Jeremy Betz URP Summer 2010

This research will explore the process of robotic grasping, including its applicability to automatic fixturing for industrial, manufacturing, and other applications. Physical experiments will be coupled with computer simulations in order to gain a better understanding of the forces and interactions that occur during the grasping or fixturing process. Included in our study of the robotic grasping problem is a parametric study of the grasp acquisition problem, where the degree of success of the grasp can be expressed numerically, allowing for a quantitative analysis of the effectiveness of various grasping strategies.

In order to make quantification of grasping strategies viable, work has been done on simulations to replicate our experimental test bed that we have build for the purpose of investigating grasping strategies. Work has already been started on developing a system for analyzing video of the experiments, so that they may be compared to simulations of the same scenario. Past work has focused on calibrating simulation parameters such as friction, physical properties of the grasped object, and system approximations to produce an accurate simulation of the system. Current efforts are going to focus on calibrating videos in batches, so as to minimize the sensitivity of parameters of specific videos, to obtain accurate parameter values to produce accurate simulations of all the possible configurations of the experiment. My role is to develop an accurate simulation system that can work with our current experiment analysis system to produce accurate parameters.

In addition to calibrating the simulation parameters to our experimental test bed, analysis will be done on parameter sensitivity using a software package called DAKOTA, by Sandia National Laboratory. With this software package, we can better quantify which parameters of the calibration are most important, in order to make our calibration parameters, and therefore our simulation as a whole, more accurate. Parameter sensitivity can be used to determine which physical parameters of the experiment are of greater consequence, as well as determine what kind of shapes are similar, my mathematically defining the geometry of the shape. This analysis can then tell us what end effectors of our moving “finger” as well as shapes to be grasped are similar in regards to the simulation, and which ones are not. With this analysis, it allows interpolation between known shape geometries to determine effective grasping strategies for untested shapes. Our beginning research will consist of finding shape geometries estimated to be similar and dissimilar, and then creating physical models of these shapes, and testing them in our test bed to verify and support our conclusions of geometric parameter sensitivities.

This research is towards an end goal of being usable with multi-fingered dexterous hands in order to grasp and manipulate arbitrary objects. By working on the simplified cases, we can better isolate contributing factors and speed our development on generalized cases that can then be applied towards the higher complexity scenarios that more accurately describe real world scenarios. This works is also being prepared for publication in the Joint International Conference on Multibody System Dynamics in Finland.