Design and Modification of Prosthetic Leg using F.E.A: A-Review

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Abstract— Bio-Mechanical is the engineering that pertains engineering ideas with improvement in Biological requirements (prosthetic design). This article is concerned on human comfort improvement through design modification on Prosthetic leg with FEA Techniques. The work comprises a simple interpreting of biomechanics and considerable use of CAD CAM techniques. In this research literature several literatures were studied to get exposure regarding human leg and prosthetic leg. All the essential data will be accumulated such as dimensions will be taken from existing model and actual human leg, According to data accumulated Modification in existing design model will be follow out using CAD software, calculation will be done and FEA of the modified design will be performed. Based on the analysis results design will be finalized

Key words: Prosthetic

I. INTRODUCTION

In prosthesis or prosthetic arm is an unnaturally made device extension that works as a substitute for absent body part. It is component of bio-mechatronics, the engineering of using artificial devices with human bones, skeleton, and muscles systems to develop motor control absent by birth disease or injury. Prostheses are typically used as substitute to the parts absent by birth disease or accident injury.

The human walking stance is a regular function of the maneuver of the upper and the lower limb. Five phases on which human stance is divided arte namely stance flexion, stance extension, pre-swing, swing flexion and swing extension. in the duration of stance position the heel of the foot directly contacts with the ground and the knee flexes and the total weight of the body acts on the leg and the lower limb moves. In the Duration of the swing position the foot detach from the ground and the knee swings till the heel of the foot is ready to place on the ground.

A. Basic Prosthetic Leg Construction:

The conventional prosthesis designs of fixed artificial legs are simple in construction, consist of two basic parts a socket which connects residual leg with another part of artificial leg. They only provide support to the leg but they do not fully anticipate in the motion of the leg. Due to the fixed nature of leg which creates discomfort to the user. There is a need for design a new prosthesis leg with knee and ankle joints to perform movements and provide ease to the user.

By using the technologies of CAD/CAM/CAE software it is possible to quickly obtain a geometric model of a part or assembly of a product, which gives a physical forming space as a mechanical part and assembly, an abstract form in the form of drawings for manufacturing and an information form in the data base. These tools enable the analysis of functionality, the analysis of stress-deformation state, testing, etc. Software packages enable the parts and assemblies to be modeled, which are then analysed in various ways and tested prior to their creation. In the previous decades, this process was extremely costly and Time consuming because it required exclusive prototypes and special analyses.

II. LITERATURE REVIEW

Muhammad Jawad Khan [1] This research is studied on the design of a prosthetic leg. It is divided by two parts: Kinematics calculation and control system design. To analyze the orientation, stance and available work space for the leg, The forward and reverse kinematics is computed. Series damping actuators are employed to control the swing stance of the prosthesis and PController is designed to actuate the swing and joint moment on knee. This paper presents that a semi prosthetic limb can represents a real limb. A series of Dampers can actuate a prosthetic leg as a means to adapt the pattern of normal human gait and the walking pattern can be controlled accordingly.

Y.Kalyana Chakravarthy & D.Suneel[2] The main objective of the literature is to analyze the design of a flexible prosthetic knee joint and measures to suit the requirement of a refined substitute of an easily operative and light weight prosthetic knee joint. The current study deals with the modeling and analysis of prosthetic knee joint. The knee dimensions are taken from human body analyzed with the help of Altair package hyperworks software. The stress and displacement analysis has been extended to the conventional materials such as steel, aluminum, magnesium, glass, boron and compared with UHMWPE material. With the development of Nano materials, polymer nano composites are the recent thrust area because of low weight to high strength ratio. Use of such silica reinforced polymer nano composite material for prosthetic knee manufacturing is also validated by the stress analysis in this Paper.

Wilson Carlos da Silva Júnior, Marco Aurélio Vinchi de Oliveira, Jean-Jacques Bonvent[3]The notion of the prosthesis is construct on a control system with sensing load, which are placed on the amputee's conserve leg and used as a replica for the manoeuvre of the prosthesis. The laboratory tests performed showed the practicality of the proposed design. The electromechanical notion that was applied enabled a controlled application of the knee prosthesis by the two load cells located on the shoe sole of the conserve leg.

Samuel K. Au, Jeff Weber, and Hugh Herr[4] In this article, author present a powered ankle-foot prosthesis design challenges. The prosthesis involves a unidirectional damper, assembled in parallel with a force controlling actuator in a series elasticity. With the help of this architecture, the leg prosthesis peers the weigh and size of the natural ankle, and is shown to be pleasing the pressurize design specifications pressurized by general human walking biomechanics. In this paper, a novel, powered ankle-foot

prosthesis is proposed. The prosthesis comprises unidirectional spring in parallel with a high performance, force-controlling accumulator with series elasticity. By utilizing both parallel and series elasticity, the design shown is able to satisfy the complex design specifications pressurize by usual human walking biomechanics.

Richard F. Ff. Weir[5]The design of full functioning prosthesis arm replacements with physiological response speed and strength which would be controlled nearly without, the objective of upper extremity prosthetics research. The present art phase prosthesis can be appraised to be a tool rather than a leg replacement. The prosthesis as a tool makes no posture of trying to substitute the limb but is there as an aid to assist provide some of the moments that were departed. The prosthesis is an replaceable device that is used as required, and then avoided As a result, upper-limb prosthetics research is like governed by considerations of control. Still, the significance of better actuators and better multifunctional mechanisms should not be ignored. Control is not worthy if productive hand and arm mechanisms are unavailable.

M. Barbara Silver-Thorn[6] Unnatural leg for lower extremity amputees are modeled by prosthetist. These limbs comprise custom interacts the residual limb and prosthetic socket and commercial components mainly considered for the independent. Biomedical engineers have been elaborated in the design of these commercial devices and in the quantitative improvements of their prostheses and the representation of the amputee with prosthesis. Biomedical engineers have also been elaborated in the improvement of computer-aided design (CAD) and computer-aided manufacture (CAM) of artificial legs. Future chances for biomedical engineers comprise continued improvement and incorporation of strengthened, light in weight materials in lower extremity prosthetic limbs, highly tech. prosthetic devices that increase lower extremity amputee performance, and prosthetic sockets and interface materials that reduce risk of dermatological breakdown of residual limb tissues.

A.P. ARYA, A. LEES, H.C. NIRULA and L. KLENERMAN [7] The current article was undertaken to estimate its biomechanical capabilities with the SACH and Seattle feet, using reaction forces. Three trans-tibial amputees cooperated in the analysis which measured the reaction force due to ground data using a Kistler forcing plate. Subject's normal foot was used as a reference. Six variants from the standing and anteroposterior devices of reaction forces from ground were passed, their statistical analysis represented that the normal foot produces remarkably larger reaction forces than the prosthetic foot from the ground. The shock absorption capability of the SACH foot was found to be better when estimated with the others, whereas the Jaipur foot permits a more natural gait and was nearly closer in concert to the local foot.

III. Identified Gaps in the Literature

The researchers in the area of biomechanics has researched on the kinematics and design of control system for prosthetic leg, flexibility in knee joint of prosthesis, sensors used in prosthesis for considerable loads. Researches have also been carried out for force controllable actuators, comparison of different types of prosthetic legs. limited and almost small amount of work has been observed for Human Comfort Improvement through modification in design of Prosthetic Leg. Understanding the problems by reviewing several literatures this work is tipically concerned on Human comfort improvement through design modification on Prosthetic leg using FEA.

IV. Problem Formulation

Various types of prosthetic legs are available in the current market. The cheap prosthetic legs are rigid and uncomfortable for the human. And the costly legs are flexible and provide comfort to the human. The cheap legs can afford by the common people but the new and advance prosthetic legs are very costly so it is unaffordable for common man. So, the primary reason for selecting this project is that the conventional prosthesis designs only provide support to the leg but they did not fully anticipate in the movement of the leg Due to the fixed nature of leg and creates discomfort to the user. There is a need for design a new prosthesis leg with knee and ankle joints to perform movement and provide comfort to the user.

By considering this problem, we design a prosthetic leg which is flexible, comfortable and it can be afford by the common man.

V. Research Methodology

In this work all the essential data will be accumulated such as dimensions will be taken from existing model and actual human leg, CAD model of the existing prosthetic leg will be generated and t its analysis will be performed using FEA .For modification in existing design calculation will be done and design modification will be done. According to the modified Cad model Finite element analysis of the modified design will be performed.

Line diagram of research methodology to be employed:

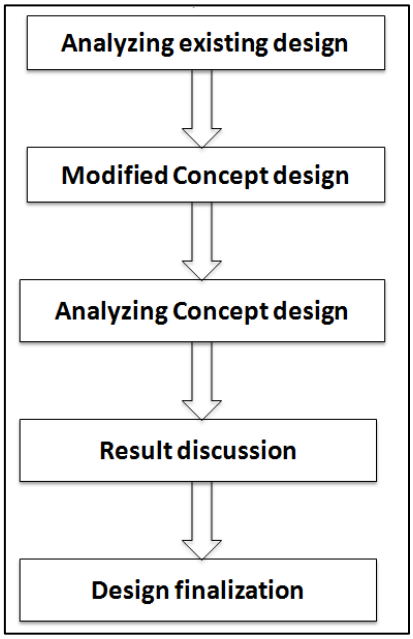

Fig. 1: Line diagram

VI. CONCLUSION

The project involves the design and analysis of prosthetic leg to improve the human comfort using CAD and FEA techniques. The detailed study of functions of human leg , existing prosthetic leg, types of prosthesis and advanced prosthesis used for legs from the sources available has help us to gain greater exposure about prosthetic leg. By performing design and analysis of prosthetic leg to improve the human comfort as the modified prosthetic leg will be flexible, comfortable and it can be afforded

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