MEGR 3156 Spring 2019 Project Description KML 1/1/19

Mobile Crane

A compact and remotely-controlled robot is needed that will maneuver between obstacles and transport spheres. These websites have interesting information: https://proliftcrane.com/different-types-mobile-cranes-explained/, http://www.sanyglobal.com/product/crane-mobile/index.html. The 'spirit' of the transporter is a lightweight, well-balanced, and cost-effective robot that can easily engage, transport and place the spheres into a specific location.

The requirements and objectives of the project are to design, build and compete with a lightweight robot that is controlled remotely to[1]:

- Start from and return to a specified position and volume that are no larger than 12.00"x6.00"x6.00" (LxWxH); the starting position will be with the robot "parallel parked" in a space with a length of ≈14". The ending position will be an area near the parallel-park space that is designated by tape.
- Maneuver between obstacles that are no closer than 6" apart; the trip out must be through the slalom course; the return trip can be made on a section of the course that bypasses the slalom course.
- **Securely** engage and transport two spheres[2] up an incline of approximately 30° and deposit them across a moat[3]. This may be done in one or two round trips on the incline. The spheres will initially be placed near each other (in shallow cups side-by-side with a gap) on the driving surface near the base of the incline.

Resource specifications:

- The vehicle's main power source is limited to four AA alkaline batteries that are on board the robot. Duracell 'Copper Top' and Energizer 'Max' are allowed batteries. Two additional battery sources can be used for powering controls, but they cannot be used to power the actuators of the vehicle.
- Remote control is required to be wireless. The control system must include a micro-controller [without motor shields]; two micro-controllers are allowed. Master on/off switches (with clear labeling and access) are required for all battery sources. All controller functions need to be clearly labeled. The use of at least one feedback signal to the micro-controller is encouraged; this may take the form of a limit switch or some other sensor that helps the operation of a function of the robot.

[1]These are the "customer's" desired requirements and specifications. It is possible that if a strong case is made for change (based on calculations, drawings, etc.), a specification could be 'tweaked'.

[2]The spheres have diameter of 1.50" and are made of E52100 steel (McMasterCarr part 9528K64).

[3]The deposit area for the spheres is across a moat of approximately 8".

Project grades will be based on numerous factors, some of which include[5]:

- the completeness and quality of the design
- the presentation of the design
- the time required to traverse the course
- the weight of the robot (it is important that they be light)
- equivalent material and supplies cost of the vehicle: <$220[6]. See below for important clarifications regarding the guidelines for costing of items.
- the labor budget associated with the time to completely manufacture and assemble the robot
- the ease of the robot to be controlled to traverse obstacles and maneuver about the course
- the functionality and quality of implementation of all of the sub-systems
- the manufacturability of the robot (based on the use of 'off-the-shelf' parts, reasonable fabrication time and cost, reasonable use of CNC machining, etc.)
- aesthetics and fit-and-finish
- the appropriate use of rapid prototyping. [Please note that plain wheels with rectangular spokes will not earn a high grade].
- peer evaluations (all members of each team will evaluate each other's contributions)
- instructor's evaluations of individuals and teams

[5]Note that many of the performance criteria will be evaluated on a relative basis among the robots based on performances at the competition. The quality of the design and implementation of each system will be evaluated subjectively by a panel.

[6]The cost of materials for the robot should be no greater than $220. However, to encourage the proper use of standard parts which are sometimes not available at reasonable cost in small quantities, some additional guidelines apply which reduce or exempt the cost applied to the budget that will be compared to the specified maximum. In all cases, the cost will appear in the bill of material, but in a separate column.

1. The costs of fasteners do not apply to the cost limit budget. Fasteners are identified as items that appear in the McMaster-Carr "Fasteners" section, including screws, bolts, nuts, waxhers, threaded inserts, spacers, pins, rivets, and retaining rings. Similar items may also be exempt by explicit agreement of the course instructor.
2. To encourage the use of proper bearings, the cost of solid bearings do not apply to the cost limit budget. These are such items as "Sleeve Bearings" and "Thrust Rings" in the McMaster-Carr catalog, and Igus plain bearings.
3. Some items which would make a good design choice in production carry a particular premium when ordered in small quantities. Where prices for quantity 100 are available, they may be used for purposes of calculating the cost limit budget even though the actual purchase of small quantities is more expensive.
4. The first $50 of rapid prototype costs at UNCC/ME Dept (Dr. Raquet) do not count towards the price limit.
5. Material costs may be applied to the cost limit budget pro-rata based on standard sizes. For example, a 6" long shaft can be budgeted at 1/12 the cost of a standard 6 foot length of stock. Where this is done should be explicitly shown in your budget. In the case of sheet metal, the area should be based on that required to cut out the robot parts and not simply the surface area of the finished parts.
6. If surface mount electronics primarily associated with a single chip are implemented using a carrier board (e.g., as commonly supplied by SparkFun) for wiring convenience, the cost of the bare chip may be used for purposes of the cost limit budget.

Additional Notes:

- If a robot touches the floor (off the course), the run must be aborted.
- If a student touches the main body of the robot, the run must be aborted.
- Donated parts and supplies must be included in the cost of the robot at fair market value.
- Teams may use up to two different CNC parts (where copies do not count as 'different').
- Teams should generally not purchase components until subsystems are designed appropriately and approved by the instructor. If a component is needed for proof-of-concept testing prior to formal approval, discuss this with the instructor to get early approval. Teams are encouraged to make early purchases of Arduino boards and a test servo in order to facilitate generation of code and experience with these units.
- A subsystem is not considered designed unless there are calculations and models that show that it can work.
- **It is the responsibility of each student to make significant contributions to the team projects and to work well within the assigned teams. Failure to do so will result in individuals forfeiting credit given to the team according to the discretion of the instructor.**
- Grades will be affected by unprofessional behavior, lack of contribution to the team project, misuse of Duke 217, mis-use of the machine shop, absences from presentations, competitions, in-class discussions, and etc.
- Once designs are fully documented and submitted, teams must request permission to make changes. Teams should expect penalties if they build robots that are different than the designs without discussing the needed changes and receiving permission, from the instructor, to make them **prior** to making the changes.

Some sources for various parts are:
Gearboxes and servos: http://www.robotcombat.com/store.html, http://servocity.com/;
Gears, chains, supplies: http://www.sdp-si.com/, http://www.mcmaster.com/
Electric supplies: http://www.digikey.com/
Metal stock: Foil's Inc., http://www1.mscdirect.com/, http://www.mcmaster.com/
Plastic stock: Piedmont Plastics, 5010 W Wt Harris Blvd, (704) 597-8200; http://www.mcmaster.com/
Micro-controllers: http://ruggedcircuits.com/html/ruggeduino.html; https://www.sparkfun.com/;