AEEM 6117: Intelligent Robotics

Course Project Option #1

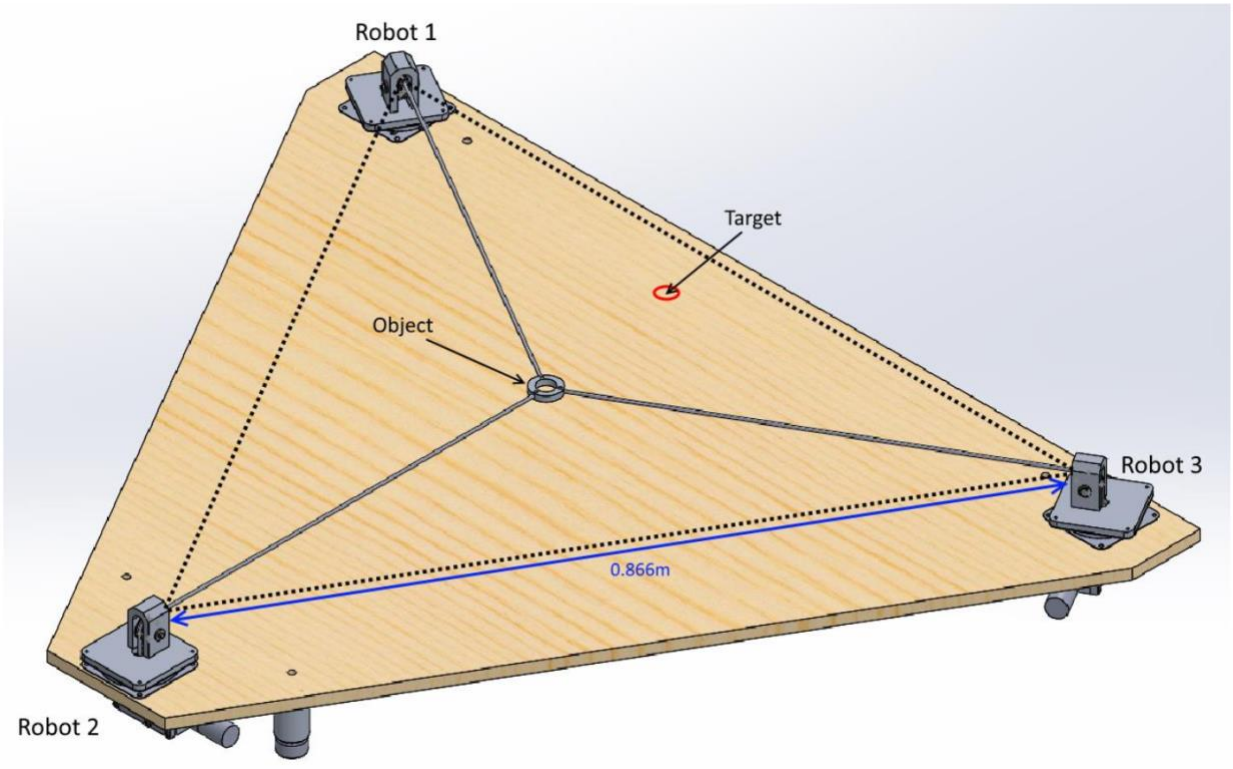
A Human Game Inspiring Collaboration

Figure 1 shows a game regarding learning and collaboration among a group of humans. In the game each member of the group pulls a string aiming at to move the ball on the other end of the string to a target position right above a cup (see Fig.1). Since the ball is pulled by independent individuals by different forces and along different directions, it cannot reach the target location easily without a good collaboration among the group members. Indeed, the individuals have to take some time to learn and adjust themselves until they can achieve good collaboration for the common goal. This game inspires researchers to develop intelligent control technology for a group of independent robots to work together collaboratively to achieve a common goal. It is a current fundamental research problem in the robotics field. We simplify this problem for our course project in the sense that the problem is a 2D problem and each robot is just a single-joint (1-DOF) cable robot.

Fig.1 A game inspiring human collaboration

Problem Definition:

Consider a platform with three fixed robots that are located at the vertices of an equilateral triangle as shown in figure below. An object is connected to each robot through elastic cables. Each robot has the ability to pull or release its own cable. Assume that the cables can wind around a spool attached within each robot. The objective of this project is to train this system of collaborative robots so that they can bring the object to any pre-defined target position within the triangle. An important constraint of this system is that each robot is unaware of the states and actions of its partner robots.



Requirements:
Consider the following parameter values:

(a) Initial position of the object is at the center of the dotted equilateral triangle.
(b) The length of the elastic cables should be within the range of 1-2m for Hooke's Law to be valid.
(c) Stiffness (k) of the cables = 95.54N/m
(d) Mass of the object (m) = 0.01kg

Project Objectives:
(a) Develop kinematics equations of the system. Design a collaborative system for the kinematic case. You can consider that each robot controls the length of its own cable that is reeled in at each instant.
(b) Extend the analysis to the dynamic case. In this case, it maybe best to assume that each robot controls the angular velocity of its own spool. You can set the maximum time as 20s in your simulations.
(c) Perform a comparison with traditional method of using a centralized controller for controlling all three robots. This can be considered as a 3-joint single robot scenario.
(d) Use simulations to demonstrate the performance of the trained systems for both the kinematic and dynamic cases.