Deliverable #1 - Needs Assessment

Team 11 – NASA/RASC-AL Robo-Ops

<u>Team Members</u>

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1.0 Problem Statement

From the competition website:

"RASC-AL Exploration Robo-Ops Competition (i.e., Robo-Ops) is an engineering competition sponsored by NASA and organized by the National Institute of Aerospace. In this exciting competition, undergraduate and graduate students are invited to create a multi-disciplinary team to build a planetary rover prototype and demonstrate its capabilities to perform a series of competitive tasks in field tests at the NASA Johnson Space Center's Rock Yard in June 2013."

The objective of this project is to design and build a robot that can traverse terrain similar to what is found on the moon and Mars. The robot must have an appendage capable of picking up rocks and a place to store the rocks. All control of the robot during the competition must be done remotely from the campus of the university, with the competition itself taking place at the NASA Johnson Space Center in Houston, Texas.

2.0 Background

This project will build on the efforts of previous STRIDe lab sponsored senior design projects, namely, last year's NASA Lunabotics competition. A hexapedal robot was designed and constructed for the competition by last year's senior design group. This robot will serve as a reference for our design.

While the participation in the competition itself may not directly serve the interests of any particular party, we will seek to demonstrate the advantages of a legged robot as a rover platform. As rovers are traditionally based on a four or six wheeled design, the successful implementation of a legged robot may spur further investigation into the platform by NASA.

In addition to the technical aspects of the project, a significant portion of our time will be devoted to seeking opportunities to get children and the general public excited about space exploration and robotics.

3.0 Objective

The primary objective of the project is to have a functioning mobile robot that meets the competition guidelines by the end of spring semester 2013. This objective will be valid whether we are selected for the competition or not (only 8 teams will receive the $10,000 grant from NASA and be allowed to compete).

The main goals for **FALL SEMESTER** are as follows:

1. Complete the full design of a new hexapedal robot that meets the requirements of the competition
2. Submit a competition proposal to NASA
3. Develop and refine control algorithms for locomotion of a hexapedal robot using currently available hardware.
4. Establish 3G network control and video streaming
5. Design and construct a prototype robotic arm and claw

4.0 Methodology

The overall hexapedal robot has been broken down into smaller sub-components in order to facilitate the design process. The main sub-components are: telecommunication controls, locomotion controls, robotic arm and grabber, and motor and frame. The telecommunication controls and locomotion controls will be developed, refined, and implemented on the hexapedal robotic platform developed by last year’s team. Once a design for the robotic arm and grabber have been agreed upon by the group, work will commence on prototyping and developing the selected design. The arm and grabber will be designed in a way which will allow implementation the on the current hexapedal robotic platform and the one we will develop and build for the competition.

Due to weight limitations and limited funding, the motors and gearboxes currently available will most likely not be used on the new design and purchasing six new sets is not feasible. Designing all of the sub-components on the current platform allows our team to move forward with the project without spending most of our expected funding on new motors and gearboxes. We will have a design for a new frame as well as new motors and gearboxes chosen which will be purchased if our team is selected to compete and given the $10,000 grant from NASA. All of the sub-components will be transferred to the new frame with the new motors and gear boxes if this is the case.

5.0 Expected Results

As stated above, we expect to have a functioning robot that meets the competition requirements by the end of the Spring 2013 semester. If we are not selected for the competition we will use the currently existing hexapedal base to complete a mock run of the competition. It is expected that the robot will be capable of traversing smoothly over obstacles up to 10 cm in height as well as 33 degree inclines and declines. The robot is also expected to be telecom controlled with the ability to selectively pick up rocks ranging from 2 cm to 8 cm in diameter and store them onboard the robot itself.

6.0 Constraints

Time: It will be difficult to design, build, test, and refine the robot to an acceptable degree prior to the competition date.

Budget: We currently have no funds allocated to the project. We are expected to receive a grant of up to $4,000 from the Florida Space Grant, but do not know when that money will arrive and do not know for sure what the exact dollar amount will be. We solicited many companies for sponsorship during “Engineering Day” and hope that this will lead to increased funding. If our design is selected we will receive $10,000 from NASA, which will help with the purchasing of hardware and travel to the competition, but these funds would not be in hand until the spring semester, which limits our ability to build and test hardware during the Fall Semester; we have kept this in mind while setting goals and developing a project plan for this semester. The team will maintain a detailed project budget and solicit educational discounts whenever possible.

Number of Team Members: Since there are 6 members on this project team, it will be important to develop a process for meetings that will allow all opinions to be heard while still staying on subject. This issue will be addressed by preparation of meeting agendas by the team leader, who will ensure meeting stay on topic. Facilitation of a democratic decision-making process we agreed on by the team in the Code of Conduct and should be kept in mind throughout the project.

It will also be difficult to schedule meetings so that all members can be present. This issue can be mitigated by careful division of tasks so that significant portions of the workload can be completed independently or in smaller sub-groups. Team agreed-upon tasks will be assigned weekly by the team leader and tracked with a software program called Asana.

7.0 Design Requirements

Mechanical Design Requirements and Goals

1. Robot Size
   - Required:1m x 1m x 0.5m max
2. Robot Weight
   - Required: 45kg max
3. Leg loading
   - Required:45kg+rocks (minimum) Desired: 150kg
4. Storage Capacity
   - Required:5 rocks Desired: 30 rocks
5. Ride height
   - Required:10 cm max obstacle size
6. Arm/Gripper Requirements
   - Rock Size
     - 2-8cm
   - Rock Weight
     - 20-150g
   - Terrain Grade
     - 33% max up/down slope
     - Flat sand
7. Robot Construction
   - Water resistance
     - Must withstand light rain
   - Required: solid underbelly Desired: Fully enclosed robot

Electronic and Control Requirements and Goals

8. Battery Life
   - Required: 1 hour Desired:2 hours
9. 3G or 4G interface
10. Camera Desired:5 Megapixel
11. Leg Control (Buehler Clock)
12. Arm Control
13. Water resistance
14. GUI/User Interface
15. Video Streaming

8.0 Gantt Chart

Name	Start	Finish
Planning	9/17/12	9/28/12
Concept Generation	9/17/12	9/28/12
Arm/Claw Ideation	9/17/12	9/28/12
Locomotion	9/17/12	9/21/12
Design	9/17/12	12/7/12
Frame Layout	9/17/12	12/7/12
Communications	9/17/12	11/26/12
Locomotion/Drivetrain	9/17/12	10/31/12
Arm Design	9/26/12	10/25/12
Control Algorithms	9/26/12	12/7/12
Vision System	10/29/12	12/7/12
Testing and Prototyping	10/1/12	5/3/13
Communications Testing		
Camera		
Arm Testing