Using 3D Scanners for Designing Peristaltic Hands: Advancements in Prosthetic Technology

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ABSTRACT

Prosthetic technology has made significant progress in recent years. It aims to improve the quality of life and functionality of people with missing limbs. Among these innovations, the integration of 3D scanning technology has emerged as a promising approach to design prosthetic hand, a type of prosthetic arm that mimics the natural movement of the human hand through peristaltic movements. This thesis explores the utility and effectiveness of 3D scanners in the design and customization of peristaltic arms, exploring their potential to create highly customizable and functional prosthetic devices.

Keywords: Prosthetic hand, 3D scanning technology, Prosthetic technology,

Introduction: The field of prosthetic technology has long been driven by the pursuit of enhancing the quality of life and functionality for individuals who have experienced limb loss. As advancements in engineering, materials science, and medical knowledge continue to reshape the landscape of prosthetic design, one technology has emerged as particularly promising: 3D scanning. The integration of 3D scanning technology into the development of prosthetic devices represents a significant leap forward, offering the potential to create prostheses that are not only highly functional but also meticulously tailored to the unique anatomical characteristics of each individual [1].

This thesis delves into a specific domain of prosthetic innovation, focusing on the design of peristaltic hands, a remarkable type of prosthetic hand that seeks to replicate the intricate and natural motions of the human hand through peristaltic movements. The integration of 3D scanning technology into the design process of these hands is at the heart of our exploration. Through a comprehensive examination of the historical evolution of prosthetic hands, the development of peristaltic hand technology, and the principles and applications of 3D scanning, this thesis seeks to illuminate the potential of 3D scanners in revolutionizing the creation of prosthetic devices.

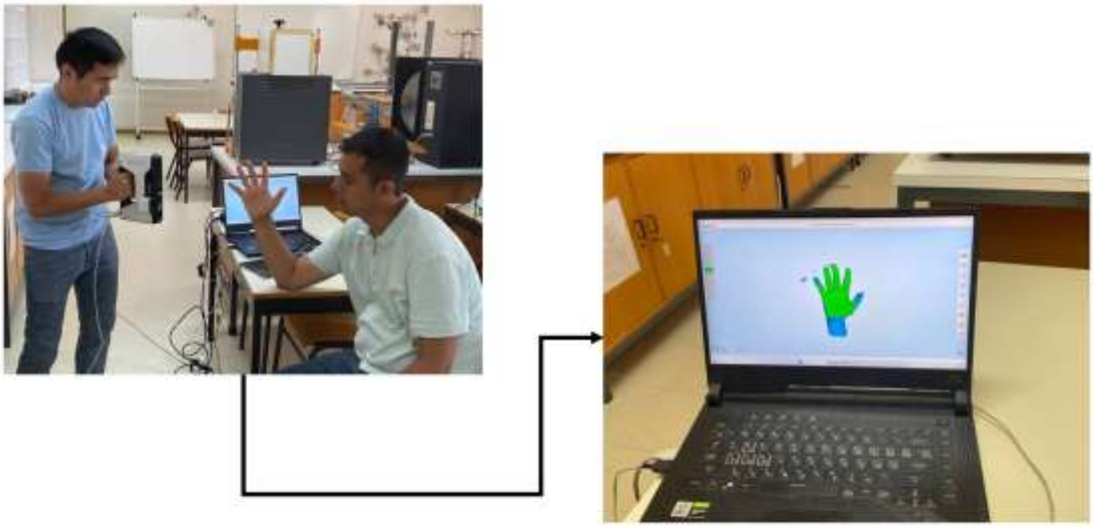

Fig. 1. 3D scanning technology for developing prosthetic hand.

Peristaltic Hand Technology: Peristaltic hand technology represents a breakthrough in prosthetic design. Inspired by peristaltic motion observed in biological systems, these hands employ a unique mechanism to mimic the natural flexion and extension of fingers. The peristaltic action involves the sequential contraction and expansion of chambers or actuators, resulting in fluid and organic movements [2].

The development of peristaltic hands has been driven by the desire to offer amputees a prosthetic hand that closely emulates the functionality of their natural hand. These hands offer advantages in grasping objects of varying shapes and sizes, enhancing dexterity, and enabling fine motor control.

Challenges in Peristaltic Hand Design: Despite the potential benefits, peristaltic hand design presents formidable challenges. Achieving the precise control of multiple chambers to replicate natural hand movements is complex. Additionally, optimizing the size and weight of peristaltic hands without compromising functionality remains a considerable challenge. Research in this area has focused on overcoming these challenges through innovative engineering solutions [3].

3D Scanning in Prosthetic Design: The integration of 3D scanning technology into prosthetic design is a recent and transformative development. 3D scanning allows for the non-invasive capture of detailed three-dimensional anatomical data, facilitating the creation of prosthetic devices that are uniquely tailored to each individual's residual limb [4].

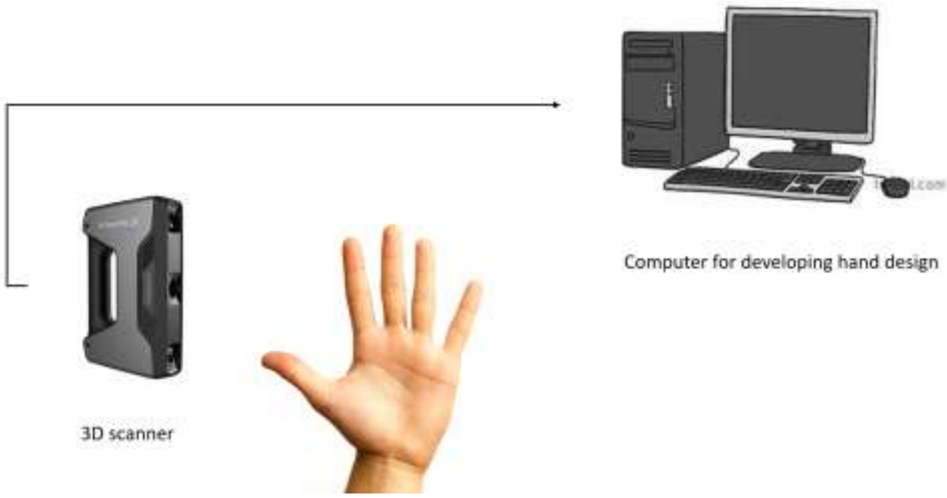

Fig. 2. 3D Scanning in Prosthetic Design technology.

Various types of 3D scanners, including structured light scanners, laser scanners, and photogrammetry-based scanners, have been utilized in prosthetic design. These scanners capture surface geometry, enabling precise measurements and digital replication of the user's anatomy. Additionally, the data obtained from 3D scans can be seamlessly integrated into computer-aided design (CAD) software for prosthetic customization [5],[6].

Advantages and Limitations of 3D Scanning: The adoption of 3D scanning in prosthetic design offers several advantages. First and foremost is the enhanced accuracy and precision in capturing anatomical data, resulting in prosthetic devices with superior fit and comfort [7]. 3D scanning also expedites the design process, reducing the need for manual measurements and iterations. Furthermore, it allows for remote scanning, enabling prosthetists to design prosthetic devices for individuals in distant locations.

However, 3D scanning is not without limitations. Factors such as cost, accessibility to scanning technology, and the need for skilled personnel to operate the equipment can pose challenges. Moreover, the scanning process may be sensitive to factors like user positioning and potential artifacts in scan data.

Previous Research on 3D Scanning in Prosthetics: Previous research has explored the application of 3D scanning in prosthetic design across various limb types. Studies have demonstrated the feasibility and advantages of using 3D scanning for creating customized sockets for lower-limb prostheses. Moreover, researchers have investigated its utility in upper-limb prosthetic design, including socket creation, hand and arm prosthesis customization, and even peristaltic hand development [8].

Conclusion: This literature review highlights the historical evolution of prosthetic hands, the emergence of peristaltic hand technology, and the transformative potential of 3D scanning technology in prosthetic design. It underscores the need for comprehensive research to evaluate the practical applications and benefits of 3D scanning in peristaltic hand design, setting the stage for the empirical exploration presented in this thesis.

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