Dental Robotics

CAD CAM Applications in Dentistry

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Overview

The success of applying robotics to the medical field has opened a new frontier with vast areas for expansion and exploration; more specifically, robotics with dental application is a relatively untraveled area to pursue. My research in designing a prototype to automate the drilling of a tooth pushes the limits of innovation in research and technology as well as decreases the gap between engineering and medicine.

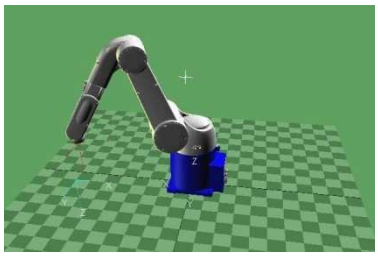
My approach follows the robotic paradigm: Sense, Plan, and Act. I used a 3D digitizer to "sense" the tooth by producing a series of XYZ points. In "Plan", I implemented Solidworks to create a mesh from the points; then I created section boundaries around this 3d model. I created a program using a script to analyze the coordinates from the boundaries. Lastly, the robotic arm "acted" by executing this program.

Background

The University of California, Santa Cruz hosts the Summer Undergraduate Research Fellowship in Information Technology. With this fellowship, funded by the National Science Federation, I could pursue this interdisciplinary research. The Principal Investigator of the Bionics Lab at Jack Baskin School of Engineering is Jacob Rosen Ph.D. Rosen, along with graduate student Levi Miller, guided me during this 9 week research program.

Equipment

The Denso VM60B1G is an industrial robotic arm with six degrees of freedom. We controlled the arm using the included teach pendant and with software Wincaps III. The software included Arm Player Plus which simulated basic code.



The Microscribe MX is a precision contact-based 3D digitizer. It can produce a series of XYZ coordinates to create a "point cloud". Because the tooth is small, we used an ultra fine tip to get more precise results.

A dental drill was attached to the front of the robotic arm. The test runs were completed on basic dental models attached to a rectangular acrylic platform.

Methods

I. I used the Microscribe MX to scan the tooth. Using this 3D digitizer to create a point cloud, I used Computer Aided Design (CAD) software Solidworks to convert the point cloud into a 3d model called a “mesh”.

II. I used Solidworks to create the path I would program the robotic arm to drill upon the tooth. Then, I wrote a script to convert the coordinates on the path into an executable program.

III. I used the Computer Aided Manufacturing (CAM) software Wincaps III to compile this program and upload it to the Denso robotic arm. I positioned the robotic arm on the tooth and ran this program to autonomously mill the tooth.

Conclusion

After three test runs using this method, I was able to successfully mill a boundary around the tooth. This initial prototype for automating the drilling of a tooth has areas for improvement. Future plans include working on the registration of the tooth, along with the tool. Furthermore using another system to give constant feedback on the dynamic origin will allow the device to be used in moving areas.