REQUEST FOR PROPOSAL
FOR ENGINEERING DESIGN

Robo-Rat

Automated rope-climbing robot

Baylor University Engineering & Computer Science

Department of Electrical and Computer Engineering
Department of Mechanical Engineering

EGR 3380
Engineering Design I
Spring 2010

1. STATEMENT OF WORK

Qualified engineering design teams are invited to submit technical proposals for the design of an *Automated Rope-Climbing Robot*, hereinafter referred to as the *Robo-Rat*. Proposals are to be submitted to the instructors of EGR 3380, hereinafter referred to as the *client*. Upon client approval of a conceptual design, each engineering design team, hereinafter referred to as the *team*, shall build, test, and evaluate a prototype device, and shall provide the client with full engineering documentation of the prototype design.

Additional instructions and schedules not included in this RFP for completing design, presentation, construction, testing, and documentation milestones will be found in the course calendar, milestone assignment documents, and other specific documents to be distributed by the client at appropriate times during the project. The design, construction, testing, and reporting of the Robo-Rat is a requirement for completion of Engineering 3380 - Engineering Design I at Baylor University for the Spring Semester 2010.

2. DESIGN SPECIFICATION

2.1 Background

In recent years there has been a lot of engineering research and development work on autonomous robotic devices capable of various types of locomotion in different environments. These include robots that fly, swim, walk, and climb. There are many reasons for the development of such devices, including performing tasks in hostile environments or locations otherwise difficult or dangerous to access by humans. These include robotic device used to seek out bombs and mines, or to operate in environments with radioactive or toxic substances. Also, autonomous robotic devices can be used to carry out inspections in hard-to-access locations of structures or machines, such as the hulls of ships, the insides of pipes systems, or inside the walls of buildings. There have even been proposals for micro-robotic devices to navigate within the human body for disease diagnosis and treatment.

One recent proposed application of a rope-climbing robot is for the structural inspection of large wind turbines (figure at right: Fraunhofer Institute for Factory Operation and Automation). Robots have also been designed to climb along high-voltage power lines to inspect the wires for damage.

2.2 Design Requirements

2.2.1 *General function:*

The general objective of the Robo-Rat device is to autonomously climb a length of rope. The process will begin by securing the Robo-Rat to the lower end of the rope. The team will then initiate the device with a single electrical switching action. The device will then ascend the rope until it reaches the ceiling. Upon reaching the ceiling, the device shall switch itself off. The Robo-Rat device shall employ a “climbing-like” method of ascension. The use of rollers or wheels to ascend the rope in a “rolling-type” motion, will not be allowed.

Desired attributes of the Robo-Rat device are, among others, *speed of climb*, *reliability*, *creativity of concept*, and *visual appeal*. The team shall design the Robo-Rat device to meet or exceed all of the criteria listed below.

2.2.2 *Climbing:*

The device shall climb an 8-ft vertical length of rope. The rope shall be secured at the top and bottom. The team shall initially attach the device to the rope within the lower one foot section. The team may have access to the lower end of the rope if necessary. The rope will be of type: TBD . The device shall ascend the rope using a “climbing-type” action. Rolling up the rope on wheels/rollers is not allowed.

2.2.3 *Power:*

Power for the Robo-Rat device shall be supplied from a single, 18 V rechargeable battery manufactured for use with cordless hand tools such as drills. The weight of the battery will be in excess of 1 pound.

2.2.4 *Control:*

After the device is attached within the lower one foot section of the rope as is readied for climb, it shall be activated by a single electrical switching action. After activation, the device shall operate autonomously under the control of an onboard microcontroller. The programming of the microcontroller shall guide the climbing action and shall terminate the climbing at the upper end of the rope. No human intervention is allowed once climbing begins.

2.2.5 *Setup & Reset:*

When the team is called upon to test their device, they will have two minutes to secure their device to the lower end of the rope and ready it for operation. When the device has finished climbing (reaches the top and switches itself off), the team will have another two minutes to reset the device to the lower end of the rope and ready it for a second trial.

2.2.6 *Safety:*

The device must be deemed safe by the client. This includes, but is not limited to, to the following considerations with respect to the operator and others nearby: safety from electrical shock hazards; safety from pinch points; safety from sharp edges and points; safety from flying debris; safety from chemical contaminants. The device shall also operate without damaging the rope or any other part of the testing apparatus.

3. SAFETY REQUIREMENTS

The team shall conduct all construction and testing with safety as the paramount consideration. Failure to observe workplace safety rules will lead to penalties in performance evaluation. Egregious or repeated safety violations, or disregard for Safety Officers, can result in dismissal from the course.

Cleanliness in the workplace is expected at all times and in all work areas. Failure to observe workplace rules will lead to penalties in performance evaluation. The design team shall clean all work areas with each use.

4. REPORTING & DOCUMENTATION REQUIREMENTS

The team shall document the design by use of manuscripts, calculations, schematics, flowcharts, computer code, and design models/drawings. Specifications for required documentation and due dates not otherwise contained herein will be contained in the course calendar and/or will be distributed by the client at appropriate points during the project.

4.1 PRELIMINARY CONCEPTUAL DESIGN REVIEW (PCDR)

4.1.1 *Date*

2/11/2010

4.1.2 *Objective*

The PCDR is a formal presentation. The client should be apprised of your conceptual design progress; i.e., you should describe one or more solution concepts that your team is considering. The main goal is to foster constructive discussion of possible design approaches for the purpose of advancing the team toward concept selection.

4.1.3 *Format*

- Duration: 5-8 Minutes
- Given by one team member.
- Visual aids using PowerPoint and/or Elmo
- Business casual dress.

4.2 CONCEPTUAL DESIGN REVIEW (CDR)

4.2.1 *Date*

2/18/2010

4.2.2 *Objective*

The CDR is a *top-down* formal presentation to the client of the selected design concept. The client should understand how your proposed design will meet the specifications in this RFP. The client should gain a clear picture of the major components/systems and their overall arrangement/function. Furthermore, the client should understand your team's implementation plan for completing the project.

4.2.3 *Format*

- Duration: 7-10 Minutes
- Given by two team members, with approximately equivalent contributions.
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress.

4.3 PRELIMINARY DESIGN REVIEW 1 (PDR 1) & DRAWING SET 1 (DS 1)

4.3.1 *Date*

2/25/2010

4.3.2 *Objective*

PDR 1 & DS 1 is for the purpose of communicating the detailed design of a major *subsystem* through a presentation and drawings.

4.3.3 *Presentation Format*

- Duration: 5-8 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.3.4 *Drawing Format*

- Subsystem Drawings
  - Assembly drawing(s) of subsystem including *bill(s) of materials*.
  - Circuit schematic(s) for subsystem.
  - Detailed drawings of subsystem parts that must be manufactured

4.4 SUBSYSTEM TEST (SST)

4.4.1 *Date*

3/4/2010

4.4.2 *Objective*

The subsystem test is a hardware demonstration of the performance of the subsystem described in the PDR 1 & DS 1.

4.5 PDR 2 & DS 2

4.5.1 *Date*

3/18/2010

4.5.2 *Objective*

PDR 2 is for the purpose of communicating the detailed design and integration of two major *subsystems* through a presentation and drawings.

4.5.3 *Presentation Format*

- Duration: 5-8 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.5.4 *Drawing Format*

- Subsystem Drawings
  - Assembly drawing(s) of all subsystems involved, including *bill(s) of materials* (and including revisions of DS 1).
  - Circuit schematic(s) for subsystems.
  - Detailed drawings of subsystem parts that must be manufactured

4.6 SYSTEM INTEGRATION TEST (SIT)

4.6.1 *Date*

3/25/2010

4.6.2 *Objective*

The system integration test is a hardware demonstration of the integrated performance of the two subsystem described in the PDR 2 & DS 2.

4.7 PDR 3 & DS 3

4.7.1 *Date*

4/1/2010

4.7.2 *Objective*

PDR 3 is for the purpose of communicating the detailed design of the entire device through a presentation and drawings.

4.7.3 *Presentation Format*

- Duration: 5-8 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.7.4 *Drawing Format*

- System Drawings
  - Assembly drawing(s) of entire system and all subsystems including *bill(s) of materials*.
  - Circuit schematic(s) for entire system.
  - Detailed drawings of parts that must be manufactured

4.8 PRELIMINARY SYSTEM TEST (PST)

4.8.1 *Date*

4/8/2010

4.8.2 *Objective*

The preliminary system test is a preliminary hardware demonstration of the performance of the entire system as described in the PDR 3 & DS 3.

4.9 COMPLIANCE TEST (CT)

4.9.1 *Date*

4/15/2010

4.9.2 *Objective*

The compliance test is the final and critical hardware evaluation. System performance will be evaluated against all specifications. Data will be collected and analyzed.

4.10 FINAL DESIGN REVIEW (FDR)

4.10.1 *Date*

4/19/2010

4.10.2 *Objective*

The FDR is a public presentation of the design to a general audience including the client, other design teams, invited faculty, students, and guests.

4.10.3 *Presentation Format*

- Duration: 3-4 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Professional dress

4.11 Final Report and Final Drawing Set (FR&FDS)

4.11.1 *Date*

4/26/2010

4.11.2 *Objective*

The Final Report and Drawings are archival documents that provide a complete and permanent record of the design.

4.11.3 *Report Format*

The format for the final report will be communicated to the design teams by the client by 4/9/2010

4.11.4 *Drawing Format*

- Subsystem Drawings
    - Assembly drawing(s) of entire system and all subsystems including *bill(s) of materials*.
    - Circuit schematic(s) for entire system.
    - Detailed drawings of parts that must be manufactured