School of Mechanical and Aerospace Engineering
Nanyang Technological University
MA4012 Mechatronics Engineering Design

Mechatronics Group Project Assignment Sem 2 (2023/24)

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1. Introduction

Assignment: Design of a compact autonomous vehicle

Description and Objective:

Your mechatronics group is to design and build a compact autonomous vehicle using the kit and equipment provided as a starting basis. The mechatronics project assignment is to test your group's ability to design the best Autonomous vehicle given the necessary equipment, resources and time and to do it within specificed constraints. The outcome and success of your design will be tested and competed against other teams taking this course.

Mechatronics Design Challenge:

Your team is to design an build a Autonomous Vehicle to perform basic functions like edge detection, target tracking, searching and retrevial. It will be pitted against another vehicle from your fellow teams. Two vehicles will be placed inside an arena on the same side in the home boundary area. 3 balls will be placed around the track arena. The vehicle that is able to search and retrieve the most balls and placed them in the delivery area behind the home boundary line will be the winner.

- The automonous vehicle should be smaller than 30cm x 30cm x30cm before the start of the event.
- The vehicle is not allowed to increase its footprint after the start of the event.
- The robot should be made up by more than half coming from parts that are provided by the lab.
- Power supply to the vehicle is limited to a 6-cell AA rechargeable battery pack provided.
- Sensors are to be deployed at the edges of the vehicle to allow it to detect the boundaries of the arena.
- The vehicle is to demonstrate good maneuverability (good wheel geometry, drive wheel or steering balance etc…)
- A sweeping sharp sensor can be use to search for the balls.
- A grasping mechanism should be available to retrieve the ball and allow the vehicle to return to the delivery area to deliver the ball.
- The vehicle will then return back to the arena to locate more balls.
- No additional sensors, servos, motors, batteries are allowed over that of what is provided.
- No restriction on the number of limit switches that you want to mount on your vehicle.

Layout of competition

- Each team will place their autonomous vehicle on the same side of the arena. Handlers have to decide the location before the balls are placed randomly in the arena
- 3* balls will be placed at random somewhere in the arena.
- A time limit of 3* mins will be allowed for both vehicles to search and recover as many balls as possible.
- The arena will be bounded by a yellow reflecting tape to allow the robots to detect the edges. The edges of the arena will have a 30mm high wall to prevent the ball from rolling out of the arena.
- Each robot can only carry one ball at any one time. (If your robot collect 2 or more balls, it must release the extra balls immediately)
- Upon the dectection and collection of one ball, the robot is to carry it back to the collection area. (No throwing or rolling from a distance back to the collection area.) The collection area has a boundary wall in which the ball has to be lifted over to be delivered.
- In the event that both robots are 'stuck' together "each not giving way" or locked in a corner, the referee will order a reset for both teams.
- The winner will be the team with the higher number of successful balls retrieved.

Rules of how the competition will be run will be briefed to the students on the day of the of the competition (e.g. team playing order, judging procedure etc…..)

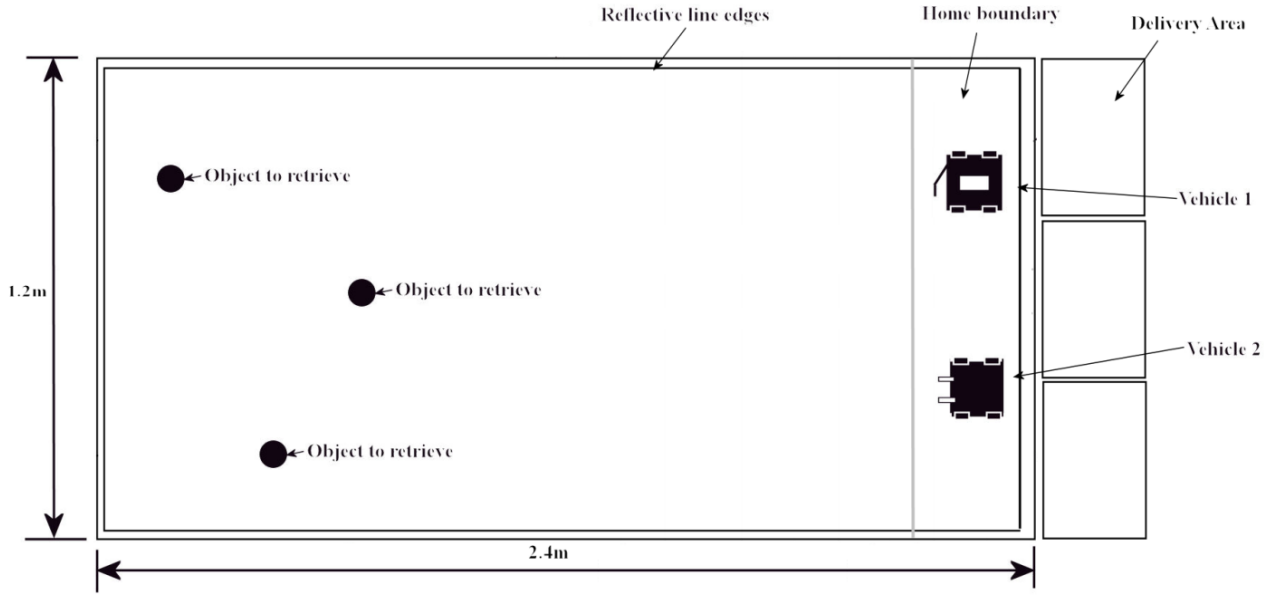

Figure of Arena.

2. Guidelines for doing the Mechatronics Engineering Projects

2.1. Class Attendance:

Sign your name on the attendance sheet for every Mechatronics Design class.
Form yourself into groups of max 10 students. Please reroll your name to a group in the MA4012 coursesite under 'groups'. There is currently a physical limit of 50 pax in the Mecht lab (as per the Covid 19 safe distancing measures).

2.2. Scheduling:

Mon/Tue (MA1/MA2) 1.30pm to 4.30pm Mechatronics Lab

MA4012 Phase I (Define and Ideate)		
Week (S2 23/24) Date	Briefing/Tutorial (1 Hr)	Project Activity (2 hrs)
Week 1 15/16 Jan	No Class	No Class
Week 2 22/23 Jan	Project Assignment Briefing	Forming of groups Use of Miro Boards
Week 3 29/30 Jan	**Tutorial 1** Functional Analysis Design Specifications (BS7373)	**Design task1**: Mechanical Design Collector Design and Strategy
Week 4 5/6 Feb	**Tutorial 2** Conceptual design generation	**Design task 2**:Mechanical Design Vehicle Design and Drive System
Week 5 12/13 Feb	No class Public Holiday (CNY)	
Week 6 19/20 Feb	**Tutorial 3** Embodiment design principles	**Design task 3**:Electrical and Electronic Design Power supply and sensor strategy
Week 7 26/27 Feb	Open briefing	**Design task 4**:Software Program Design Software strategy for power, sensing and navigation
Semester Recess		
MA4012 Phase II (Prototype and Test)		
Week 8 11/12 Mar	Open briefing	Prototype Build of Autonomous Vehicle
Week 9 18/19 Mar	Open briefing	
Week 10 25/26 Mar	Open briefing	
Week 11 1/2 Apr	Open briefing	Testing and programming of vehicle. Optimization, Defense,Search, Collection and Delivery Strategies.
Week 12 8/9 Apr	Open briefing	Trial Run. Aim to have your vehicle running by 8/9 Mar. Give your group 1 week for fine tuning. Preparation of project report.
Week 13 15/16 Apr	MA4012 Competitions Mon 15 Apr 2024 Final report submission. (Dateline:19 Apr 2024)	

2.3. Work procedure:

Every student must maintain a record of his/her week-to-week work and contributions to the team. Individually kept logbook may be inspected by the tutors and queried on demand.

Programming: Details of the programming of the Vex controller is in the MA4012 coursesite.

2.4 Marking rubric:

Report			Robot Vehicle				Total
20	10	10	20	20	**10**	10	100
Report Quality	**Calculations**	**Engineering Drawings**	**Vehicle Design/ Performance**	**Construction Quality**	**Competition**	**Log Book**	

Competition	Marks
1st	10
2nd	9
3rd	8
4th	7
5th	6
6th	5
7th	4
8th	3

Project Marks	Final Exams	Subject Total
50	50	100

Before submitting your group report, please use the following checklist to ensure that your report contains the entries required.

Project Report Requirements:

1. Product Design Specification /Technical Specification- The requirements/needs/aspirations of the product to be developed is outlined. A comprehensive technical specification using BS7373:1991 or equivalent as a guideline.

2. Conceptual Design - All the different alternatives considered should be presented.

3. Detailed Design – Detail design of the automous vehicle

4. Design Calculations - Performance, strength/ stiffness, loading....

5. An overall assembly drawing where all the items are identified. Drawings should be in orthographic projection and can either be hand drawn or produced with a CAD package.

6. Part drawiings - Only detail drawings of major parts and components/ are required. (around 6 good quality part drawings are required).

7. Control Systems/Wiring Diagrams- A circuit or wiring diagram of all the components in the vehicle are to be provided. Power supply, sensors, cabling lines actuators etc…

8. Chapter of valuable lessons learnt during the Project Assignment Activity.

9. Miro Log File of each member. The file to show individual and dyad contributions to the group project. Submission of pear review form from each team member.

Website for information on using the Vex controller:

https://www.vexrobotics.com/

https://www.vexrobotics.com/vexcode-download

https://www.vexforum.com/

Peer Review Form

Team Name:_____ Gp (no):_____

Peer Assessment by:_____

Insert score of 1 to 5. 1.. Strongly Disagree 5… Strongly Agree

Team Member Name:	Punctual/ Committed	Proactive	Leadership	Teamplayer	Technical Knowledge	Communication	Teaching/ Coaching		Total