ME579 - Robot Kinematics and Dynamics
Final Project - Kinematics and/or dynamics of a non-trivial or “real” system

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Due December 17, 2020 by 5PM

The intent of the final project is to give you a real world scenario in which you either derive kinematics and dynamics of a new system or implement a robot controller on an existing system. As this is 25% of your grade, it should be a non-trivial effort. Since there will be no homework or final exam, each team member should expect to spend at least 10 hours per week on the project. There are two options for the project: (1) my pre-defined project of controlling a mobile robot with a camera and (2) you propose a project to me (hopefully that helps you in your graduate research somehow). In each choice, expect to generate a report that gives a complete story of your project, what you accomplished, etc. It should be something you feel comfortable showing in a job interview as a non-trivial robotics project that you have completed. The report must be presented and demonstrated by the deadline. Send me an email when you are ready to pass it off.

There is a **project proposal that will be due on Monday, November 20, 2018**, which we will discuss in class together. It should be about 2 pages long and give a complete description of which option below that you have chosen and a description of your objectives and how you will measure success. Make sure you have some figures to help everyone visualize the proposed work.

Option 1 : Pre-defined mobile robot. In the pre-defined project, you will have access to a mobile robot platform with a Raspberry Pi 3 running Linux and pre-loaded with the Robot Operating System. The task will be to implement two custom ROS nodes and interface with the existing ROS camera node. The first custom ROS node will accept a velocity command for the forward velocity and a postions commands for the front wheel angle, and the camera tip & tilt angles. The second custom ROS node will implement a controller that reads in the camera image data, searched for a red ball through camera tip/tilt, calculates the appropriate steering angle and wheel velocities, and continuously drives toward a red ball. If the ball is not visible, the robot will execute a search pattern to find the location of the ball. I will be providing further information to teams that choose this route about learning resources for ROS and how to get/share the hardware

Requirements:

- Learn the Robot Operating System infrastructure
- Learn to implement custom ROS nodes

- Learn to use OpenCV for camera image processing
- Research, understand, and implement a continuous controller for controlling both the camera angle and the robot steering angle and robot forward velocity to smoothly drive toward the target.
- Write a report describing the architecture, design of each node, vision processing algorithms used, and controller design & tuning.

Option 2 : Project proposal. For project proposals, I suggest that you pick something the will be of benefit to your lab or to your future research. This could mean taking a small portion of your current research and devising a project scope that adequately addresses a portion of it. For project proposals, the expectation is that they will scale according to team size and help push your own work forward or give greater understanding about the research problems you currently face.

- **Choice 1** Derive kinematics and dynamics of a system you use in your lab

  This must includes the full analytical derivation and detailed drawings

  This must include an accurate simulation of the dynamics of the system

  This must include either a detailed analysis of the dynamics and the simulation (e.g. lots of plots, linearized models of the system, etc.) or a complete controller representing the closed loop control of the system

  For large teams (3+) this would also require the fabrication of the modeled device.

- **Choice 2** Duplicate the work from Option 1 with a robot or mechanical system from your own lab/research.

  As part of this option, you would need to define a different control objective than finding a colored ball in the camera view as I suspect your own hardware doesn't necessarily have a camera.