GEORGIA INSTITUTE OF TECHNOLOGY
George W. Woodruff School of Mechanical Engineering
ME 2110 - Creative Decisions and Design
Spring 2019

INTRODUCTORY DESIGN PROJECT: ROBOTIC COLLECTION SYSTEM

Project Summary: Automated grasping and collection of objects is a very common requirement of robotic systems used in industrial manufacturing applications as well as in consumer service sector applications. Typical automated grippers are based on high degree of freedom robotic systems and employ complex end effector designs. In this project, you will explore the constrained design of an inexpensive robotic collection system similar to those used in the ME2110 final design competitions. This conceptual design project will focus on understanding the customer needs associated with this type of system, development of engineering requirements and generation of a concept alternative to address this problem. The final deliverables are laid out in this document.

Project Description: Your team is tasked with designing a robotic collection system capable of retrieving an object sitting on a flat raised platform that is 2.5 feet wide, as depicted in Figure 1. The object of interest is a sphere 3 inches in diameter and 3 ounces in weight. The object is located on top of a platform and is nominally 3.5 feet away from your position and at a height of 1 feet and must be retrieved behind the starting line. The position of the object can vary up to $\pm$0.5 feet from this nominal position along the platform mid-line. The system must not encroach closer than 3.5 feet from the object of interest prior to triggering. Assume that the use case for which the system must be designed involves a user: (1) initially positioning the robotic system in any orientation behind the staring line and (2) triggering the system by an electronic signal to the robot's onboard embedded controller. Also assume that the position of the object of interest is not known beforehand and the system must be robust to different positions, as depicted in Figure 1.

Ideal characteristics of the robotic collection system in achieving this task are that it is autonomous, fast, accurate, inexpensive, portable, durable, serviceable and any other qualities that the customer (you) consider important. The design is constrained by several pre-determined factors including available power sources, cost and volume. In terms of actuators (and sensors), you have available to you all the components of your mechatronics kit, whose bill of materials (BOM) is available on the ME2110 website. The robotic system must be powered by the actuators available in the mechatronics kit, but you may also use power due to gravity and pre-loaded springs. The cost of the system must nominally have a maximum material cost of $100 beyond the components already provided in the mechatronics kit. The size of the system is bounded in that it must initially fit within a volume that is bounded by 1.5 feet x 1 feet x 2 feet. After it is triggered, it may occupy a bounding volume greater than this limit.

You must follow a structured design process in addressing this need using the design tools you have been learning in class. During the early phase of the design process, you should strive to thoroughly understand the customer needs and establish engineering requirements/specifications that can be useful metrics for the system to achieve these needs. You must determine functions that the system must achieve and generate solution approaches for accomplishing these functions. A set of solution approaches will determine feasible alternatives. The focus of this project is not to design an optimal alternative or choose a preferred design among a set of given alternatives, but to generate a single feasible alternative. You should also investigate related products/solutions and seek to incorporate the best features from them into your design.

Deliverables

1. **Draft document of populated design tools.** Submit draft figures/tables to Canvas of your team's completed/harmonized design tools for this problem. Your instructor will review these and provide comments to your team. This should include the house of quality, the specification sheet, the function tree and the morphological chart. Captions should be provided for each figure/table. Figures and tables should be numbered sequentially. This document should be submitted in PDF form to Canvas before the deadline.

   **Deadline: This draft document is due at the start of studio in Week 4 (28 Jan – 01 Feb).*

2. **Final presentation.** This presentation should cover the complete design problem and solution. It should include a restatement of the problem at hand, customer needs, engineering specifications, functions, concept generation, and explanation of the generated design. The presentation should be submitted in PDF form to Canvas before the deadline. One person on your team will give this presentation, it is limited to 8 minutes.

   **Deadline: This presentation is due at the start of studio in Week 5 (04 Feb – 08 Feb).*

3. **Final report.** This report should containing the following:
   - Cover Page: See book for example cover page.
   - Abstract: One-paragraph summary of the report including key findings and results.
   - Introduction: Restatement of the problem, goal of the study and inherent design challenges associated with achieving this goal.
   - Problem Understanding: Review important customer needs, engineering specifications to address these needs, tradeoffs and synergies, critical functions and concept generation.
   - Design Overview: Presentation of a single concept alternative, detailed description of the design including quality sketches (preferably computer-generated) that shows its parts and how it operates.
   - Conclusions: Summary with key results and potential next steps and final thoughts.
   - Appendix: All figures and tables put here with proper captions and in proper sequential order as cited. Figure captions should be provided for all figures and go below the figure. Table captions for any tables are to be placed above the table. Figures and tables must be cited in sequential order in the text and all figures/tables must be cited.

   Consider dividing your report into the sections listed in the outline above for clarity. The report should include a maximum of **3 pages** of text. The cover page, abstract and appendix do not contribute to this 3-page limit. Before you prepare your report, you should first read the textbook's guidelines for using drawings and preparing reports (Chapters 9 and 10). The report should use 12-point font, 1-inch margins and single-spaced (unless otherwise specified). Use page numbers at the bottom of each page. See the textbook for further guidelines on proper formatting and writing style for reports and technical writing. All reports should be uploaded to Canvas before the deadline.

   **Deadline: This report is due at the start of studio in Week 5 (04 Feb – 08 Feb)*

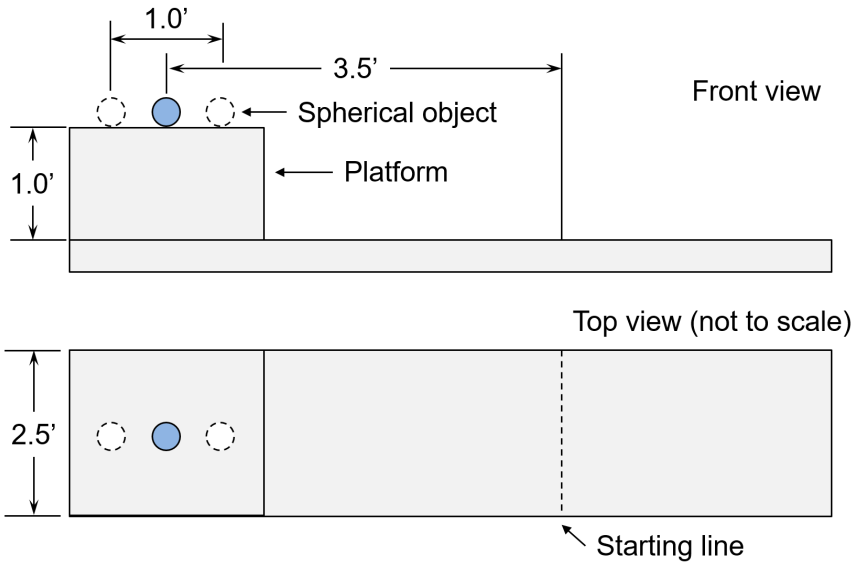

Figure 1. Layout and variable location of spherical object on platform relative to starting line.