

Previous Research

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I joined the Bionics Lab at UC Santa Cruz the summer following my sophomore year. I approached the experience with equal parts zeal and trepidation. My task- autonomously mill a tooth in preparation for a dental crown using an industrial manipulating robotic arm. I began by scanning the target tooth using a 3D digitizer to collect data points of the surface of the tooth. This assignment required me to gain expertise in computer aided design (CAD) software, such as SolidWorks, and data analysis methods. I used the data analysis to triangulate the results to create a virtual model of the tooth. Then, I used CAD software to create cross-sectional planes of the virtual tooth to generate milling trajectories. I exported the trajectories using custom Perl scripts and Computer Aided Manufacturing (CAM) tools to program the robotic arm. Lastly, I executed the program with a dental tool placed on the end of the robot arm to autonomously mill the boundary paths around the tooth.

Accomplishing my goal and presenting my successful research at undergraduate conferences brought me immense pride. However, expanding and finessing the project since that summer had changed me as an engineer. I have since taken robot manipulation, non-linear dynamics, and feedback and control courses. Using the knowledge I gained in my coursework, I implemented reference tracking between the industrial manipulating robotic arm from my previous project and a passive manipulating robotic arm. Then, I worked on integrating the reference tracking with my previous dental procedure project to execute autonomous proce-

dures on moving dental models and designing an algorithm to create intelligent trajectories to safely return to the surgery site if the model has moved a significant distance.

The recurrent most influential aspect of my research project is never achieving an objective; conversely, it is every setback along the way. I am not a dentist, I had never used SolidWorks, programmed a robotic arm, or even read a data sheet. I worked directly with the principal investigator, who delicately guided me in the theoretical process by assisting me in breaking down the objective into smaller subsections without showing me how to actually implement any of these ideas. By giving guidance rather than firm instruction, I had the opportunity to make the research process my own. I learned how to approach problems systematically, find resources, overcome failures productively by finding alternative solutions, and develop my own thought process. The skills I gained that summer were the impetus for the next step in my career as a graduate student at the Learning and Intelligent Systems (LIS) research group at the Massachusetts Institute of Technology.

This summer, as a research assistant at LIS I worked on robust robotic grasping with the Willow Garage PR2 robot. I began to explore the use of force and tactile sensing to construct a robust procedure for closing the fingers on an object. This initial effort gave me the background to begin the research on improving robotic grasping by integrating planning, sensing, and control, a project that I plan to continue throughout my graduate career.