論　文　要　旨
Thesis Abstract

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主論文題名　（Title）

Dynamic Analysis of Transfemoral Prosthesis Function using Finite Element Method

内容の要旨　（Abstract）

Prosthetic socket is a device that use by an amputee to assist their daily routine activity. It is also used to help an amputee to overcome their lack of confident because of the disability and help to improve their quality of life (QoL) from post-traumatic accident. The demand of prosthetic device in recent years has increased and it was driven by increasing the number of amputees in around the world. The high demand of the device gives an opportunity to the fabricator to increase their prosthetic device fabrication. However, due to extensive time used during fabricating the socket and lack of expertise in the prosthesis and orthotic (PO) field, fabricator cannot achieve the demand. In conjunction of the matter, engineer and prosthesis has provide an assistive method to reduce the time consume during the socket fabrication. A pre-fabrication analysis by quantitative measurement was proposed to develop an evaluation system for improving the existing prosthetic device fabrication. In the study, utilization of finite element method (FEM) to conduct the quantitative evaluation of transfemoral prosthetic socket has been proposed. The study consists of analysis the accuracy of the Magnetic Resonant Imaging (MRI) based three-dimensional (3D) model used in the simulation, analysis of the geometrical deformation of the residuum during interaction with socket and analysis of the pressure distribution occurred inside the socket during various situation. The finding of the study suggests FEM can be classified as an alternative method to evaluate the pre-fabrication prosthetic device. FEM can help the engineer and prosthesis to design the prosthetic device according to subject comfortability without undergone the preliminary socket fitting session. Furthermore, with the pre-fabrication evaluation system, the intervention of prosthesis can be reduced together with the fabricating time.

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In the first chapter of the thesis, the author provides an outline of the whole work. The background study will be elaborate in this chapter. The introduction of transfemoral prosthesis, finite element method and the relationship between proposed study with the real-world activity will be elaborated. The objective, scope of study, limitation of the study also will be clarified in this chapter. Then in the second chapter will explain the needed of the study and a relationship with the past study. This chapter will review a technical study of finite element analysis (FEA) that act as a fundamental of the overall study. This chapter also presents a revision of the previous studies. Some prevailing results of studies are also introduced to clarify the novelty of the contributions in this work. Third chapter present an evaluation towards 3D reconstructed model of residuum. This chapter explain the important of the model accuracy towards providing an alternative method replacing the actual human experiment. The accuracy of the model will be evaluated based on the relationship between number of intersections point during constructing the model and the volumetric value of the model. The fourth chapter present the evaluation on the effect of prosthetic socket changes towards residuum. The chapter focusing on evaluating two type of prosthetic socket. The geometrical shape of residuum and the socket consider to be differed to enhance the contact surface between both of it. The geometrical changes were observed during complete stage of donning simulation. The evaluation result is an important key toward improving an accuracy of the model design. The fifth chapter presents a pressure distribution analysis occurred in prosthetic socket. The pressure measured in donning process simulation and gait cycle simulation. The 3D model created in the simulation were MRI based. The models were pre-determined with dynamic parameter that based on previous study. The result then compared with actual experiment data conducted from previous study. The result showed high correlation between simulation and experiment measurement. The sixth chapter present a process of developing an evaluation system of transfemoral prosthetic socket that was created using Magnetic resonant imaging (MRI) database. The evaluation is defined by the volume changes of residuum before and after inserted inside the prosthetic socket. The evaluation then will be compared with database from actual volumetric volume from the experiment.

The last chapter of the thesis will present the conclusions of the study about the transfemoral prosthesis function analysis using finite element method. The achievements and the limitation of this research was explained briefly. Furthermore, some solution to improve of this work was discussed. In this chapter, the proposal of walking gait has been explained for the future reference.

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