

## Design And Development Of 3D Printed Five Finger Prosthetic Hand.

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**ABSTRACT :** The life of an amputee is very difficult to complete their daily tasks, to make the life of an amputee more convenient, prosthetics hands are designed. Prosthetics are defined as an artificial device designed to replace the missing part, that may be lost by a condition of polio or an accident and may be a disease. It's better to replace the missing limbs with a prosthetic prototype. Our aim is to develop the prosthetic hand, which is operated by the Bluetooth. The whole hand is operated by tension strings with motors, to get high strength for holding the objects. As there is no control of the manufacturing the prosthetics hand from any authority, so prosthetic hand is designed only for a special person (do it yourself). We are using an 3D printer for making prosthetic hand, which is most conveniently available at economical price.

**Introduction:** Robotics are the devices developed for the particular application, these are designed and developed and manufactured. These systems have the features of control, sensor feedback and information processing unit. Robots are commonly having three aspects of systems. They have mechanical design and manufacturing, electrical system and some computer coding for the automation of the robot. The component of robots includes a power source by pneumatic, hydraulic, by electric motors and air muscles, for sensing the vision camera and the touch sensors are used. For the manipulation mechanical and vacuum grippers are used for locomotion, by rolling or wheeled or bi-ped and dynamic balancing. The robotics are now going to use in the medical sector for the development of the artificial body parts like legs, hands and other missing parts, which were lost by the person in an accident or any diseases. The knowledge of the robotics is more necessary for the development of the prosthetic body parts for the accurate movement of the developed part. Actually, the robotics are used for the development of the prosthetic hand, it actually comes under the sector for the do it yourself. The parameters of the amputee are not same. As it leads to lack of the manufacturers around the industry. The technology of robots is used for the development of the prosthetic hand, the prosthetic hands are consisting of the different motions and has its own degree of freedom. The motions of the hand were analyzed and by using the suitable mechanism the hand was controlled by the robotic system as it

consists of the 2 mechanical unit, electric unit, sensing system, feedback system. By using the above units, a system of the robot environment is created for the completion of the task. The study of motion can be divided into kinematic and dynamics. Kinematic are referred to the calculation of the forces developed, velocity and acceleration, when the force values are known. Similarly, the dynamic refers to the calculation of the accelerators in the robot once the applied forces are known. In this project the forces are applied by the electric motor and the motion are done by the string. The prosthetic hand was designed and developed by the considering the relative motion between the joints.

### **Need of prosthesis:**

Our body parts like legs, hands, thighs, can be replaced by using of prosthesis and helps for the people to do their own functions. The prosthetic items are more reliable in nature and they are water resistant. Due to using of 3D printing the hand should have good strength and good properties. The technology of robots is used for the development of the prosthetic hand, the prosthetic hands are consisting of the different motions and has its own degree of freedom. The motions of the hand were analyzed and by using the suitable mechanism the hand was controlled by the robotic system as it consists of the 2 mechanical unit, electric unit, sensing system, feedback system. By using the above units, a system of the robot environment is created for the completion of the task. The study of motion can be divided into kinematic and dynamics. Kinematic are referred to the calculation of the forces developed, velocity and acceleration, when the force values are known. Similarly, the dynamic refers to the calculation of the accelerators in the robot once the applied forces are known. In this project the forces are applied by the electric motor and the motion are done by the string. The prosthetic hand was designed and developed by the considering the relative motion between the joints.

### **Design:**

The design software is used for the development of the 3D model. In our project the AutoCAD and solid works are used for the development of the 3D model. These tools are most widely used in the engineering industry for the development of the design. All parts are made up of ABS plastic.

### **3D printing :**

The prototype of prosthetic hand was done by using the 3D printer. This would be the ideal for this project because of its robust quality and somewhat lighter weight depending upon the filament. The technology of the 3D printing is suitable for small scale industries and making the prototype is more easily. The objected

is created by layering the material one on the other. The thickness of material or layer height is defined within the range of 0.1 mm to 0.2mm

The thermoplastic is heated in the extruder and then placed on the workspace for producing of the object in layer by layer. The temperature of the bottom base of the 3D printer is lower to facilitate the solidification of the thermoplastic quickly. This process is continued until the completion of the object.

### Steps of 3D printing:

The steps involve in developing the prototype of object view 3D printer,

- To develop the 3D object, the design is created in the cad software like AutoCAD, solid works, Catia...Etc.
- After that converting the part design into the STL (standard tessellation language) format. This format describes the surface if the object through the differ set of triangles. The more set of triangles the more accurate can be achieved.
- Then choosing the reference plane, the reference for the STL file is used to divide the 3D object into layers. The smaller layer the more accuracy can be achieved.
- Each layer of the object is defined in the form of the GCODE for the control the motion of the extruder, movement of the base plate, temperature of the extruder, speed and position.
- Finally, the 3D printed object is achieved after some struggles of the GCODES developed by the 3D printer.



## Passive Prostheses

### Electrical design and components:

The electrical design is important in this project. In our project we are using some electrical components for the operation of the prosthetic hand. The signals from the Bluetooth are received by the Arduino controller and the analog signals are transmitted to the servo motors. Then according to the mechanical design, the operation of the prosthetic hand is performed. In our project all the electrical components are equipped by considering the operation of the prosthetic hand. The details of the electrical components are explained below.

### Arduino UNO:

The Arduino Uno is an open-source microcontroller board manufactured by Arduino cc. The Arduino board is equipped with different digital and analog inputs and output pins for the external connections to the expansion boards and other connections. This board has 14 digital input and output pins and six are capable of PWM output. It has 6 analog input and output pins which are programmable with the Arduino IDE (integrated development environment), via type B USB cable. We can run this microcontroller via USB cable or external power source varying range between 7 to 20 volts.

### Servomotor:

We are using MG995 servo motor for the expansion of the fingers. This MG995 servomotor can rotate approximately 180 degrees and it has a metal gear which provides 10kg/cm at 4.8V and 12kg/cm at 6V. The servomotor is totally made up of plastic case which makes water and dust resistant servo motor is a digital motor which receives and processes PWM signal faster and better. It has an internal circuitry that provides good torque, holding power, and faster response to external forces. This motor is equipped with 3 wires with connectors. The red is for positive terminal, the brown is for negative terminal and the orange is for the signal from the controller.



## Servo Motor

### Software integration:

Arduino is integrated with the code program for the control of the prosthetic hand by using the Bluetooth. The prosthetic hand was controlled by the code. The automation and the actuation of the prosthetic hand was done by using the code. The code was written in the Arduino IDE then it is uploaded to Arduino and the certain operations are done by the servo motor controlled by the Arduino that is micro controller. The code required for the operation of the prosthetic hand was developed by our own to make the regular tasks by the prosthetic hand. The hand was coded in such a way that it will operate by the control of the code. The prosthetic hand was needing more implementation of the sensors and other feedback system and code to operate is need are implemented by the code. The software implementations are done.

The software plays a important role in the development of the prosthetic projects. The software is key to control the prosthetic hand design and development and user control. The software will help to operate the accurately. Due to the macro size of the controllers these are easy to hold and light weight and efficient performance and the software modifications are easily done by the controller. The software is simply implemented by using the data cable connected and the file is compiled and transferred to the Arduino. Our system can perform different function if we made a lot of modifications in the code. at present we are using the Bluetooth controlled prosthetic code to make our project.

### System specifications:

The thumb, index and middle fingers each move independently and the ring finger and small finger move in tendon. The system has the electrical components and the mechanical assembly. This system has the long-life battery as we can change easily. our aim to improve the battery life and it is done by our project. The system can run any environment as we designed in such a way. The

prosthetic hand was having the more capacity battery and the hand was having some fixed parameters such as mechanical components and assembly. The prosthetic hand has the same features as the electronic components and other components. The specification is can be given as the same as the components mentioned on the chapter.

The fingers can apply the enough forces to hold the objects and the necessary parameters can be done to operate the motion to the fingers. The system has the mechanical assembly, software implementation, electrical circuits and the physics behind the prosthetic hand

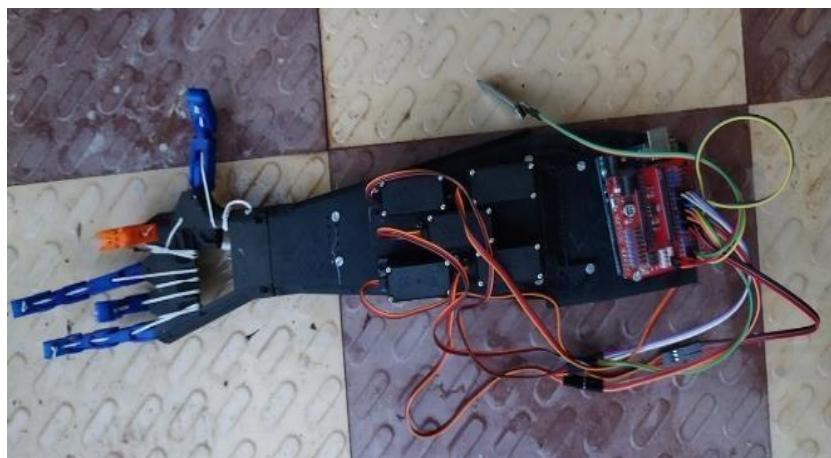
### **Cost:**

We made this 3D printed hand at a cost of 15,000/-. we mostly use the waste from the dustbin and we tried to reduce the cost of the hand developed. The most of the cost is printing. For making the consumed by means of the 3Dprinting it taking the more cost. The next major cost is consumed by the electronic components.in that the controller and the servo motors are consuming the more cost. Remaining are not that much costlier.

### **Methodology:**

The process involves of printing the prosthetic arm with help of the 3D printing machine. For that first we should observe the normal human hand structure regarding to size, shape and mechanism involved in working of the hand. Size can be defined by taking the standard data available from Ergonomics which deals with the human hand structure. By observing it we can able to design a prosthetic hand by the use of the software cad, catia , solid works .We utilized Cad software to design the human hand parts and developed with the use of this software.Our Design includes of Fingers, palm ,Forearm and also an additional equipment for placing of Arduino which is called Arduino compartment.The design should be uploaded in a 3D printing machine in order to obtain the parts .3D printing machine uses a filler material for manufacturing process It is an electrically operated machine which heats the filler material by using of an electric heater to melt and further shaped into our Requirement. The filler material we used is ABS plastic which is a strong plastic and it is ecofriendly to the nature and it does not harm to the people using the prosthetic hand.The material is very costly and rarely available.The 3D printed parts are assembled according to their positions with the help of suitable fastening devices like nuts,bolts,studs etc.we can also use some resin compounds for assembly purpose .The forearm should be facilitated with the space for placing of servo motors.There are 5 sevo motors for 5 finger movements and the motors should be facilitated with portable size of horns for tying threads which are connected to individual finger.Threads are responsible for carrying of motion from the motor to the fingers.threads are made up of Nylon which are used for the pulling

and for reverse action we used elastic strings which does not require power. All are servo motors which are controlled by an Arduino board. For safe connections we used an extension board which is soldered to the Arduino board. arduino coding should be provided in our desired programming language for specific fuctions such as grasping ,releasing,closing and opening of fingers and our daily life actions. So that the finger works according to the servo signals which are controlled by the Arduino board. Each and every fuvnction should be programmed.



**WORKING MODEL OF PROSTHETIC HAND**

#### **conclusion:**

The final system provides relatively good performance and characteristics for a prototype 3D printed model. The device is fast and responsive to Bluetooth user input but offers limited strength. Over the course of testing the system has proven to be reliable and has required minimal maintenance since being assembled.

The biggest downfall of this design is its lack of toughness. Certain regions such as the wrist are at a high

risk of breaking if the device is subject to moderate forces. In the real world a practical prosthetic arm must be able to absorb sudden shocks and support heavy loads without failing. Ways to improve the strength and toughness have been discussed in the previous results section.



## References:

N. Carbonaro, G. Anania, M. Bacchereti, G. Donati, L. Ferretti, G. Pellicci, G. Perrini, N. Vitetta, D. De rossi1, and A. Tognetti1, [1] the aim to develop a prosthetic hand using multi sensors which leads to make an individual finger movement, and as to develop more light weight and more accurate to the performance of prosthetic hand. But the design is more complicated and its appearance is very odd to see. It has 11 degree of freedom and operated by dc motors.

GK jonesa, R stopforthb [2], the most of the designs are most expensive, so we decided to develop more gripping strength, power consumption, controller, cost of the prosthetic hand, with own custom controller for the convince of the space. The most of the part of hand is

made of aluminum, titanium, abs, carbon fiber. The prototype is made by using the 3D printer. The power consumption is reducing the using the shape memory alloys.

M. Saiful bahari, ahmed jaffar, cheng yee low ,roseleena jaafar, kolja roese, hanafiah yussof [3], the prosthetic hand is designed by using the belt and pulley for each finger joins and a controller is placed at the palm...And to control the movements. The prototype is developed using the rapid prototype technique to reduce in weight and the best quality can achieved. It is controlled by the graphical user interference I.E., By using the joystick. As it can control 14 degrees of freedom.

Alireza mohammadi, jim lavranos, hao zhou, rahim mutlu, gursel alici, ying tan, peter choong, denny oetomo[4]. The prosthetic hand is developed by using the monolithic soft material which, it is consists of a single unit...Its drastically reduce the cost of the prosthetic hand, but the life of the developed prosthetic hand is very low due to regular flexing of the fingers. However, the cost can be reduced for developing the hand. In this design the single tendon actuation system is used to operate the fingers of the prosthetic hand.