DESIGN AND FABRICATION OF ABOVE-KNEE PROSTHESIS FOR AMPUTEES USING EXTERNAL MOTION ASISTANCE SYSTEM

R Bhargav Prasad and Vikram Srinivas

Anna University, Chennai, TN, India
E-mail: srinivas_vikram_10@yahoo.com

INTRODUCTION

In spite of many path breaking advances in medicine, little has been done to address the needs of amputees who constitute nearly 5% of the population of Third World countries. A majority of the population of these countries are already worn down in their struggle to make ends meet and invariably end up with no means to support themselves upon amputation. The products available to help them lead a normal life require high maintenance and are built with sophistication making them far too expensive. The paper is a report of the analysis, design and fabrication process of artificial limb for Above-Knee Prosthesis. We are confident that our design is cost-effective without compromising on gait.

OVERVIEW

Static force analysis of an A-K amputee was done to determine the load and their inclinations on the joints (as shown in the figure 1). The horizontal, vertical components of the forces and the torque equations are:

\[ \sum F_H = F \cos 70^\circ - R_H \]
\[ \sum F_V = F \sin 70^\circ - R_V - \frac{W}{7} + W \]
\[ \sum \tau = (F \sin 70^\circ)7 + (W/7)3 - 11W \]

Assuming equilibrium and solving,

\[ R = 1.51221 \quad F = 2.43 \quad W \]
\[ \Phi = 13.071^\circ \]

PATIENT SPECIFICATION

Name : James Anandan
Age : 28
Type of Stump : Trans-Femoral
Amputation Detail : Lost left leg due to road accident in the year 1992.

DESIGN AND FABRICATION OF THIGH SOCKET

The socket conforms to the body dimensions of the patient’s stump. The socket design was done such that no power loss occurs. The material chosen should be extremely resistant to impact damage, have high strength/weight ratio and cost-effective. It should also be easily moldable into complex shapes. Hence, Fiber-Glass was chosen over other options like Kevlar and Carbon-Fiber. Adopting negative-casting method using
Plaster of Paris, Fiber-Glass socket was fabricated as shown in figure 2.

**Figure 2: Fabrication of Thigh Socket.**

**DESIGN OF KNEE JOINT**

Knee joint is the most important constituent of an A-K type artificial limb. So care should be taken to design and easily operative, light weight and cost effective model. Standard ALIMCO single axis knee joint with Indian squat of 140° enabled, is a standard component available in the market that satisfied the requirements and was hence purchased.

**DESIGN OF FOOT**

The foot with an inbuilt rocker and toe-spring that enables it to move even in the absence of an ankle joint was selected in design process. PUF (Poly Urethane Foam) foot with inbuilt toe spring system was thus used.

**OPTIMIZATION**

The standard ALIMCO knee setup used in our case has a knee lock which has to be activated prior to walking to clear the ground by moving the limb in an arc like fashion. To avoid this, the knee lock has to be deactivated. When deactivated, there is a possibility of buckling of the knee. Addressing this problem, design and fabrication of an External Motion Assisted System (EMAS), using nylon as the material and spring control of the knee, is done. Here the bending is controlled by virtue of stiffness of the two springs which use two screws to guide them. The entire setup is attached to the kneecap as shown in the figure 3.

**Figure 3: EMAS Mechanism.**

**FINAL PRODUCT**

**Figure 4: Patient using the Fabricated Artificial Limb.**

**CONCLUSION**

The limb designed and fabricated costs USD 79.60 and is hence 30% more economical than commercially available limbs such as ALIMCO (USD 120.00) and OTTO BOCK (USD 160.00) limbs.

**REFERENCE**