

GT Night Rover PURA Application

Georgia Institute of Technology
Team Alpha
NASA Inspired Night Rover

Overview of Proposed Work

This research project aims to store and utilize electrical and thermal energy efficiently while investigating systems for prolonging the useful mission life of spacecraft. We intend to design an autonomous rover to locate sources of solar energy during a period of daylight and a period of darkness.

This project will develop technologies necessary for competition within the NASA Night Rover Centennial Challenge¹, by way of participation in the Intel Cornell Cup. The rover for the Intel Cornell Cup will be modified, improved, and expanded to satisfy the later deadlines and objectives of the NASA Night Rover Centennial Challenge. In so doing, Team Alpha will develop, test, and analyze systems that could be used to increase the operational life of solar-powered spacecraft.

Objectives for Semesters Research

Team Alpha will produce:

1. A functional robotic vehicle
2. A system to efficiently collect and store solar power
3. An autonomous control system for the robotic vehicle

The intention of this project is to demonstrate a working model of solar energy collection and storage for autonomous vehicles that shall operate continuously over one (1) day-night cycle. This project will serve as a continuation of work begun during the Fall 2011 semester.

Methods/Techniques Used

The rover will utilize an array of peripheral devices to sample its surroundings and to maintain proper orientation. A photometer will be used to measure light intensity which allow the rover to point its solar panels in the direction of the highest concentration of energy. The rover will also carry a set of ultrasonic sensors for the detection of obstacles in its immediate path. Ultrasonic technology will be a cost effective method in allowing the rover to sample its surroundings in real time and maintain its heading accordingly.

The bulk of the rover's navigation systems will consist of a digital compass used in conjunction with a gyroscope. The gyroscope allows the vehicle to orient itself on all three axes while the digital compass will provide a heading.

Research and Related Work Background

Cost effective devices and components will be used for harvesting solar power and implementing the required functionality³. An array of solar panels directed toward light sources will act to power the autonomous system and charge a reserve power supply during lighted hours. The panels pitch and orientation will be directed according to input from multiple light sensors and computations according to a digital compass and clock, accounting for the sun's location. Other peripherals such as low resolution cameras and ultrasonic distance sensors will aid in navigation across diverse terrain.

Autonomous navigation and resource harvesting algorithms will be computed on an Intel Atom board. The Atom board provides unprecedented computation power for spacecraft and allows for the implementation of complex real-time systems. Each mechanical device will be driven with a custom embedded processor.

The in-house design will be implemented using custom electronics and algorithms to minimize energy consumption and maximize operation time.

Requested Budget

| System | Amount (\$) |
|--------------------------------|-------------|
| Power (Solar, Batteries, etc.) | \$ 250 |
| Drive | \$ 300 |
| Intel Board | \$ 200 |
| Electrical Control System | \$ 300 |
| Raw Materials | \$ 250 |
| Peripherals | \$ 200 |
| Testing | \$ 400 |
| Miscellaneous | \$ 100 |
| Total: | \$ 2000 |

Team Members and Background

Kevin Reilley (AE 2013)

- Experimentation, testing, and development of micro renewable energy system.
- Flight Systems Co-Lead for Georgia Tech University Student Launch Initiative.
- Systems and engineering design experience.

David Esposito (CS-MATH 2012)

- Experience working with embedded systems and custom hardware design.
- Member of the Georgia Tech MAKE (Embedded Microprocessors) club.
- Developed on mobile systems using various peripherals.
- Experienced with large scale software engineering and artificial intelligence algorithms.

Baris Arin (CS 2012)

- Experience building small electronics.
- Skilled with low-level languages and assembly language.

Farzon Lotfi (CS 2013)

- Taken classes implementing path finding and computer vision algorithms.
- Developed motor controls for embedded devices.
- Experience with digital design logic.
- Skilled with low level languages such as C.

Roberto Pereira (ECE-CS 2013)

- Taken classes in digital design and implemented a custom hardware using a FPGA .
- Worked with micro-controllers implementing various electronics projects.
- Skilled in the use of oscilloscopes and digital analyzers.
- Experience in working with HDLs.

Resources and Mentors

Multiple lecture and research professors from Georgia Tech's College of Computing, College of Computer Engineering, College of Electrical Engineering, College of Mechanical Engineering and College of Aeronautical Engineering have been approached in regards to this project. Each professor extended an invitation to make use of his/her office hours as a resource for this project.

Team Alpha will be supervised by Dr. Jay W. Summet. Under the guidance of Dr. Summet, who specializes in prototype systems which includes robotics.

In addition to expert advice, Team Alpha will utilize the Electrical Engineering Lab, facilities at the Tech Square Research Building (TSRB), and the Invention Studio at Georgia Tech to maximize the research project's potential.

References

1. <http://nightrover.org/>
2. <http://www.jameco.com>
3. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.21.7046&rep=rep1&type=pdf>
4. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.118.5316&rep=rep1&type=pdf#page=92>

The students ability to carry out the proposed project. Please include any past or present experience supervising this student in research (for pay or credit), in a course, or in another capacity. Mention, if appropriate and known, any previous research the student has performed in the past under other advisors or away from Georgia Tech if you believe it has bearing. *

- David Esposito is currently working on a computational biology research project for the mathematics department at Ga Tech. He also work with a peer to develop a large scale automatic grader to be used by Java based classes, saving 15-20 man hours per week.
- Farzon and Baris are currently working on an interdisciplinary research between the High Performance Computing Lab and the School of Molecular Sciences and Engineering. They are working to optimize molecular simulations on GPU computer clusters.
- Each of the student from the group applying for funding have proven themselves academically as well as leaders in the Computer Science department. The three members have 10 semesters of leadership experience and responsibilities as Teaching Assistants to my personal colleagues.

The relationship between the students project and your own research. *

Explain how the funding will benefit both the student and yourself. For example, does the funding completely enable the work to be undertaken due to the students need for a part-time job? Or does the funding allow you to begin research in a new area, follow a newly discovered trend in your own research which is not currently funded, or develop an idea for a possible new proposal? *

- David will be able to explore his interest in robotics before he starts his graduate program in the Fall 2012. While excited about the opportunity to work on a "from-scratch" robotics project, funding would provide a invaluable learning experience.
- Baris will further develop his knowledge of computer architecture and embedded systems in the context of this hands-on project. He will also be able to apply the concepts from his CS/ECE background to supplement the team's diverse skill set.
- Farzon is the only member of the group with an Intelligence thread background. He would like to apply the knowledge he has gained in these classes towards a real world project.
- Roberto will be able to gain experience in the design of autonomous robots and to apply his hardware knowledge in the implementation of the design.

Additional comments with respect to this applicant that you feel would be helpful to UROP in making final PURA decisions. * "

- I feel this funding would provide the initial momentum necessary for my group of students to grow intellectually, strengthen communication skills and complete a successful project on time. I am looking forward to leading this team of highly motivated young men.