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Design and Analysis of Artificial Human Wrist Joint

Matin Vahora[1], Tian (Richard) Zhao[2], Zheng (Jeremy) Li[3]
[1]*M. S student,Department of Mechanical Engineering, University of Bridgeport, USA.*
[2]*M. S student,Department of Mechanical Engineering, University of Bridgeport,USA.*
[3]*Assitance professor, Department of Mechanical Engineering, University of Bridgeport, USA.*
Corresponding Author: Matin Vahora

ABSTRACT: -Invention of artificial human wrist joint has been very useful in biomedical application as well as patients of wrist joint. In this paper design artificial human wrist joint and analysis motion of wrist joint by using of solid-works s and ANSYS software. This paper describes the anatomy of wrist joint and design of artificial wrist joint. A preliminary prototype is developing to characterize the design concept.
KEYWORDS: -artificial human wrist joint, design, mathematical model, analysis, solids work model.

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I INTRODUCTION

Nowadays. people have joint problem; this joint problem occurs by arthritis. Arthritis is involved one or more of any joint of human body. Arthritis mainly symptoms are pain and stiffness[1]. When arthritis occurs in human wrist joint, daily activities can became difficult. There is different type of arthritis in wrist joint like osteoarthritis, rheumatoid arthritis, psoriatic arthritis, posttraumatic arthritis[2]. So, its caused serious joint damage in wrist joint. Wrist joint is complex joint in human body, and it's made of multiple small joint. Arthritis damage cartilage in wrist joint. As the disease progress, there is loss of cartilage. So, in this condition joint is to stop the bones from rubbing against each other and this rubbing cause pain. This cause arthritis.In this condition patients need to replace joint with artificial joint, its gives smooth surfaces for moving without pain. Artificial wrist joint gives good pain relief and improve wrist strength and function for daily activities. There are common complications in artificial wrist joint likes infection, loosening, blood vessel injury. All complications show up sometimes early or may not show up months or year after replacement to artificial wrist joint. The risk of complication is much higher in younger, more active peoples. Artificial wrist joint will usually last 10 to 12 years. This paper describes the anatomy of wrist joint and design of artificial wrist joint[3].

II WRIST JOINT ANATOMY

Wrist is also called carpus. Wrist joint is made up of many number of joint. Wrist made of eight separate small bones called carpal bones. Carpal bones connect with two bones forearm and radius and ulna to the bones of hand. Ligaments connect all the small bones to each other. The wrist also includes several component joints: the distal radioulnar joint, which acts as a pivot for the forearm bones; the radiocarpal joint, between the radius and the first row of carpal bones, involved in wrist flexion and extension; the midcarpal joint, between two of the rows of carpal bones; and various intercarpal joints, between adjacent carpal bones within the rows[4]. Figure 1[5] shows the wrist joint anatomy.

Figure 1 Wrist Joint Anatomy

III THE DESIGN OF ARTIFICIAL JOINT

It's mainly made of two main components radial components and Distal components.

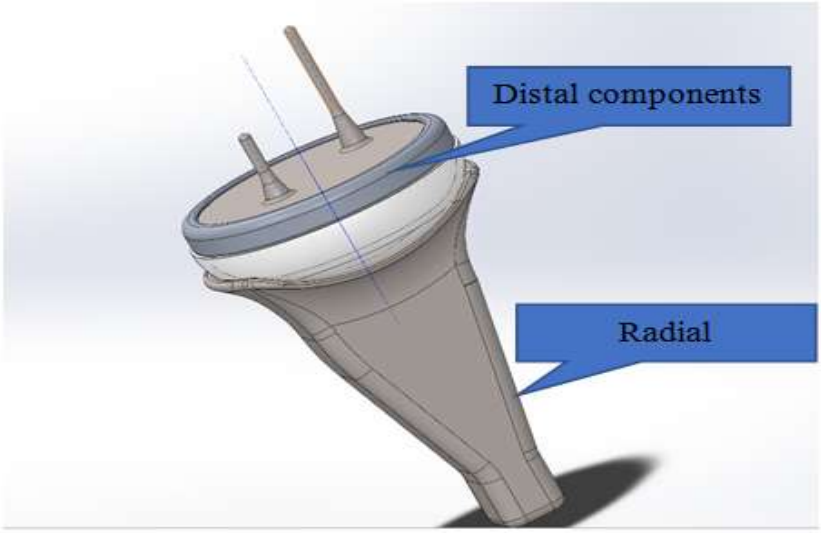

Figure 2 Model of Artificial Wrist

Radial components: end of radius bone of the forearm is called radial components. It is made of two pieces. Flat metal pieces placed on front part of radius. A stream that attached down into canal of bone.

Distal components: small wrist bones are called distal components. It is made of completely of metal. Its global shaped to fit into plastic socket end of radius. Metal distal components joint to hollow bone narrowcaster of carpal and metabola of hand. Plastic using in joint is tough and slick. its allow the two pieces of new joint to guide easily against each other as your wrist. figure 2 shows model of artificial wrist joint.

IV MATHEMATICAL CALCULATION

When people are lifting weight, a torque will be generated on their fingers of hand because the stress point is not exactly same as the rotation center which is issued on the wrist joint[6]. For the situation of lifting, the stress point is mostly on the fingers and there is a distance between the rotation center and the stress point.

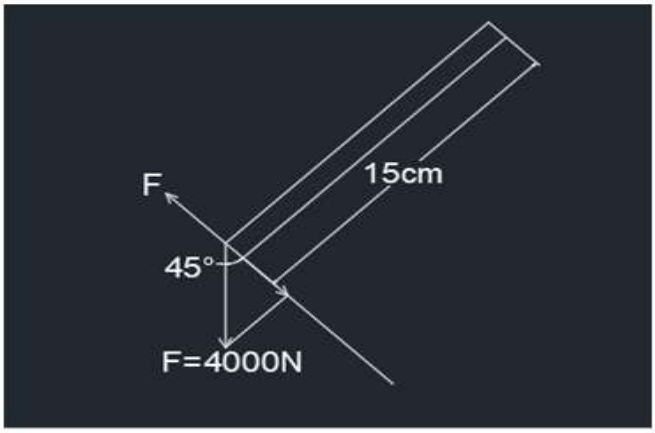

Figure 3 Mathematical Model

$\tau = FN \cdot \Upsilon$[7]

$FN = -FBcos\theta\Upsilon$

Thus, $\tau = FB \cos \theta\Upsilon$

$= (4{,}000N)\ (cos45°)\ (15cm)\ (1/100\ m)$

$=424.26\ N/m$

V MECHANICAL ANALYSIS

Design of artificial wrist joint is modeled on solid works and analysis carried through solid works simulation. In this paper applied 4000N in SI units on distal components artificial joint which means 400 kg to lifting weight. usually for artificial joint titanium alloy is common material, so I used as material in my analysis. the results are show below.

A. *Mesh Model*

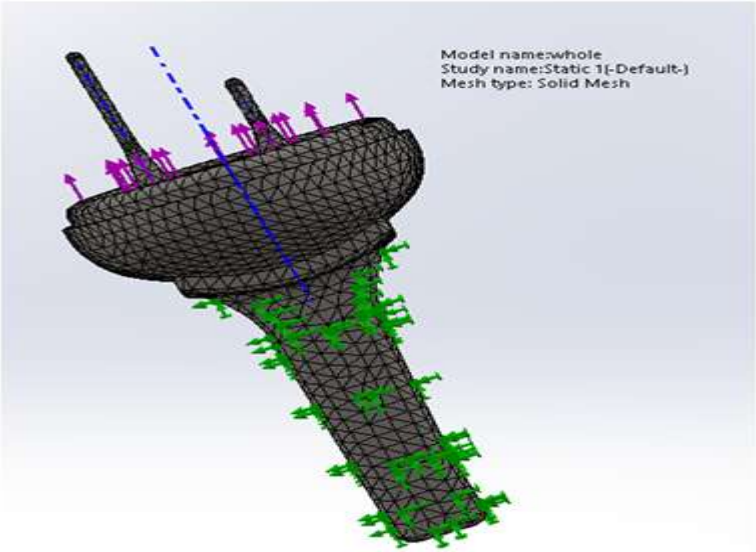

Figure 4 Mesh Model

The mesh of the model is generated by solid works simulation. In this mesh model radial components consider fixed support and applied load upward direction on distal components.

B. *Stress (Von Mises)*

Applied 4000N force upward direction on Distal components of artificial wrist joint which means 400 kg lifting situation. the results in shows model is strong enough to hold that situation.

Table I : Results of Von Mises

Stress (von Mises)	Results
Minimum	2.397e+007 pa
Maximum	6.148e+007 pa

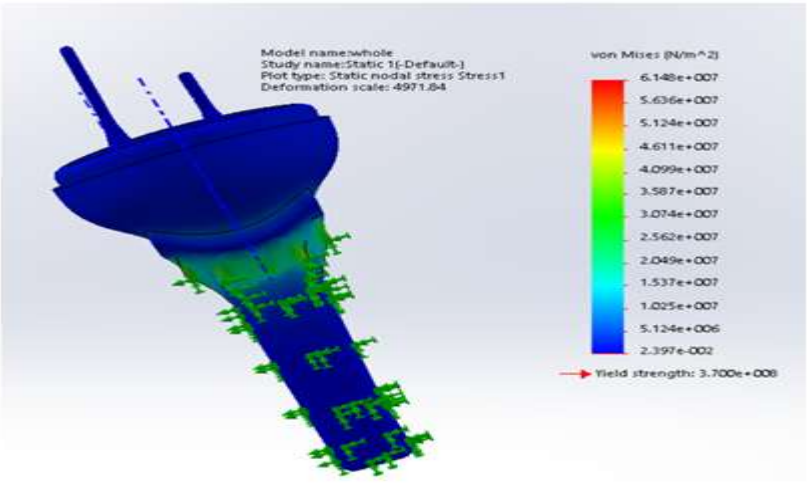

Figure 5 Von Mises

C. ***Displacements***

Applied 4000N force upward direction on Distal components of artificial wrist joint which means 400 kg lifting situation. the results in shows model is strong enough to hold that situation.

Table II : Results of Displacements

Displacements	Results
Minimum	1.00e-030 mm
Maximum	2.127e-030 mm

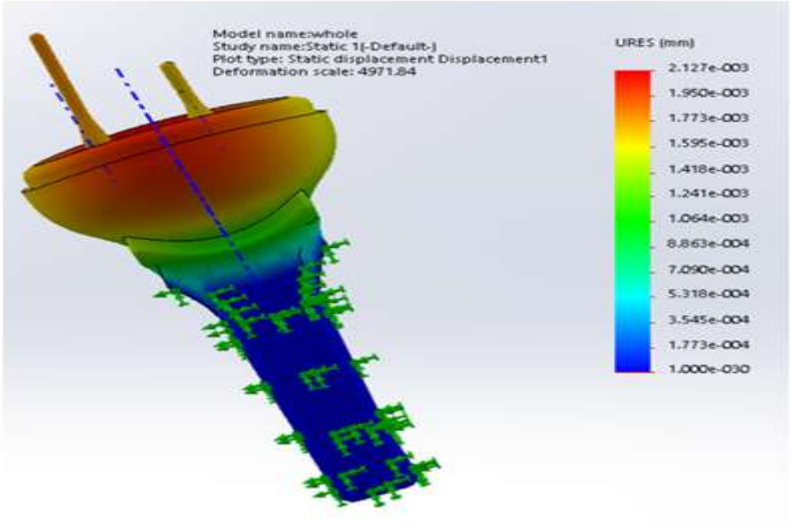

Figure 6 Displacements

D. ***Safety of factor***

The safety of factors describes a system of ability to carrying load capacity. The safety of factor is ratio of strength to applied loads. Results show me the maximum load carrying capacity, so design is safe. Safety of factor is 6 which means person can lifting 400 kg weight.

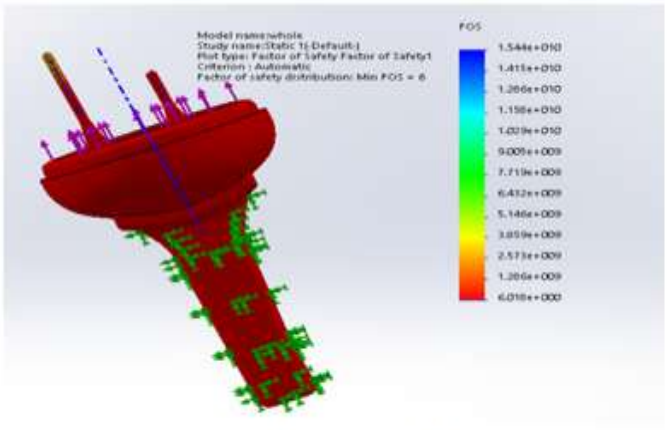

Figure 7 Factor of Safety

VI CONCLUSIONS

The paper presents Design of artificial joint base on design in design software solid works and mechanical analysis in analysis software soil works simulation. This artificial wrist joint is developing to perform movements of wrist joint. The study of analysis of the artificial wrist joint indicates satisfactory results and its reliable and safe use.

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