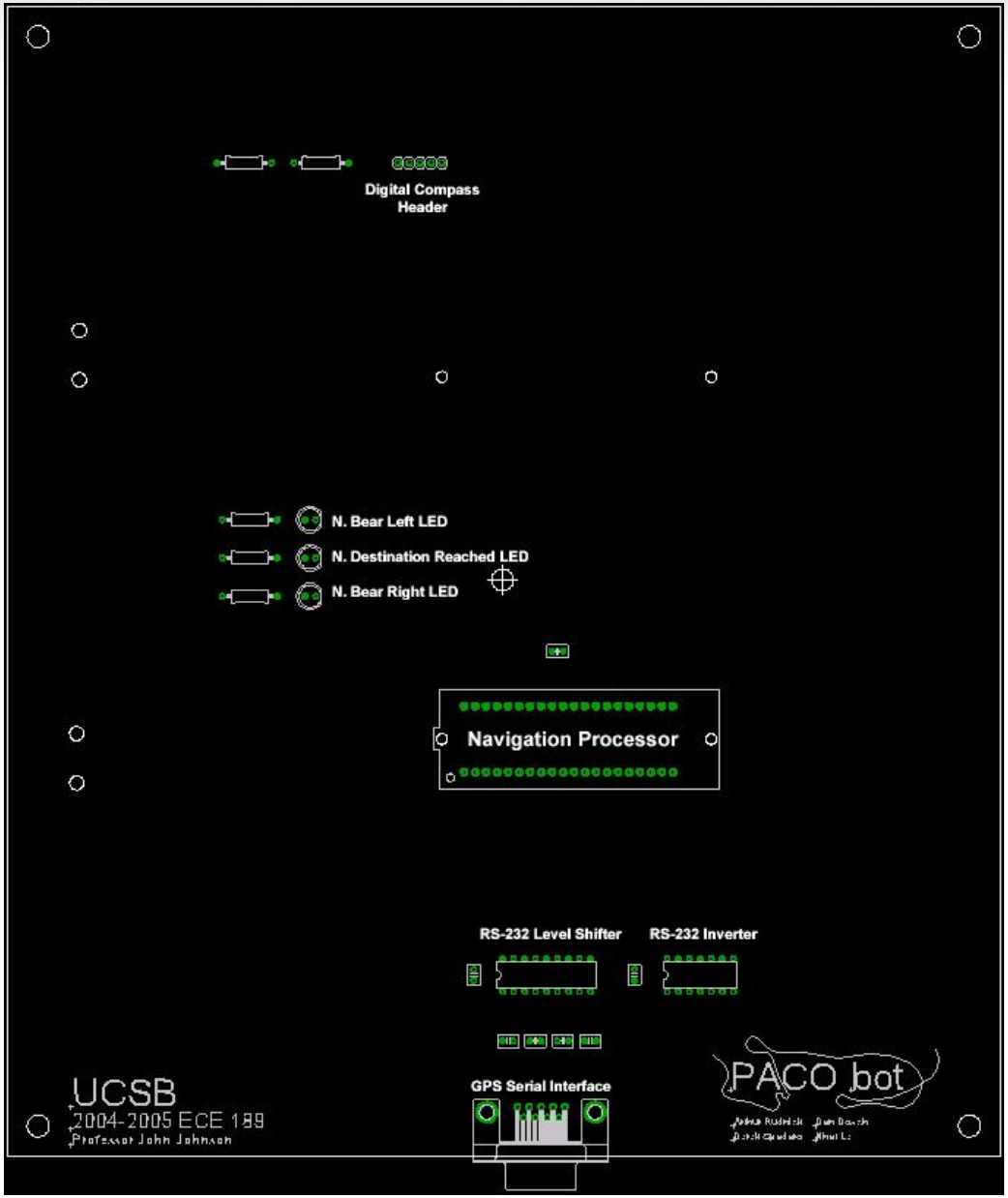
- 4 HOB-10 Gearhead Motors (12v)
  - Speed: 500 RPM
  - Stall Torque: 105 oz/in
  - Stall Current: 4.7 Amps
- 2 KCMD L298 Motor Control Modules
  - Voltage Range 6v – 26v Operation
  - Thermal Overload Shutdown
  - Regenerative Braking
- 2 GWS S-19CLMG Servo Motors (6v)
  - Stall Torque: 100 oz/in
  - Stall Current: 1.5 Amps

Object Detection (Sensor Subsystem)

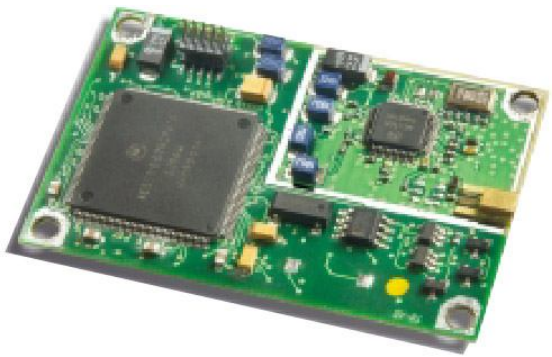


- 1 SRF08 Ultra Sonic Range Finder
  - I2C Interface
  - 56 mS Average Response Time
  - 11 Meter Range
- 5 Sharp GP2D05 Infrared Sensors
  - Binary Interface
  - 30 mS Average Response Time
  - 1.5 Foot Range

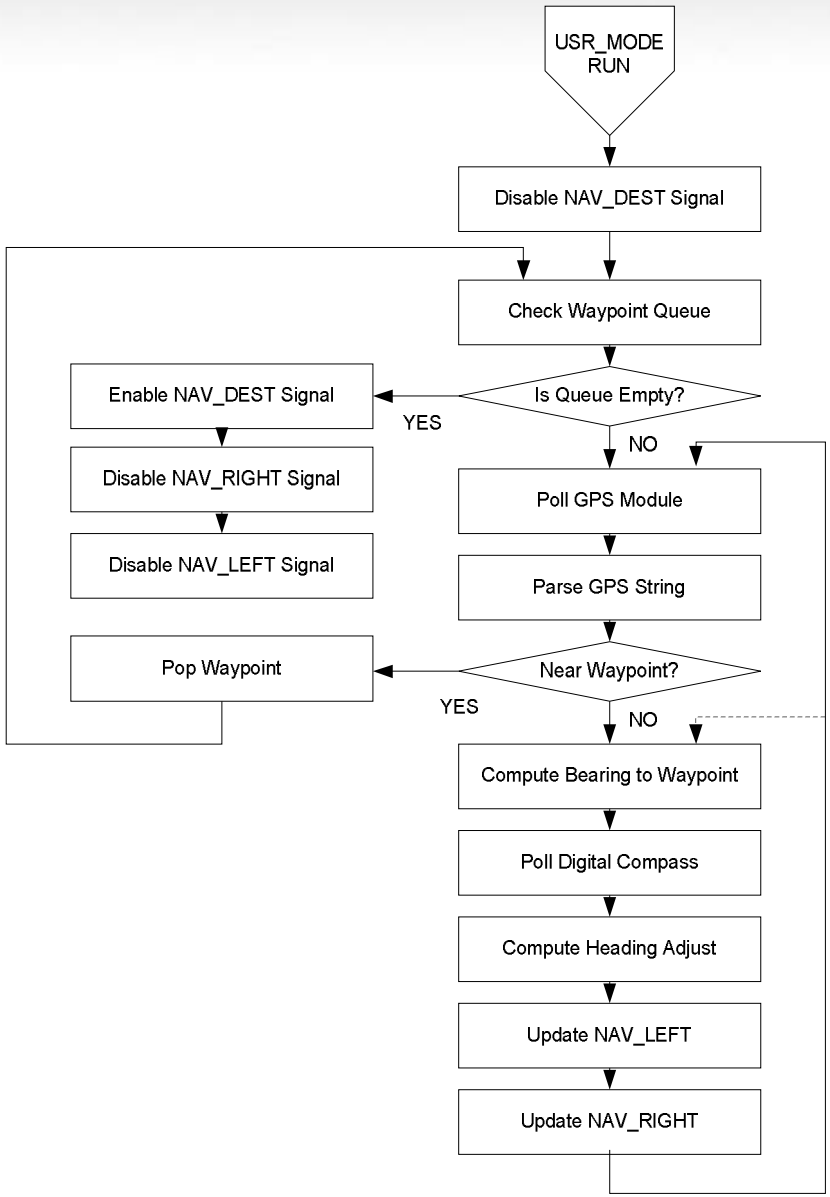
Navigation (GPS & Digital Compass Subsystems)



- Devantech CMPS03 Digital Compass
  - I^2C Interface
  - 8 Bit Precision
- Motorola Oncore FS GPS Eval Board
  - RS-232 Interface
  - 12 Channel Receiver
  - 1 Hz Refresh Rate

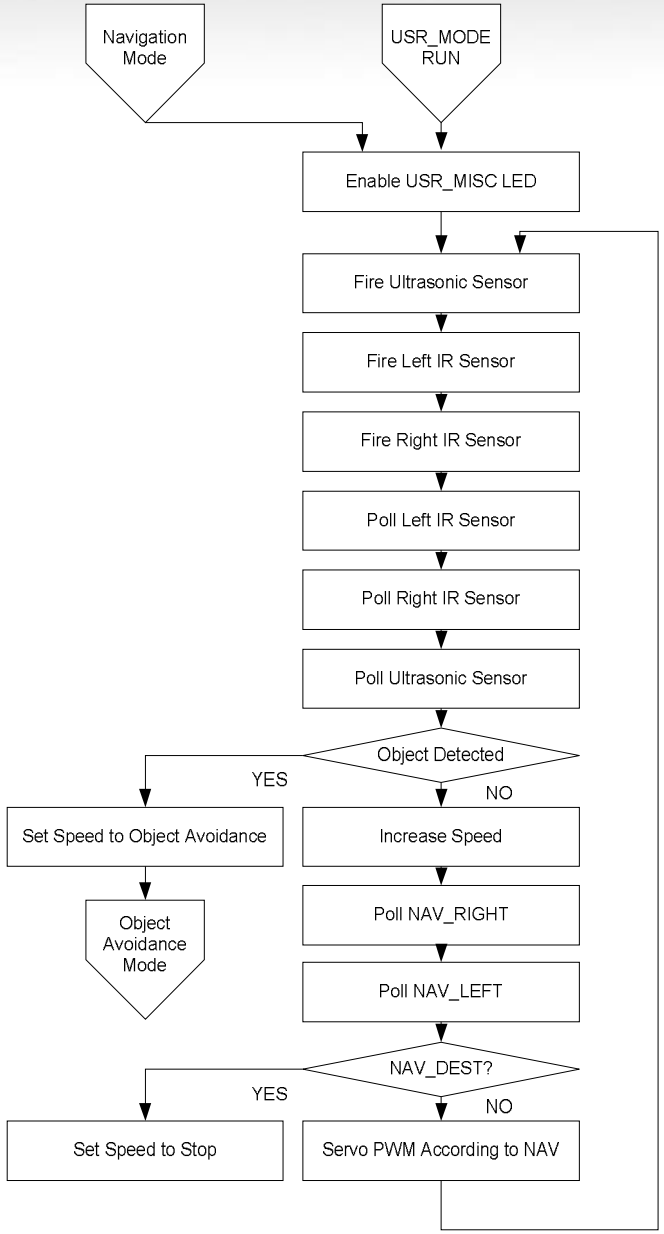


Software (Navigation Processor)

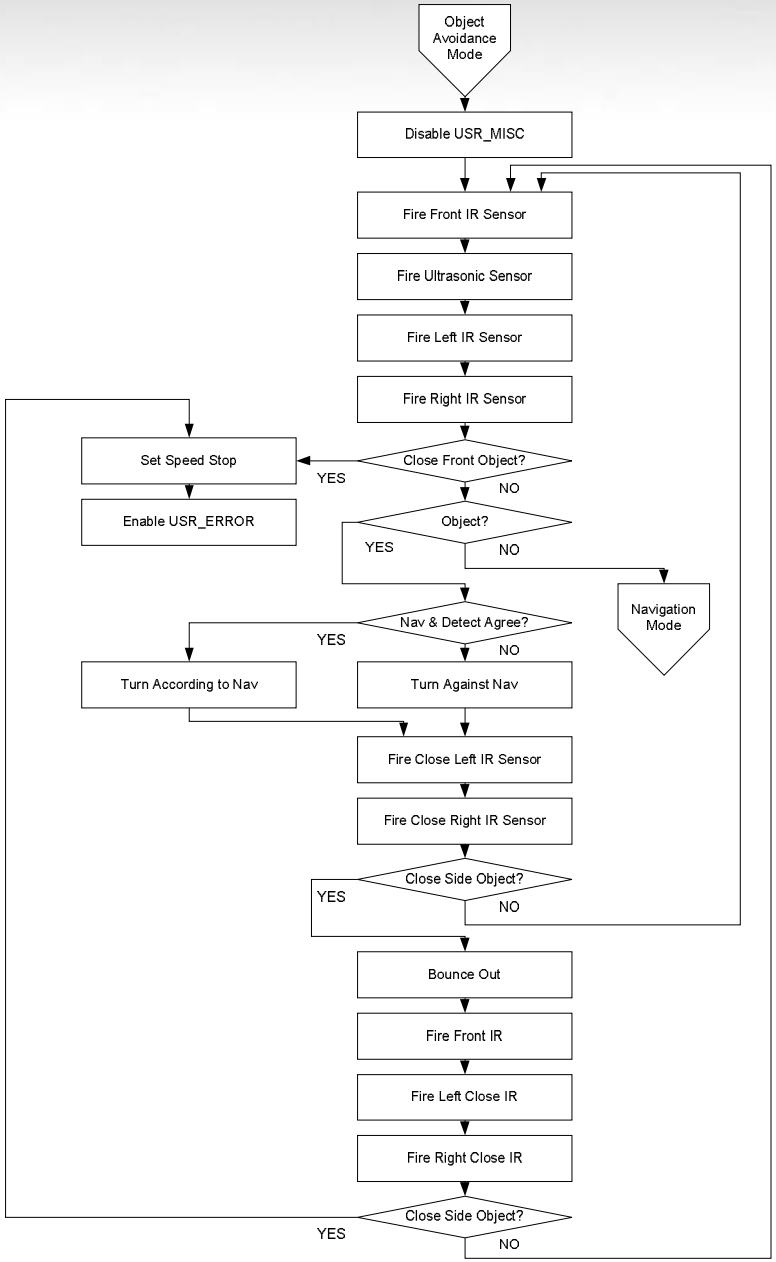


Possibility for increased responsively by skipping GPS polling step N times (determined by empirical testing in the spring)

Software (Control Processor Navigation)



Software (Control Processor Object Avoidance)



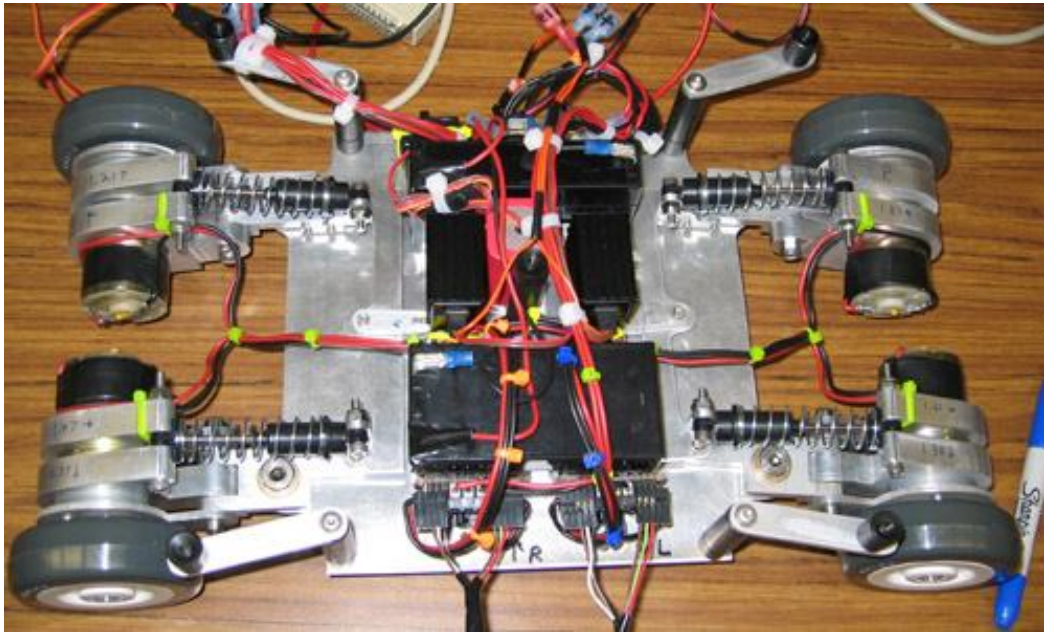
Chassis and Power Distribution

Power Distribution Specifications

- 12v Capacity: 1.3 AH Sealed Lead Acid
- 12v Peak Current Draw: 10 Amps
- 12v Average Current Draw: 1 Amp
- Protected by 10 Amp Quick Blow Fuse

- 6v Capacity: 1.3 AH Sealed Lead Acid
- 6v Peak Current Draw: 6 Amps
- 6v Average Current Draw: 0.5 Amps
- Protected by 6 Amp Quick Blow Fuse

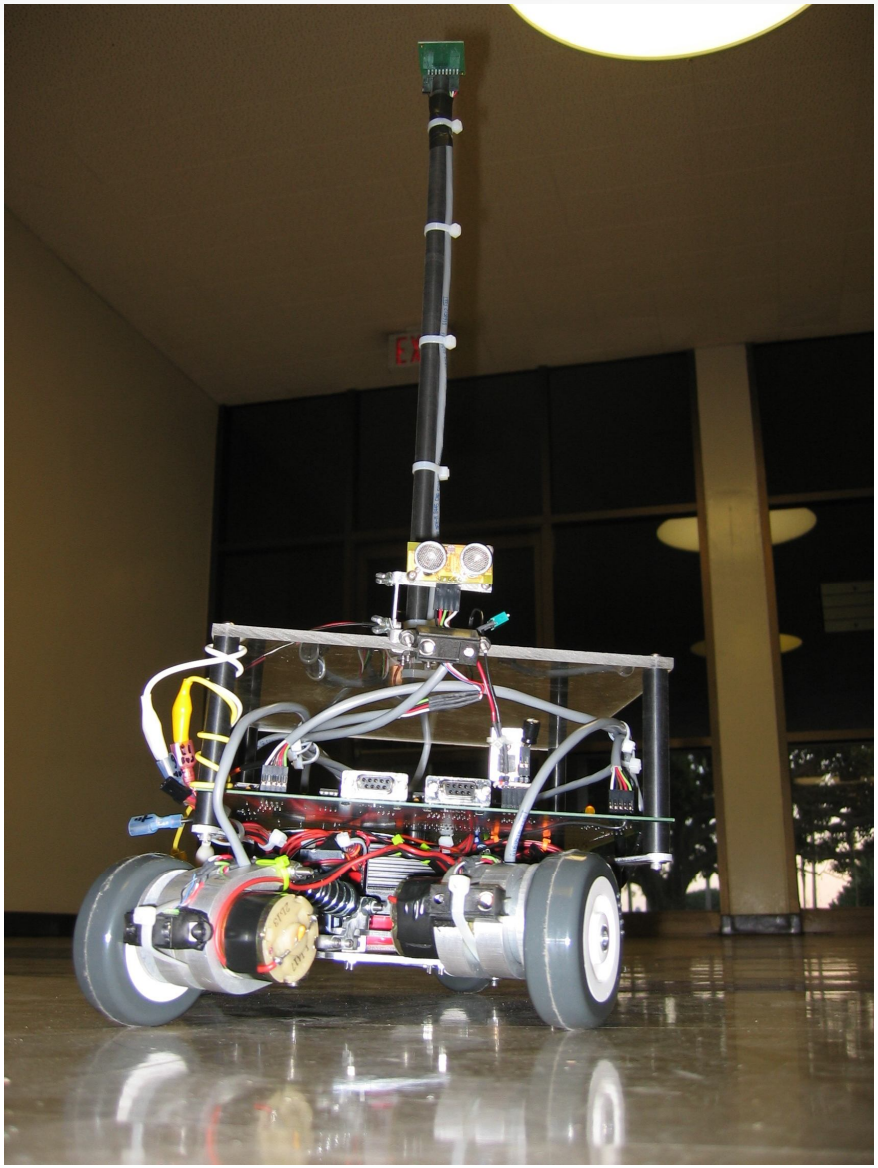
- 5v Capacity: 700 mAH NiCad
- 5v Peak Current Draw 40 mA



Chassis Specifications

- 4 Wheel Steering
- 4 Wheel Independent Suspension
- Top speed 5 MPH
- Turning Circle 2 Feet
- 1 Hour Average Run Time

Finished Product



- Autonomous Point to Point Navigation
- Autonomous Obstacle Avoidance
- Highly Adaptable and Extensible

Video

DIVX Medium Quality

Microsoft DV Super HQ

End of Presentation

Questions?

http://www.AtotheR.com/robotics/PACObot/