

Prosthesis Scanning, Modeling, and 3D Printing for Upper Limb Below-Elbow Amputation without Controlling

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Abstract

Below-elbow amputation has been among the most challenging to restore function and independence. Traditional prosthetic fabrication methods have been beset by high cost, long fabrication time, and minimal tailoring. Passive prostheses, even with the lack of electronic control, have continued to offer useful aid for activities of daily living. With improvements in digital fabrication, alternate workflows have become available to improve affordability, accessibility, and anatomic fit. A modern solution for below-elbow non-controlled prosthetics has been proposed in this project through the use of 3D scanning, modeling, and printing technologies.

A complete procedure was followed to digitally scan the residual limb geometry using Laser Scanning. Hybrid modeling was used to model prosthesis components from anatomical landmarks. Fused filament fabrication (FFF) was used to print the prosthesis using biocompatible TPU, PETG materials. Finite Element Analysis (FEA) was used to check the structural integrity under simulated loads. The universal forms of grip were studied and replicated in the passive terminal design so that it would work without active control. The multi-material construction process was employed to balance flexibility, comfort, and strength in different components of the device.

The suggested workflow has been found to be less production time and cost compared to traditional techniques, with high mechanical performance and customization. The feasibility of the workflow has confirmed the reality that 3D printed and digitally designed passive prostheses can be user-specific, functional, and safe solutions. The process can be scaled up for wider clinical use, particularly in resource-poor or under-resourced clinical environments.