A Review on: Design of Anthropomorphic Prosthetic Hand with Enhanced Strength, COSMESIS and Dirt Repellent Properties using CATIA V5 R20

Saurabh Kumar Dadhore[1] Pradeep Dhote[2] Arvind Singh[3]
[1]Research Scholar [2,3]Assistant Professor
[1,2,3]Millennium Institute of technology, Bhopal 462044, India

Abstract— The objective of this research is to analysis the design of scalable prosthetic hand as per stipulated criteria which manifest enhanced and optimized solutions to common designing problems such as Stress distribution, better suitable material, cosmesis and dirt repellent characteristics. Current 3D printed prosthetic hand designs are openly available and inexpensive to produce with a 3D printer; however, these prosthetics are also prone to failure. Tolerance issues, printing errors, and poor instructions lead to a significant number of prosthetics that cannot be assembled, do not work correctly, or break with light use. We aim to provide a solution to these problems through the use of equation based scaling and proper instructions. Our design scales using equations to scale different features at different rates, and a provided text file allows for variable editing. It is also as reliable and easy to assemble as currently available hands. Here our main aim is to focus comprehensive utilization of latest available software technologies such as Ansys, Solidworks, Pro E ,Catia , CAD . But due to our excellency and as per need We concentrate our concern relating to the use of Ansys and CAD . After designing process the utility and application of prosthetic hand mostly depends upon its efficient and effective mechanism vis a vis its cosmesis properties as well. So designing must need to analyse cosmesis properties as well which mainly focus upon its decorative and adaptive look. Now a days looks matter a lot because its adaptive nature depends upon human mentality of its perception . As per daily life applications its interactions with local atmospheric constraints is a continuous process which directly impact upon the longevity of material and its performance . So it needs to better assign and implant Dust removal techniques and technologies associated with it which directly manifest its usability.

Key words: Prosthetic Hand, Catia, Ansys, Simulation

I. INTRODUCTION

This research work will proceeds with the introduction of earlier research on Prosthetic Hand designing and simulation but our work is solely focus upon its designing parameters only due to limitations in time and knowledge and our expertise in designing by automation. For this project after considering and in depth analysis of earlier research we have selected many features and parameters from variable available sources with regards to this view the carrying on research on this topic is based upon "Design of cost effective Prosthetic Arm for disabled" which is latest in this domain. Moreover I am also working for cosmesis as well which seems to be work of acceptability of any device as human hand in the view of perception as ultimately it's the human mind that first concentrate upon its look and art than after its application so cosmesis properties also plays a pivotal role in this equipment with the add on of its dirt repellent properties which manifest its all-time use and better performance. Dirt in any form tends to barrier in desirable mechanism as per designed and manipulated so material testing and selection process also coincide with the quality selection of desirable material with dirt resisting and non-accumulating tendency of material.

II. PROBLEM STATEMENT

Human Hand is a vital part of body which is having a coordinated high level intelligence for processing high level mechanised operations with a multitude of great accuracy and precision. So utilization of its mechanism in development of prosthetic hand so that its applicability will be more enhanced for other purpose like automachinary applications and latest devised intelligence units. The main problem concern here is its wide range application of mechanism thus so involved in natural human hand which was impossible to replicate few decades earlier but due to involvement of latest research and innovation in science and technology it is seemed to be an easy task for general human to proceed this task with an ease using currently available 3-D printing technology. So to proceed this task its manipulation for robotics is very essential and for the enhancement of its working methodology the main driving mechanism is to asses and design better analytical techniques which coordinates in the assemblage of its virtue and advantages to this paper.

III. METHODOLOGY

In this section, design specifications, the methods and procedures of mechanical design, material research and mechanical calculations and analysis are discussed.

A. Material & Process Selection:-

Material selection for the following purpose is one of the most crucial part of the project as this factor binds with many dependencies such as market availability, easy access, performance characteristics and its durability moreover cosmesis is also an accountable factor.

Considering above mentioned factors and due research we arrived at following conclusion that

Light weight metals, Alloys, Plasticsetc. are available options for this project. Selection factors are density, Ultimate Tensile Strength,Manufacturing process and total manufacturing cost. In metals we have selected Aluminiumalloy 6061-T6 which is widely used for Aluminium cans for the packaging of food and beverages,automotive parts such as wheel spacers, construction of aircraft structures, suchas wings and fuselages etc.

Whereas ABS (Acrylonitrile butadiene Styrene) is selected from plastics because of availability of 3D printing process is low cost manufacturing process. ABS's light weight and ability tobe injection moulded and extruded make it useful in manufacturing products such as drain-waste vent (DWV) pipe systems, musical instruments (recorders, plastic clarinets, and pianomovements), golf club heads (because of its good shock absorbance), automotive trimcomponents, automotive bumper bars, medical devices for blood access, enclosures for electricaland electronic assemblies, Household and consumer goods are the major applications of ABS.ABS material is selected because of availability of low cost manufacturing process – 3D printingcompared with other materials, Light weight (Density = 1100Kg/m3) and having better loadcarrying capacity.

B. Design Specifications

Specification	Unit/Description	Information
Weight	.18 ± .05kg	Weight of the assembled hand
Max load	31 ± 0.44 N	Total allowed force on the fingers from carrying a weight
Range of Motion Wrist	+20 to -20 ±10 degrees	Angle 0 when wrist and arm are parallel. Positive angle indicates bending wrist upwards.
Range of Motion MCP	0 to -90 ±5 degrees	Joint and knuckle. Angle 0 at straight extension, curving inwards
Range of Motion PIP	0 to -60 ±5 degrees	Joint at end of proximal phalanx
Range of Motion DIP	0 to -80 ±5 degrees	Joint at end of Middle phalanx
Time to Assemble	4 ±1 hours	Cleaning/finishing parts and connecting finished pieces with the given tools by someone 16+
Life Expectancy	1000 ±50 grip cycles	Number of times the hand can open and close before reduction in Performance
Specification	Unit/Description	Information
Max Operating Temperature	140F (60C) ± 10F (5C)	At around 140F, the PLA will reach its glass transition temperature.
Min Operating Temperature	-10F (-23.3C) ± 10F (5C)	At around -10F, most rubbers will begin to reach their glass transition temperature. Significant performance degradation will occur at around 0F.
Material	ABS (Acrylonitrile butadiene Styrene)	Selected from Plastics because of availability of3D printing process is low cost manufacturing process.

C. Decision Matrix scaling weights

1) Weight

The system will need to be very light weight keeping the system as light as a regular hand will help the device feel more natural and reduce discomfort.

2) Max capable load

If the device cannot hold a weight or withstand a load, its functionality is greatly diminished.

3) Range of motion

Limiting the range of motion of the fingers would reduce the functionality of the device. By allowing for a greater range of motion, smaller objects can be grasped, and larger objects can be grasped more tightly and in different ways.

4) Time to assemble

Not everyone has a significant amount of time that they can devote to assembling a product. By reducing the time to assemble..

5) Durability

Increasing durability means that the device can operate for a longer period of time without need for repair. This lowers the cost of replacement parts, and makes the prosthetic more of a convenience than a hassle.

6) Operating temperature

By allowing for a wider range of temperatures means that the device can be used around the year and around the world.

7) Cosmetics

While functionality is important, the cosmetics of a prosthetic are critical to the usage of the device. An ugly prosthetic will generally be used less than a more attractive option, regardless of the functionality.

8) Safety

Safety is critical to the prosthetic, as the device is meant to help a person, rather than cause any harm.

9) Serviceability

Because the device is made of plastic, parts are expected to break at one point or another. A device that is easy to repair or fine-tune is always a more preferable option than one less so.

IV. DESIGN OF PROSTHETIC HAND

By using Computer Aided Design 3D model is generated. CATIA V5 R20 software had used for modelling, drafting & Simulation purpose. By using digital mock up workbench functionality has checked & modifications in model created as per requirements.

A. 2D drawing of the hand :

The hand is designed by taking new parameters chosen on the basis data found in literature survey and after studying the anthropomorphic structure of actual human hand. Only some parameters from the dimensions are required to construct the whole unit by the use of specific ratios.

2D diagrams from CATIA V5 are drawn as follows :

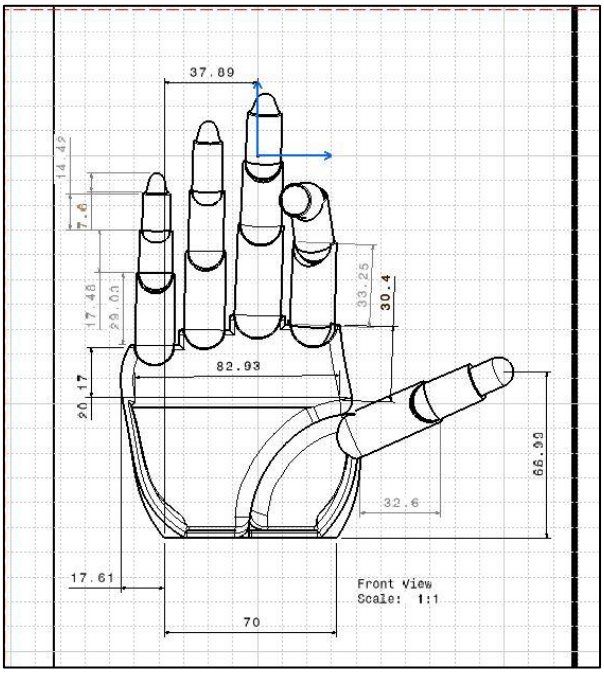

Fig. 1: 2D Sketch of hand with dimensions

B. 3D design of the hand :

The hand is basically an assembly of multiple sub assemblies that are also consists of multiple parts. In order to consider with the human hand its sub assemblies are well known as index finger, middle finger, ring finger, pinky finger, thumb, left side and right side palm.

Its fingers are also made up of small units or parts having upper, middle and lower portion. Some fingers are long having four parts and some are small having three or two parts.

Modelling is done by making parts and then product in CATIA is created by assembling them. Finally the main product is made by assembling all sub assemblies.

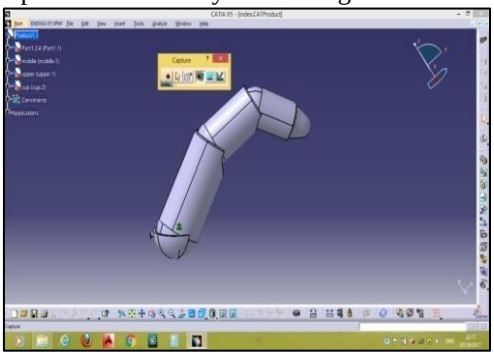

Fig. 2: Design of Index Finger

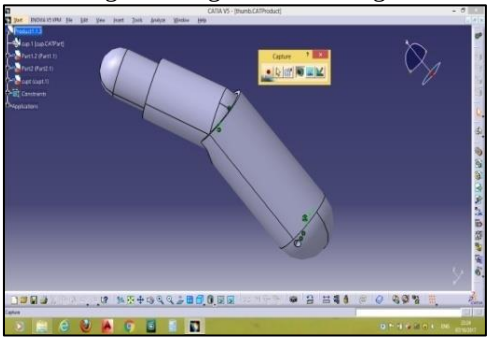

Fig. 3: Design of Thumb

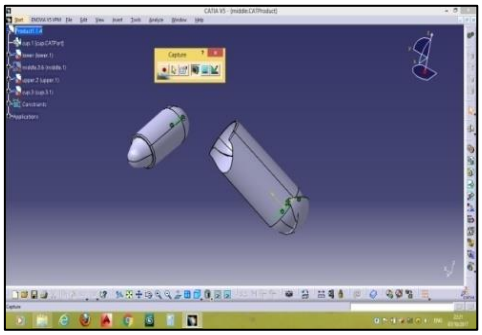

Fig. 4: Design of middle finger

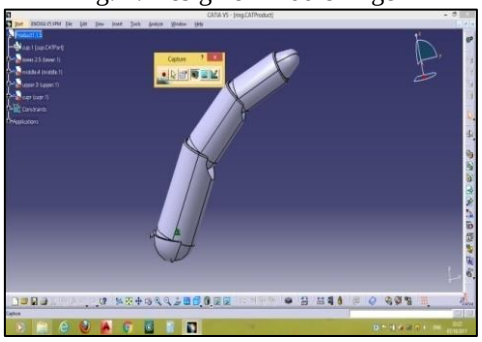

Fig. 5: Design of ring finger

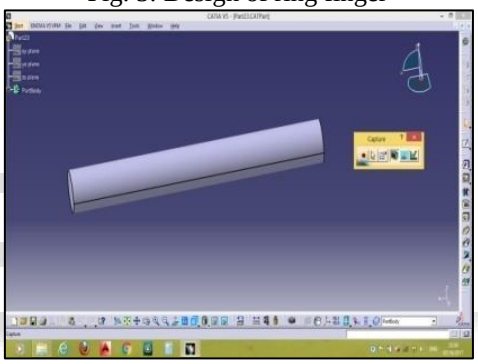

Fig. 6: Design of small shaft

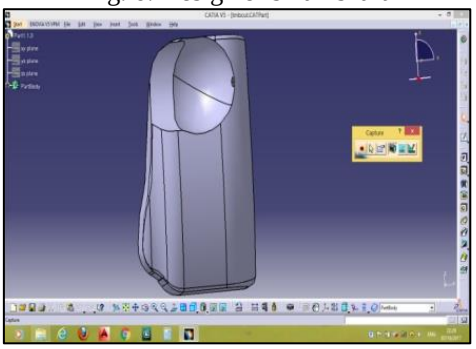

Fig. 7: Design of palm portion

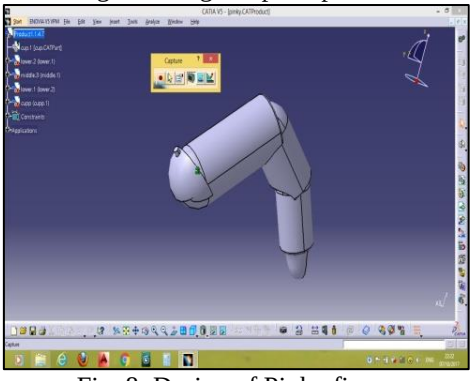

Fig. 8: Design of Pinky finger

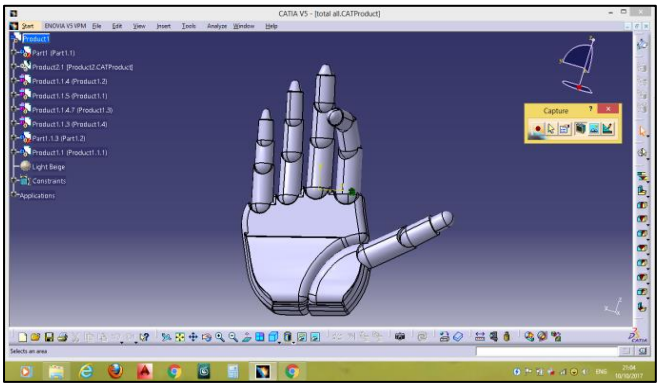

Fig. 9: Main Assembly of hand

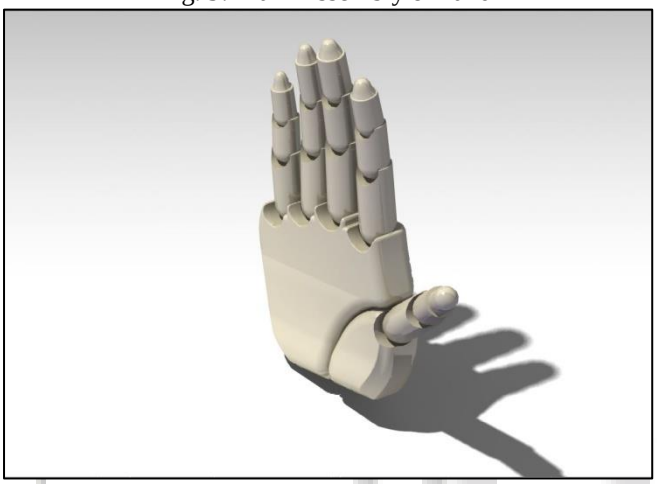

Fig. 10: Hand Rendering with shadow

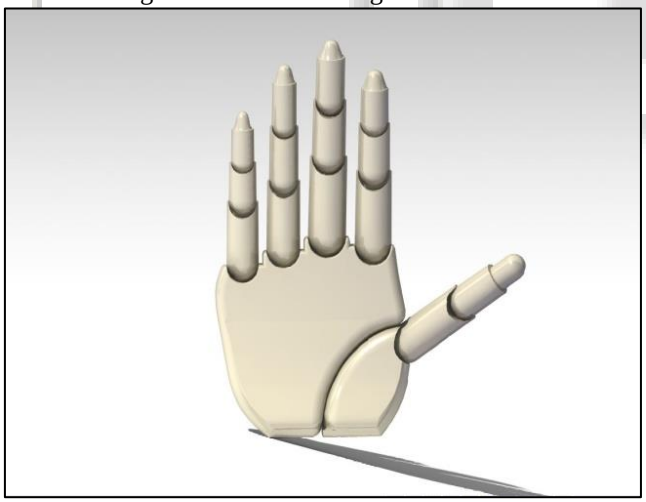

Fig. 11: Hand Rendering

V. FUTURE SCOPE OF WORK

The strength can be always increased by changing dimensions and design parameters as well as it can also be designed as a two way prosthetic hand that is able to fold on backside also so that it can be used as right and left hand at the same time.

VI. CONCLUSION

Design is done after rendering and simulation on selected desirable material properties of ABS or best available option so that it will conclude which is best for prosthetic hand designing as per the criteria predefined i.e. as per strength, toughness, cosmesis and dirt repellent properties.

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