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An Interface System to Support the Production of Prosthetic Socket for Transtibial Amputee

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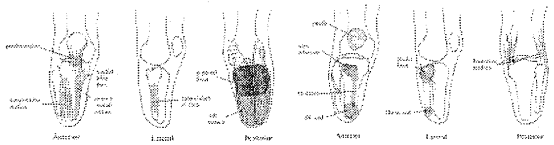
Introduction

This study aims to develop a computer-aided system that is to assist a prosthetist for easily designing and manufacturing a prosthetic socket for specific transtibial amputee by employing the contemporary technology including reverse engineering, application programming interface functions of a CAD system and rapid prototyping (RP). For a below-knee amputee, the comfortableness of wearing prosthesis depends on whether the distribution of interface pressures between socket and pressure-tolerant and pressure-relief areas of the stump (Fig.1) is appropriate. Currently, the production of a prosthetic socket still depends on prosthetists' skills and expertise. These processes are often tedious and susceptible to human error. In some cases, they are inconvenient and even uncomfortable for the patient. Most of these processes can be improved through the use of a computer-aided system such as the interface system proposed in this article, allowing the prosthetist to spend less time on tedious tasks. Many research groups have employed commercial systems, such as Omega Tracer [1] and CAPOD [2], to capture stump shape to design and manufacture prosthetic sockets. The main objective of this study is to integrate contemporary technologies including reverse engineering, CAD and RP [3] for the development of an interface system to support the design and manufacture of RP prosthetic sockets.

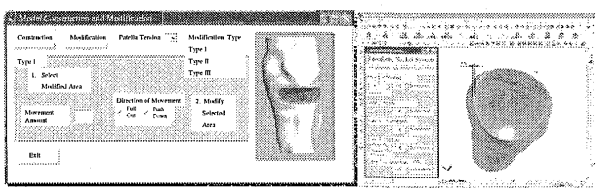
Methods

Current CAD system is capable of building the CAD model of a stump based on its scanned points by an experienced user of that CAD system. However, an experienced user is needed to operate sophisticate CAD systems. If a customized interface system is available and easily operated by any user such as a prosthetist, the stump shape may then be conveniently constructed. Employing the functions of SolidWorks API [4], this study is to develop a prototype system that is to assist a prosthetist to build and modify stump shape. The data of the modified stump model will be stored in the computer for the applications of CAE/CAM and rapid prototyping to produce a required prosthetic socket.



(a) PT areas (b) PR areas

Figure 1 PT areas and PR areas

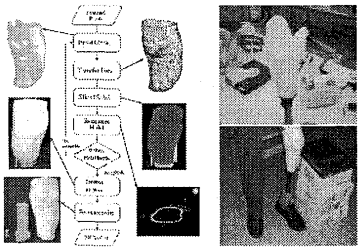


(a) (b)

Figure 2 The interface of constructing CAD stump model and RP model

Results and Discussion

To date, this study developed a prototype system (Fig.2) that allows a prosthetist to easily design a prosthetic socket for a below-knee amputee, and has demonstrated the feasibility of using CAD modified stump model to duplicate a RP stump and then laminate resin to fabricate ordinary socket. A RP socket (Fig.3) has also been made by using a fused deposition modeling (FDM) machine. This proposed computer-aided engineering process (Fig.4) is expected to replace the manual process of conventional approach of fabricating prosthetic sockets without the need of using any plaster mold. Furthermore, since thin-layer RP socket is easily broken, coating a resin layer on RP socket to enforce its strength is underway. To validate various types of sockets developed by this study for a specific volunteer amputee, measuring the interface pressures between the sockets and stump is also ongoing.



(a) (b)

Figure 3 Prosthetic sockets made by using CAD model and RP machine

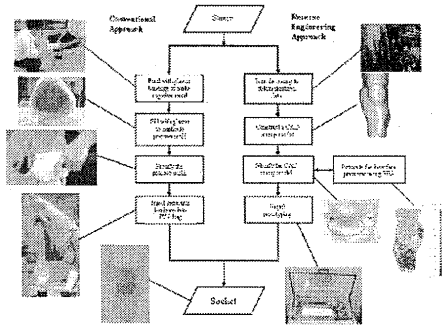


Figure 4 Two different processes of fabricating prosthetic socket

Reference

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