Roxi

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May 10, 2011

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2 Electronics Design

The electronics for Roxi can be broken into three major catagories: Senors, Power, and computers.

2.1 Sensors

Roxi uses vision and LIDAR as its primary sensors used for the navigation challenge and also has GPS and wheel encoders to allow for waypoint navigation.

2.1.1 Vision

The vision system consists of a AVT ”Guppy” F-XXX camera connected via an IEEE 1394a link to the main computer. This camera is capible of XXX x XXX resolution at XX fps.

2.1.2 Wheel Encoder

2.1.3 LIDAR

2.1.4 GPS

2.2 Power

2.2.1 Main Power

Main power for the robot comes from two sealed lead acid gell-cell batteries. These batteries are connected in series to produce a nominal 24 VDC supply for the motors and other systems. This provides approximatly XX $W \cdot hr$ of energy, XX hours of runtime of the motors, and XX hours of runtime of the electronics and motors.

The batteries are connected to a power distribution board, which allows the connection to each motor to be fused with XX Amps, allowing power to be cut in the event of a motor stall to prevent damage to the H-bridge. Power is also provided to several DC-DC boost converters, which output 5 VDC, 9 VDC, and 19.5 VDC for other electronics on the robot.

2.2.2 H Bridge

Each motor is connected to an OSMC H-bridge. This board is used to allow a low power signal from the microcontrollers to generate a high power PWM input to the motors. Each OSMC is capible of switching up to 50 VDC at 160A cont / 300A peak, allowing significant margin above our standard operating power of around 24 VDC / 20 A.

2.2.3 Component Power

Other systems are provided power through the use of DC-DC converters to produce voltages at 5 V, 9 V, and 19.5 V. This allows for the usb tethered microcontrollers, the firewire camera, and the main computer to be powered off of the main lead acid batteries. This greatly simplifies charging the robot, as only one battery system needs to be maintained.

2.3 Computers

2.3.1 Main Computer

Nearly all computation is performed on a single laptop containing a quadcore Intel Core i7 cpu, cuda enabled NVIDIA 285M gpu, and 6 GB of RAM. This computer is responsible for all vision, lidar, and GPS data processing and all path planning and control algoritms. It also forms the core of the sensor interconects, providing the firewire and USB bus the camera, GPS, and microcontrollers use.

2.3.2 MCU

Microcontrollers are used on Roxi as data aquisition boards to collect data from the wheel encoders, and as motor control boards to generate PWM signals to drive the H-bridges. There are 6 ATmega328p based Arduino Duemilanove boards on the robot, 4 interfacing with the wheel encoders, and 2 to drive the motors.

3 Software Design

3.1 Architecture

3.2 Algorithms

4 Performance

References

[1] *Space Network User's Guide*, pages 35–257, 317–327, 365–389. Number 450-SNUG. NASA GSFC, 9th edition, August 2007.

[2] Advanced Scientific Concepts Inc. *DragonEye 3D Flash LIDAR Space Camera*. http://advancedscientificconcepts.com/products/dragoneye.html.

[3] Allied Vision Technologies. *Big Family*.

[4] Allied Vision Technologies. *Prosilica GE4900 Datasheet*, v2.0.1 en edition.

[5] G. Richard Curry. *Radar Systems Performance Modeling*. Artech House Publishers, 2004.

[6] Zhaoxu Dong. *Mechanical Behavior of Silica Nanoparticle Impregnated Kevlar Fabrics*. PhD thesis, Purdue University, 2008.

[7] Du Pont. *Technical Guide Kevlar Aramid Fiber*.

[8] European Space Agency. *New Rdar Satellite Technique Sheds Light on Ocean Current Dynamics*. http://www.esa.int/esaEO/SEMZRQEMKBF_economy_0.html.

[9] European Space Agency. *Sentinel-1*. http://www.esa.int/esaLP/SEMBRS4KXMF_LPgmes_0.html.

[10] Navid S. Fatemi, Howard E. Pollard, Hong Q. Hou, and Paul R. Sharps. Solar Array Trades Between Very High-Efficiency Multi-Junction and Si Space Solar Cells. pages 2–3. Emcore Photovoltaics, September 2003.

[11] Christophe Geuzaine and Jean-Francois Remacle. Gmash: A three dimensional finite element mesh generator with built-in pre- and post- processing facilities. *International Journal for Numerical Methods in Engineering*, 79(11):1309–1331, 2009.

[12] Honeywell. *M50 Controll Moment Gyroscope*, 7th edition, January 2006.

[13] Jorgen Jensen and George Townsend, editors. *Orbital Flight Handbook, Part 1 - Basic Techniques and Data*, volume 1 of *Space Flight Handbooks*, pages V–52. Martin Company Space Systems Division, 1967.

[14] Bassem Mahafza. *Radar Systems Analysis and Design Using MATLAB*. Chapman and Hall, 2005.

[15] Malin Space Science Systems. *ECAM-C50*.

[16] Malin Space Science Systems. *ECAM-DVR4*.

[17] Malin Space Science Systems. *ECAM-IR1*.

[18] Malin Space Science Systems. *ECAM Optics*.

[19] et al Mikhalaylovskiy, Yuriy. *Impact*. http://impact.sourceforge.net/.

[20] PRC Laser Corp. *FH Series High Power Lasers*, 2005.

[21] Ramsey Electronics. *The 'LOGI' Log Periodic Antenna*.

[22] Mark A. Richards. *Fundamentals of Radar Signal Processing*. McGraw-Hill, 2005.

[23] Wolfgang O. Schall. Orbital derbis removal by laser radiation. *Acta Astronuatica*, 24:343–351, 1991.

[24] Merrill Skolnik. *Introduction to Radar Systems*. McGraw-Hill, 2002.

[25] SpaceX. *Falcon 1 Launch Vehicle Payload User's Guide*, 7th edition, May 2008.

[26] SpaceX. *Falcon 9 Launch Vehicle Payload User's Guide*, 1st edition, 2009.

[27] John F. Stocky and Christopher M. Stevens. Guidelines for preparing project risk management plans. Technical report, NASA, 2005.

[28] J.D. Weinberg, R. Craig, P. Earhart, I. Gravseth, and K.L. Miller. Flash lidar systems for hazard detection, surface navigation and autonomous rendezvous and docking. page 1. Ball Aerospace & Technologies Corp., 2007.

[29] James R. Wertz and Wiley J. Larson, editors. *Space Mission Analysis and Design*, pages 301–497, 894–897. Microcosm Press and Springer, 3rd edition, 2008.