ENGN4627 Project: Climbing Robot

Due Date: 10am Monday 26th September

Task

For this project, students will work together in teams of three students to design and program a robot to climb a steeply inclined ramp. The ramp will be fabricated from particle board, and will have holes drilled in it of various sizes and spatial layout. The ramp will have a length of 3.6m, and the idea will be for students to design a robot that uses these holes to climb from one of a set of starting holes at the bottom of the ramp, to any of a set of finishing holes at the top of the ramp. To make the project more interesting, a competition will be conducted at the end of 3rd teaching period between all the project groups, where the group with the fastest time wins, and where (valuable!) prizes will be awarded to the groups placing first, second or third (see below).

Materials

Lego:
Each team will be provided with a set of Lego Mindstorms Robotic Invention System. Each team should have (and is limited to):

1 set of Lego pieces
1 RCX CPU brick
3 Motors
3 Light Sensors
3 Touch Sensors

Other Lego parts may vary, depending on the precise kits. Spare Lego is available if you need extra standard parts for the robot (provided that it does not result in an unfair advantage). It is the responsibility of the team to ensure that the Lego pieces do not get lost or mixed up with sets of other teams. Gluing together of Lego pieces is not permitted. Note, the Lego must be returned tidy! Until the returned lego kit is to the satisfaction of Padma, the report for that group will not get marked.

Non-Lego:
It is permissible to use other materials, besides Lego, but within limits. No additional sensing, propulsion or computation capability is allowed. The structural strength must come from the Lego (no steel chassis). No more than 10 dollars in materials is permitted. Only commonly available materials are allowed (e.g. available from any supermarket, newsagent or hardware store). Only very basic hand tools are allowed to be used (no machining of parts). No damage to the Lego pieces is permitted.
Logistics:
Students will need to form themselves into project groups of three members. They should go to Padma to be given their allocation of lego pieces. Padma will record the name of each member in the group for administration purposes.

Competition Environment

Size:
The climbing ramp for the final competition will be 3.6m high by 1.2m wide, inclined to the horizontal at 60 degrees. Because this project task is new for this year, in the first instance we will supply a section of ramp 1.2m high for testing purposes, in order to see if the hole size/arrangement is appropriate. This section of ramp will be mounted in the Controls lab during the first part of the semester to allow easy access by groups to test their robots. Once we determine the suitability of the hole size/arrangement in this test section, we will manufacture the remaining five sections to make up the full 3.6m length.

Location:
The final ramp will be mounted between the toilet level and ground floor level near the stairs at the northern entrance of the Engineering building (i.e. near the Controls Lab).

Surface:
The surface of the ramp will be painted a light grey colour, with white strips protruding down each of its sides to a distance of 25mm in from the edge. Every effort shall be made to ensure that the field is flat and at a constant gradient, however it is recommended that teams design their robots to be able to cope with slight curvatures of the surface.

Holes:
The hole spacing in the section of test ramp is at 100mm centres, with 50mm distance between all outer holes and the edge of the board. The hole diameters have been set at 10mm and 30mm. Note that the holes pass completely through the board. Note also that it is not envisaged that the remaining five sections of ramp will be fabricated with holes of the same size, or spatial layout, of the test section.

Boundaries:
Walls to a height of 50mm shall be placed on the inclined edges of the board. They will be made of unpainted aluminium.

Lighting:
Teams must come prepared to calibrate their robots based on the lighting conditions at the venue. Every effort will be made to keep ambient light to a low level with infra red sources from incandescent lights and natural lighting removed.
Software

The Lego RCX controller (the big yellow and grey brick) contains a Hitachi H8 micro-controller. The RCX will be programmed using your choice of language. Firmware and operating system for a standard language “Not Quite C”, which is a C derivative language, is provided on the course web site.

Rules

More rules may be added if and when required:

1. Robots, in any configuration, must fit inside a 30cm diameter sphere.
2. Robots must stay within the white edge lines of the ramp. Robots straying into the white area for any significant period of time will be disqualified. No use of the aluminium boundary wall is allowed.
3. There can be absolutely no contact between the robot and any human during its operation on the ramp.
4. Solutions to the task not in the overall spirit of the project are illegal. If in doubt, ask for a ruling. Rulings will be posted on the web site.

Competition

Date:
The competition will be held at 9.00am - 11.00am, Friday 23 September

Attendance:
Each project group must attend and compete in the competition in order to be able to submit a project report.

Assessment

Report:
A project report will be due on Monday, 26th September, 10am.

This is essentially a report on a scientific investigation into designing an optimal (in the sense of the task described above) climbing robot, and it should be structured as such; with a clearly stated aim, body, results and conclusion. It is envisaged that the body will hold much of the analysis and design documentation. Some of the things that may want to be discussed (but there will be others) are:

• Climbing strategy selection analysis
• Mechanical and Electro-Mechanical Design, (and maybe even any interesting aspects of the code), using the selected strategy
• Design of the sensor systems adopted
• Obviously students should aim to use, and document the use of, any aspects of the course material that are useful or relevant.
• As in any design process, choices need to be made that involve compromise. Students may wish to report on the strengths and weaknesses of the final design decisions taken, but may also want to document alternative possibilities that were investigated, but not pursued.

The absolute maximum upper limit for the report is 10 pages (at an 11 or 12pt. font size in Times or similar).

Note that it will be difficult to furnish marks for the mechanical design aspect of the report without a suitably precise description of the robot (i.e. photographs - a picture is worth a thousand words!). Please provide these photographs at the end of the report (i.e. not counted in the 10 page report size limit).

As a gauge for the work required for this project (ie. design, build, test, compete, report), note that the project mark provides 20% of the final course mark, compared to 15% in total for all 6 assignments. That is, each member should contribute to the project approximately one and a third times the effort taken to complete the full assignment set.

Prizes:
The prizes for the teams placing 1st, 2nd and 3rd respectively in the competition to be held at the end of the 3rd teaching period are:

• Full marks awarded for three assignment questions of the team members choice, irrespective of whether solutions to these questions are submitted for marking
• as above, except that only two questions can be selected
• as above, except that only one question can be selected