Laboratory for CAD & Biorobotics and Biomechanics Lab

Bezier surface mesh from point cloud of a forearm stump for a commercial CAD program

Mechanical Engineering
Technion – Israel Institute of Technology
Faculty of Mechanical Engineering

Alon Spinner, Yam Ben Natan

Guidance: Prof Anath Fischer, Ms. Ronit Shneur, Professor Alon Wolf , and Mr. Yair Herbst

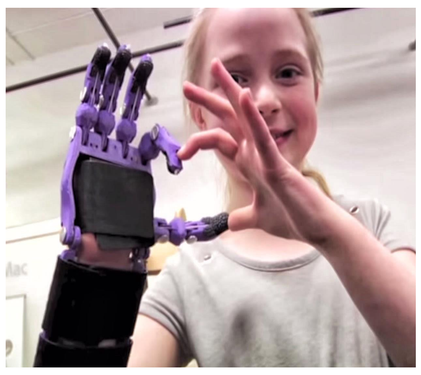
Abstract

Currently, creating a prosthesis is an expensive process which requires manual measurements of a stump by a technician.

By scanning the stump with a 3D camera and fitting a surface mesh which is transferable to a commercial CAD system, the technician will be able to measure more intuitive measurements, faster and with greater ease. This process will also open doors for advanced prosthesis planning methods using the negative of the stump surface.

The proposed method will be integrated in the E-Nable project that is lead by a nonprofit organization that manufactures fitted prostheses for people from developing countries. The pipeline suggested in [4].

An example of a technician measurement



An example of the Enable prosthesis

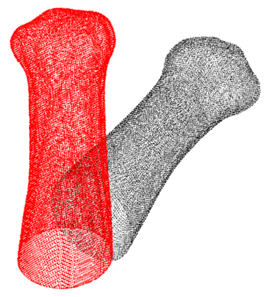
Advantages of parametric surfaces

Creating a CAD model from a 3D point cloud is most commonly done by STL triangulation. We had decided on taking a parametric approach which has significant advantages in the context of simple convex shapes:

- Reduces the number of segments is significantly.
- Allows for a more extensive and accurate surface analysis.
- Enables more intuitive changes in model form
- Preserves continuity between surface patches

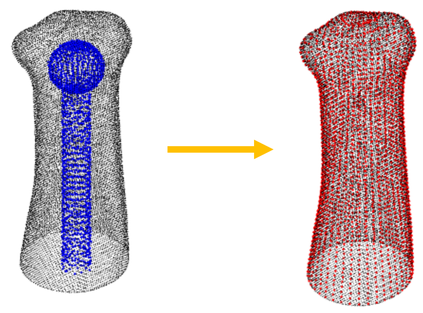
The proposed approch:

Input: A scanned point cloud of a forearm stump



PCA and rigid body transformation

Calculate Initial Bezier control points by matching a sphere and a cylinder to stump

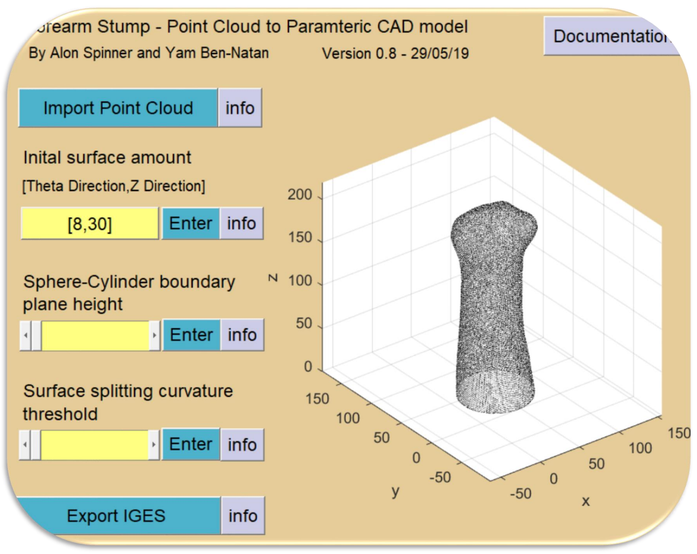


Optimize Bezier surfaces with respect to their curvature, distance and geometrical continuity

Output: Bezier surfaces for a commercial CAD program in IGS format

Graphic User Interface for ease of use

A graphic tool requires only three input parameters from a technician was designed to enable on-the-spot results and accommodate the automation pipeline



References

1. M. I.D.Faux, Computational Geometry for Design and Manufacture, Chichester, West Sussex: Chichester, 1987.
2. H. K. Farin, Handbook of Computer Aided Geometric Design, North-Holland, 2002.
3. S. Allavarapu, A New Additive Manufacturing (AM) File Format Using, Cincinnati, 2013.
4. Y. Herbst, S. Polinsky, A. Fischer, Y. Medan, R. Schneor, J. Kahn and A. Wolf, "Scan-Driven Fully-Automated Pipeline for Personalized, 3D Printed Low-Cost Prosthetic Hand".

Special Thanks to:
Mr. Benjamin Groisser for counseling and
Prof. Gershon Elber for providing required tools.