MCT 332|Design of Mechatronics 2
Spring 2024
Project Description

It is required to design a mobile robot that would achieve a certain task or goal, fulfill a certain need or can be of assistance in completing a specified objective.

The constraints for this mobile robot's design are as follows:

↳ For the mechanical design

- The robot should be mainly constructed of metal.
- Mechanical design methodology should be applied when designing shafts, bearing placements, wheel configurations, lifting mechanisms (if any)

↳ Navigation

- Semi-Autonomous: The robot should be able to observe, process information and take a decision e.g., avoid an obstacle or pickup an object without any human interaction or aid, no remotes or joysticks can be used to navigate the robot.

↳ Functionality

- All robots must contain a computer vision module that either aids in objective completion or is incorporated into the robot's navigation system.
- PID control must be implemented in your motion actuators' low-level control.

↳ Other

- The robot must include at least one micro-controller board that is designed by the team.
- You must provide a GUI application on a PC using **QT** that communicates with the robot using WiFi.

↱ Each team must consist of no more than 6 members

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Presentation [1] Submission

Total Marks:

- 5 Marks

Date:

- Week 4

Deliverables:

- Mechanical Design with full details including **sensors**, **actuators**, **bolts** and **nuts**, **kill switch**, **charging port** presented in the form of **PowerPoint presentation**.

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Spring 2024
Midterm Submission

Total Marks:

- 25 Marks

Project description:

The idea of the project is to firstly go through a product design stage to study different users' needs, after targeting a certain need it is required to look at the product from a business point of view and develop a business model for the product. Model creation for physical systems and the use of control schemes for developing control systems and testing system-level performance will be done in the VREP Simulation environment. The physical models will first be created using SOLIDWORKS or Inventor software and then imported into the simulation environment. Then students go through real implementation of the robot, manufacturing different parts of the robot experiencing different manufacturing techniques integrating this with purchased components and testing their software modules on real life.

Project Objectives:

The project ensures that the students will be able to use VREP simulation environment and be familiar with its features and use it for developing any physical system. Moreover, they will be able to import any cad model from SOLIDWORKS/Inventor platform into the environment and use VREP for improving and developing the system performance. They will link python programming library with VREP to incorporate computer vision modules in their system. Then finally test their software modules on the real robot.

Outcomes of the project:

1- Modeling and simulation of all robot systems like mechanical & electrical systems.
2- Understanding VREP simulation platform.
3- Importing a SOLIDWORKS/Inventor model into the VREP environment.
4- Using VREP for creating model of physical system and inserting all the required parameters to optimize the performance of the system using many of the platform's components.
5- Using python programming language and linking it with VREP to incorporate computer vision modules within the system
6- Experiencing different manufacturing techniques and integrating their manufactured parts with purchased components
7- Testing same software modules developed to test with VREP on the real platform

Deliverables:

1- Video for a **VREP Simulation** showing your full robot functionality in an environment similar to the real environment that the robot is designed to operate in, all the functionalities should be shown except the vision-based functionality.
2- Mechanical design with full details
3- Actuator sizing by hand and using software (SOLIDWORKS Motion Analysis/Inventor Dynamic Simulation)
4- Software Architecture [Flow Chart]
5- Block diagram for micro-controllers with Raspberry Pi with communication protocols between them
[All the previous should be in the form of a PowerPoint presentation]

6- Technical Report
7- Poster

Report Contents:

1. Abstract containing brief description of your project.
2. Mechanical Design: Robot CAD model showing Working drawings with descriptions for different parts, full assembly, mechanisms and their role, and stress analysis.
3. Software Architecture (Flow Chart), Block Diagrams describing how the robot works.
4. Actuator Sizing by hand and using software
5. Simulation: showing your environment in your simulation platform, commenting on different test cases with reference to scripts used (Python/ MATLAB/ LUA). You can attach a link to a video here showing the different test cases with an option to do it with voice-over.

Poster Contents:

1. High Quality Renders from the CAD Model
2. Renders for the robot in the working environment
3. Robot Specifications application wise
4. Block Diagrams describing how the robot is designed and software architecture

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Spring 2024
Presentation [2] Submission

Total Marks:

- 30 Marks

Date:

- Week 12

Deliverables:

- **Vision Module** Tested on VREP
- **Integrated** Manufactured Mechanical System
- **Motors PID** Control Implemented and Tested

MCT 332|Design of Mechatronics 2
Spring 2024
Final Submission

Total Marks:

- 40 Marks

Project description:

The idea of the project is to firstly go through a product design stage to study different users' needs, after targeting a certain need it is required to look at the product from a business point of view and develop a business model for the product. Model creation for physical systems and the use of control schemes for developing control systems and testing system-level performance will be done in the VREP Simulation environment. The physical models will first be created using SOLIDWORKS or Inventor software and then imported into the simulation environment. Then students go through real implementation of the robot, manufacturing different parts of the robot experiencing different manufacturing techniques integrating this with purchased components and testing their software modules on real life.

Project Objectives:

The project ensures that the students will be able to use VREP simulation environment and be familiar with its features and use it for developing any physical system. Moreover, they will be able to import any cad model from SOLIDWORKS/Inventor platform into the environment and use VREP for improving and developing the system performance. They will link python programming library with VREP to incorporate computer vision modules in their system. Then finally test their software modules on the real robot.

Outcomes of the project:

1- Modeling and simulation of all robot systems like mechanical & electrical systems.
2- Understanding VREP simulation platform.
3- Importing a SOLIDWORKS/Inventor model into the VREP environment.
4- Using VREP for creating model of physical system and inserting all the required parameters to optimize the performance of the system using many of the platform's components.
5- Using python programming language and linking it with VREP to incorporate computer vision modules within the system
6- Experiencing different manufacturing techniques and integrating their manufactured parts with purchased components
7- Testing same software modules developed to test with VREP on the real platform

Deliverables:

1- Implementation Of the real Robot
2- Technical Report
3- Poster

Report Contents:

1. Abstract containing brief description of your project.
2. Photos for the real robot
3. Mechanical Design: Robot CAD model showing Working drawings with descriptions for different parts, full assembly, mechanisms and their role, and stress analysis.
4. Software Architecture (Flow Chart), Block Diagrams describing how the robot works.
5. Actuator Sizing by hand and using software (SOLIDWORKS Motion Analysis/Inventor Dynamic Simulation)
6. PCB Schematics and Layouts
7. Simulation: showing your environment in your simulation platform, commenting on different test cases with reference to scripts used (Python/ MATLAB/ LUA). You can attach a link to a video here showing the different test cases with an option to do it with voice-over.

Poster Contents:

1. High Quality Renders from the CAD Model
2. Renders for the robot in the working environment
3. Photos for the real robot
4. Photos for the Manufactured PCBs and Electrical Wiring
5. Robot Specifications application wise
6. Block Diagrams describing how the robot is designed and software architecture