Deliverable #1 - Needs Assessment

Team 11 – NASA/RASC-AL Robo-Ops

Team Members

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1.0 Problem Statement

From the competition website:

"The RASC-AL Exploration Robo-Ops Competition (a.k.a., Robo-Ops) focuses on a specific system in an interplanetary mission – robotics. Robo-ops annually invites undergraduate and graduate students to create a multi-disciplinary team to build a planetary rover prototype and demonstrate its capabilities to perform a series of tasks in field tests at the NASA Johnson Space Center's (JSC) Rock Yard."

The objective of this project is to design and construct a planetary rover that can traverse environments commonly found in outer space planets such as Mars and the Moon. The rover robot must be able to perform tasks such as picking up small rocks with an extracting unit while on rough terrain. The control of the rover must be done away from the competition site at the NASA Johnson Space Center in Houston, Texas via 3G network at a local university to simulate space mission environments.

2.0 Background

Since the launch of the Mars Curiosity Rover in 2011, the public awareness of robotic exploration on space planets has been catapulted to the front of the line. NASA hosted the RASC-AL Exploration Robo-Ops: Robotics Systems competition aimed to increase public awareness and also provide a great platform to showcase ingenious, sophisticated new rover ideas for potential application in future space missions.

This project will be contrasted on the effort of the FSU Robo-Ops competition team from 2012-2013. Although the Space-Hex platform performed well in the competition, earning fifth place nationally, there are still room for improvement to increase the functionality and robustness of the platform. The Robo-Ops team of 2013-2014 intends to adapt the advantage of the legged platform from the existing platform but also strides to incorporate robust new designs to take the competition to the next level.

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 2014. 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 2013 SEMESTER** are as follows:

1. Complete the full redesign of a new planetary rover robot that meets the requirements of the competition
2. Submit a competition proposal to NASA
3. Refine control algorithms for locomotion of a hexapedal robot using currently available hardware.
4. Refine 3G network control and video streaming.
5. Design and construct a new extraction unit.

4.0 Methodology

The 2014 Robo-Ops hexapedal robot design is divided into five sub-components for maximal design efficiency. The sub-components are telecommunication, locomotion, robotic arm, gripper and frame/thermodynamics. The main emphasis of the telecommunication sub-component will be improving the latency and signal reliability issues between mission controls to the hexapedal rover on competition site via 3G network as experienced by last year’s team. As a returning team, the basic locomotion platform and algorithm for the hexapedal rover is already in place. The team will focus on improving the robustness and dexterity of platform locomotion such as sharper turning angle and faster speed. Based on last year’s competition experience and feedback, it was decided by the team the arm and gripper mechanism will have to be redesigned to improve performance and weight. Development and implementation of the arm and gripper will begin when a design has been agree upon by the team. The frame of the hexapedal rover will require a complete redesign if the team choose to take the approach of building multiple smaller hexapedal rover in place of the larger platform currently in use. The novel approach is limited by the funding for this project, as multiple sets of every component will be needed.

The sub-component designs will be transfer and assembly into a complete design regardless which frame design approach the team decide to take.

5.0 Expected Results

The team expects the design of the rover be completed by the end of Fall 2013 semester for the competition proposal and finish construction of a functioning rover by the end of Spring 2014 semester. If the team is not selected as one of the eight teams for the competition, a mock run of the competition will be performed with the existing hexapedal platform. 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: Although the current team has the platform from last year's competition, it will still be difficult to complete the redesign and refine the robot to a satisfactory state with consistent performance.

Budget: The team currently has limited funds for the project. The team has contacted several sponsors from last year and has reestablished some sponsorship. The team also had attempted to seek out potential sponsorships during the campus career fair "Engineering day" and is in the process of contacting several organizations that had shown interest. If the team's design is selected as one of the finalist of the competition, the team will receive $10,000 from NASA in spring semester. The team has taken the budget constraints into account to establish a plan that minimize the effect of an uncertain budget.

Team Dynamics: The SpaceHex team is made up of three ME and two ECE students, thus it is very important to ensure the different disciplines can work together smoothly without conflicts. Department leads were chosen to facilitate the democratic decision-making process to guarantee no team members' voice is neglected. Regular team and faculty meetings are carefully scheduled to certify the team is making a forward progress and stays on track for the timeline.

7.0 Design Requirements

Mechanical Design			
		Required	Desired
1	Robot dimension	1m x 1m x 0.5m max	
2	Robot Weight	45 kg max	30 kg
3	Leg Loading	45 kg+rocks	150 kg
4	Storage Capacity	5 rocks	30 rocks
5	Ride Height	10 cm max obstacle size	
6	Arm/Gripper Requirement	2-8 cm rock size, 20-150g rock weight	
7	Robot Construction	Water resistance, solid underbelly	fully enclosed
Electronics and Control			
		Required	Desired
8	Battery Life	1 hour	2 hour
9	Telecommunication	3G/4G	
10	Camera		5 Megapixel
11	Leg Control (Buehler Clock)		
12	Arm Control		
13	Water Resistance		
14	GUI/User Interface		
15	Video Streaming		

*Grey blocks denote not particular value required by the competition.

8.0 Gantt Chart

	Task Name	Duration	Start	Finish
1	**Fundrasing**	35 days?	Mon 9/23/13	Fri 11/8/13
2	Complete Funding Proposal	2 days?	Fri 9/20/13	Tue 9/24/13
3	Engineering Day Presentation	1 day?	Fri 9/20/13	Mon 9/23/13
4	Contact Individuals we know	10 days?	Wed 9/25/13	Tue 10/8/13
5	Pray For Money	160 days	Mon 9/23/13	Fri 5/2/14
6	**Locomotion Controls**	115 days	Mon 9/23/13	Fri 2/28/14
7	Turn While Walking	115 days?	Mon 9/23/13	Fri 2/28/14
8	Finer Turning Motions	115 days?	Mon 9/23/13	Fri 2/28/14
9	Turning while climbing	115 days?	Mon 9/23/13	Fri 2/28/14
10	Control with and Xbox	91 days?	Fri 10/25/13	Fri 2/28/14
11	**Sample Extraction Module**	95 days?	Mon 9/23/13	Fri 1/31/14
12	Gripper	95 days?	Mon 9/23/13	Fri 1/31/14
13	Brainstorming	5 days	Mon 9/23/13	Fri 9/27/13
14	Prototyping -- Cardboard Stage	20 days	Mon 9/30/13	Fri 10/25/13
15	Selection of Final Design	5 days	Mon 10/21/13	Fri 10/25/13
16	Determine Parts Necessary	5 days	Mon 10/28/13	Fri 11/1/13
17	Complete CAD Model	5 days	Mon 10/28/13	Fri 11/1/13
18	Construction	20 days	Mon 11/4/13	Fri 11/29/13
19	Attachment to Arm	1 day	Mon 12/2/13	Mon 12/2/13
20	Testing Gripper	20 days	Tue 12/3/13	Mon 12/30/13
21	SEM Mechanism	95 days?	Mon 9/23/13	Fri 1/31/14
22	Brainstorming	5 days	Mon 9/23/13	Fri 9/27/13
23	Prototyping -- Cardboard Stage	20 days	Mon 9/30/13	Fri 10/25/13
24	Selection of Final Design	5 days	Mon 10/21/13	Fri 10/25/13
25	Determine Parts Necessary	5 days	Mon 10/28/13	Fri 11/1/13
26	Complete CAD Model	5 days	Mon 10/28/13	Fri 11/1/13
27	Construction	20 days	Mon 11/4/13	Fri 11/29/13
28	Testing SEM System	20 days	Mon 12/2/13	Fri 12/27/13
29	**Communication**	115 days?	Mon 9/23/13	Fri 2/28/14
30	Develop Communications Design	20 days	Mon 9/23/13	Fri 10/18/13
31	Determine Necessary Components	15 days	Mon 10/21/13	Fri 11/8/13
32	Acquire Necessary Components	20 days	Mon 11/11/13	Fri 12/6/13
33	Build Communication System	34 days?	Tue 12/10/13	Fri 1/24/14
34	Test and Debug Communications	20 days	Mon 1/27/14	Fri 2/21/14
35	**Thermal Fluid System**	95 days?	Mon 9/23/13	Fri 1/31/14
36	Concept Generation	5 days	Mon 9/30/13	Fri 10/4/13
37	Concept Selection	5 days?	Mon 10/7/13	Fri 10/11/13
38	CAD Model	10 days	Mon 10/14/13	Fri 10/25/13
39	Determine Components	10 days?	Mon 10/14/13	Fri 10/25/13
40	Construction	20 days	Mon 10/28/13	Fri 11/22/13
41	Testing Thermal System	20 days	Mon 11/25/13	Fri 12/20/13
42	**Complete System Integratio**	40 days	Mon 3/3/14	Fri 4/25/14