International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 11, 2019 (Special Issue)

DEVELOPMENT OF SMART HUMANOID FLEXO GRAB

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Abstract:

Design of user-friendly gripper to grasp both symmetrical and non-symmetrical complex geometrical objects. The proposed design is Modelled, analyzed and simulated using Creo Parametric and Ansys software’s. The fabrication of gripper should be using 3D printing technology with PLA. The operation and control will be carried out by using PLC, Pi boards and Pneumatic technologies which enables gesture control, programming control and wireless control. The fabricated gripper will be tested with different objects for different applications. Performance results are properly validated by conducting different experiment trials.

Keywords:

Gripper, PLA, PLC, Pi boards, Pneumatic Technology, Gesture Control.

Introduction

Service robotics aimed at assisting humans in everyday life environments is nowadays gaining increased interest from researchers and industry. Such robots are programmed to perform continuously changing tasks in unstructured human environments.

Methodology

Literature Review

Collecting relevant i) Literatures related to human hand gripper from Journals, ii) Details of existing methodologies available to grasp the objects and iii) Controlling of movements of various joints with the aid of pneumatics/PLC/Pi boards.

Modeling of Smart Humanoid Flexo Grab

The normal hand in the human body is made up of the fingers, wrist and palm. The most flexible or versatile part of the human skeleton, the hand enables all of us to perform many of our daily activities. The major components to design are palm, interlink, proximal, distal and pushing link. These links are actuated with the aid of servomotors controlled by Pi/PLC boards.

Simulation of Smart Humanoid Flexo Grab

The modelled components will be analyzed using Ansys software to know the behavior of various joints under dynamic conditions. Simulation of the gripper will be done using Autodesk Fusion 360 software.

Fabrication of Smart Humanoid Flexo Grab

Based on the proposed design, the fabrication will be initiated by two stages.

Stage-I

Using 3D printing technology like Fused Deposition Modeling (FDM) with PLA as a material the components of gripper will be fabricated as a shell model of thickness as 4-6mm.

Stage-II

Fabricated components should be assembled by bottom to top approach using conventional techniques.

Programming of Smart Humanoid Flexo Grab

Conduct of gesture control with the help of sensors and Pi boards

Demonstrate the motions of an end effector through various channels like PLC, Pneumatics and Pi boards.

Experimentation, Validation and Report submission

The gripper will be experimented using symmetrical and non-symmetrical objects. The results are monitored and adjustment in programming could be done based on the performance of the gripper.

Literature Survey

In "Analyzing, Modelling and Simulation of Humanoid Robot Hand Motion", Procedia Engineering (2014) [7] Ivan Virgala et.all suggested that Particular places of motion are replaced by corresponding mechanical joints. Subsequently the kinematic configuration of humanoid flexo grab design consists of 24 degrees of freedom. By consider the all rotary and revolving joints the 24 degrees of freedom is calculated. Inverse kinematic model is introduced using MATLAB functions and dynamic model of humanoid hand is introduced using model-based design by means of MATLAB / SimMechanics.

In "An Empirical Framework to regulate Artificial Gripper of Hand System victimisation sensible Glove",Procedia e ngineering (2014)[22].A.Malik MohdAli et.all suggested that a human hand is a very complex grasping architecture which can handle objects of different sizes and shapes. When such necessary feature is lost, the replacement artificial hand ought to capable to imitate the real hand capability, hence it ensures the user comfort. A system to control multi finger grippers with emphasis on the finger tips and finger joints was proposed.. It has 2 modules specifically good glove in master module and hand gripper in slave module. The former accountable to infer user management command whereas the latter dominant the automaton arm movement in keeping with the user instruction. In master module, the system comprises combination of flex sensors and force sensor mounted under the glove to determine fingers bending angle and the force value.Such data is helpful to regulate the bogus gripper for grasping objects in numerous shapes with correct quantity of force. In the slave module, the robot arm consists combination of power window motor and servos to initiate the arm and finger movement. Experimental results have shown the practicableness of the projected system for dominant the bogus gripper and arm exactly in keeping with the user command.

In "Dynamic Modelling and Control of a Multi-Fingered Robot Hand for Grasping Task", Procedia Engineering (2012) [21] RimBoughdiri et.all suggested that Multi-fingered robot hands are crucial functionalities of several robotic systems, including service robots, industrial robots and wheel-type mobile robots. In this work, the problem of model-based control for a multi-fingered robot hand grasping an object with known geometrical characteristics is considered. A mathematical model of the dynamics of a designed multi-fingered robot hand with five fingers with twenty DOF (three for each finger, two for the thumb and six for the wrist) which grasps a rigid object is derived.

After a literature review, it is found that there are few works are available related to gripper to grasp the geometrical and non-geometrical shapes. In this proposed work, an attempt is made to design and develop the gripper to grasp the symmetrical and non-symmetrical objects with the nominal amount of pressure to hold the object. Also, with various add-ons like gesture control, wireless controlled etc. Finally, it is proposed to develop an end effector "Smart Humanoid Flexo Grab" to handle various objects in food industries.

Modeling and Simulation of Smart Humanoid Flexo Grab

The modelling of our gripper is done using the solidworks 2018 premium edition. We have used the concept of Reverse Engineering in developing our modelling. We have used top down approach process in modelling our gripper. We have also succeeded in attaining the degree of freedom for each finger. The Front view of our complete humanoid hand model is as shown in fig.1.1

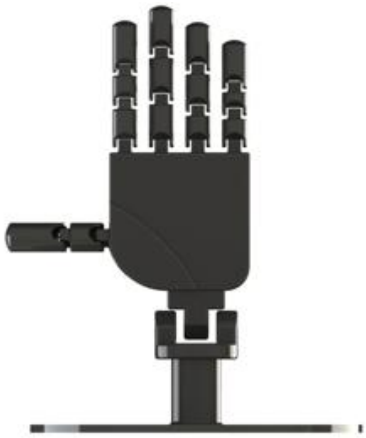

Fig 1.1: front view of 3d-model

The Stages of grasping an object is given below.

Stage-I

The first stage of our humanoid hand model is as shown in fig1.2.1

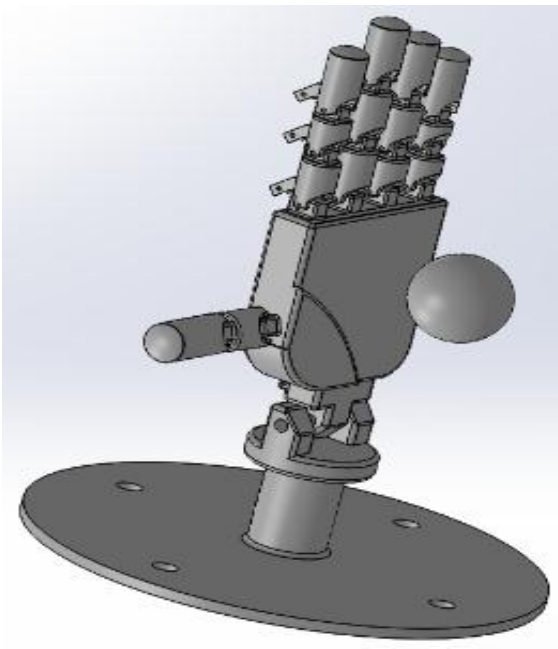

fig1.2.1

Stage-II

The second stage of our humanoid hand model is as shown in fig1.2.2

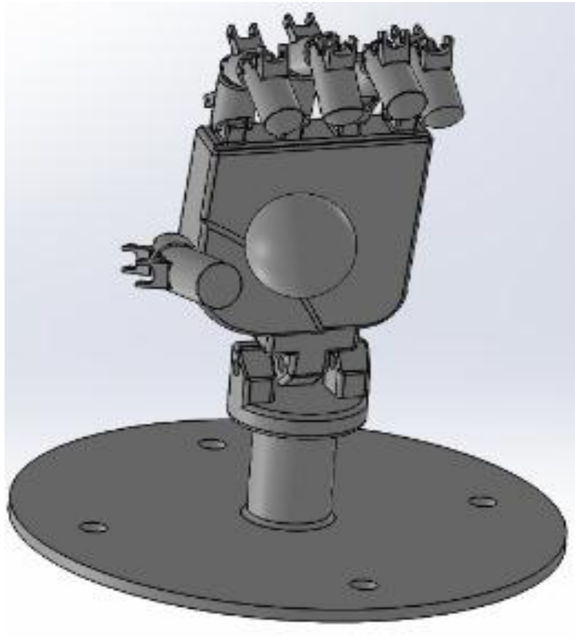

fig1.2.2

Stage-III

The third stage of our humanoid hand model is as shown in fig1.2.3

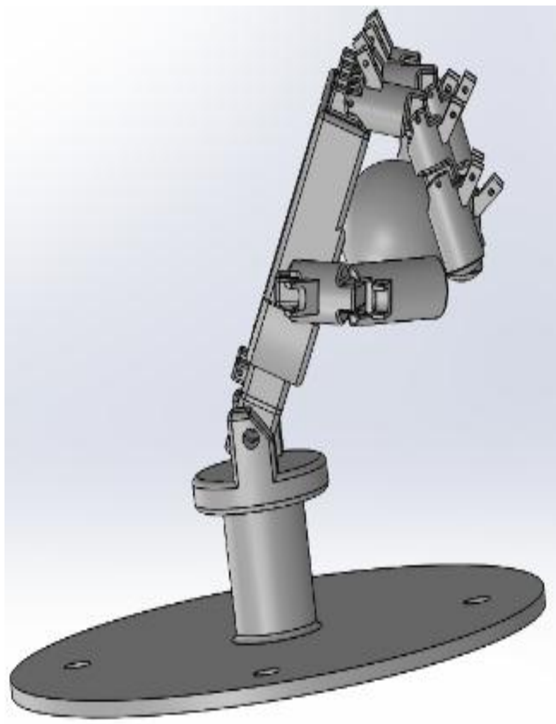

fig1.2.3

We have also done our modelling by keeping our hand also for a reference in order to achieve the shape of the humanoid hand. Simulation of the gripper will be done using solidworks software After the modelling of gripper, we have done our analysis process using the ANSYS-2017 to determine the gripper under the various dynamic conditions. We have done thermal analysis and structural analysis to determine our gripper strength and durability.

The simulation of our Humanoid hand is done by using ANSIS R2017 simulation software. The static structural analysis is done in the software and the results were taken and shown in the fig1.3&1.4.

The simulation for maximum principal stress on our humanoid hand is as shown in fig.1.3.1, 1.3.2

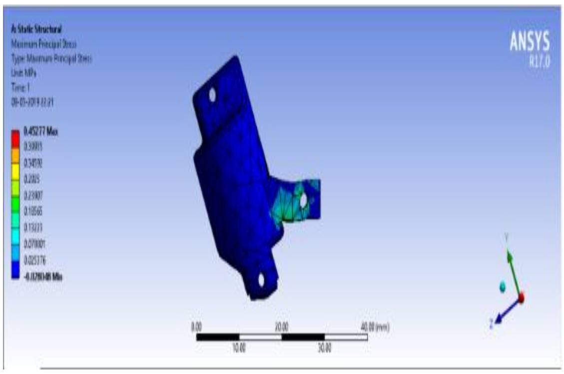

Fig1.3.1: Simulation of finger for maximum principal stress

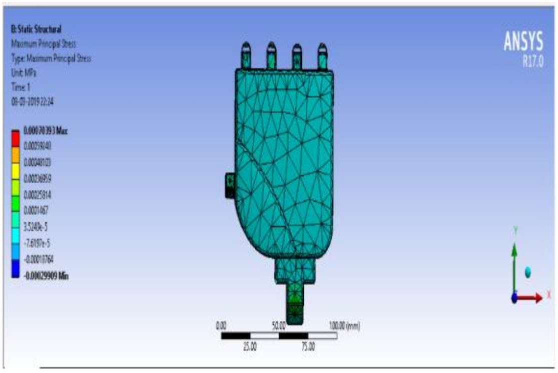

Fig1.3.2: Simulation of Palm for maximum principal stress

The simulation for maximum shear stress on our humanoid hand is as shown in fig.1.4.1, 1.4.2.

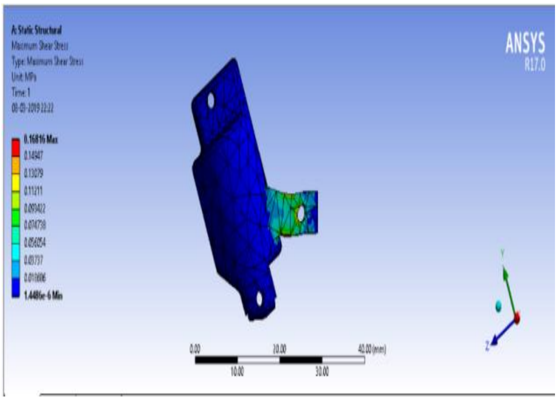

Fig.1.4.1: Simulation of Finger for maximum shear stress

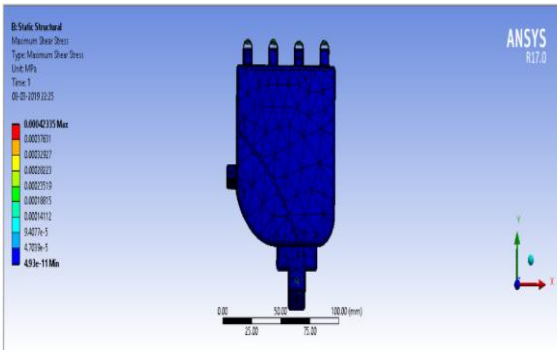

Fig1.4.2: Simulation of Palm for maximum principal stress

Fabrication of Smart Humanoid Flexo Grab

The above specified model has been drafted in the software solidworks 2018 premium edition. The dimensions were shown in different views of our humanoid hand model.The humanoid hand model is drafted to show the specified dimensions.

The complete drafting of our model is as shown in fig 1.5.1, 1.5.2,1.5.3.

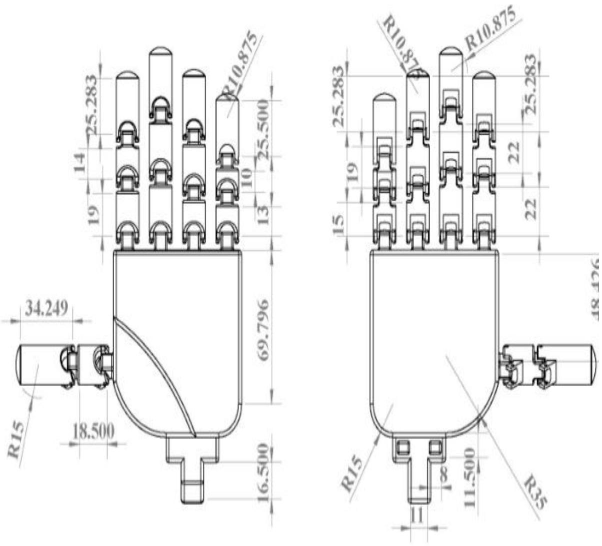

Fig 1.5.1

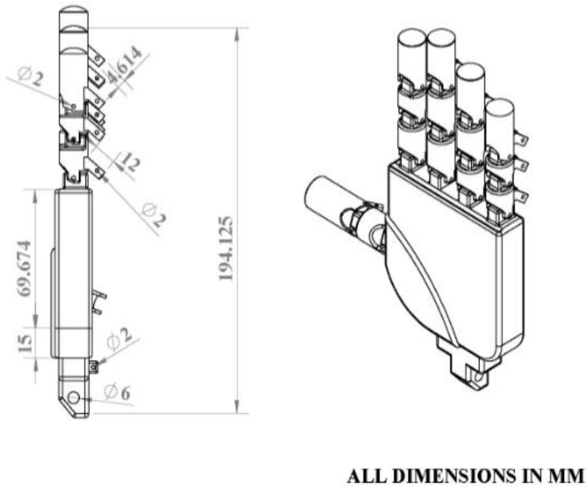

Fig 1.5.2

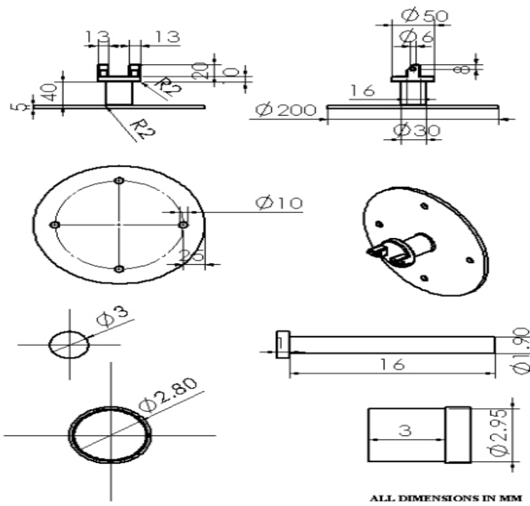

Fig 1.5.3

The Fabrication of our product has done by using 3D printing technology like Fused Deposition Modeling (FDM) method. For printing the product, we have used (PLA) Polylactic Acid as a material. For modelling we have used Top-Down approach which is a technique of Reverse Engineering. But for printing, we printed each part separately and assembled it. Fabricated components will be assembled by bottom to top approach using conventional techniques. Our Humanoid hand will have sixteen degrees of freedom. It will be able to move to and fro, it will have rotational motion and each finger will have three degrees of freedom and only thumb have two degrees of freedom. The fabricated structure of our humanoid hand is as shown in fig.1.6.

Fig1.6: Fabricated Gripper

Programming of Smart Humanoid Flexo Grab

The entire programming of the Humanoid Flexo Grab has done by using Programmable Logic Controllers (PLC) and Arduino board. The variable declaration of PLC program is as shown in fig.1.7

```
VAR_GLOBAL
    Start    AT%IX2.0    :BOOL;
    Stop     AT%IX2.1    :BOOL;
    Reset    AT%IX2.2    :BOOL;
    S1   AT%QX0.0    :BOOL;
    S2   AT%QX0.1    :BOOL;
    S3   AT%QX0.2    :BOOL;
    S4   AT%QX0.3    :BOOL;
    S5   AT%QX0.4    :BOOL;
    S6   AT%QX0.5    :BOOL;
    S7   AT%QX0.6    :BOOL;
    S8   AT%QX0.7    :BOOL;
    R1   AT%MX4.0    :BOOL;
    R2   AT%MX4.1    :BOOL;
    R3   AT%MX4.2    :BOOL;
END_VAR
```

Fig1.7: PLC program (global variable declaration)

The image sensor is attached in the front side of the palm which will sense the objects passing through it. The images of the objects were given in the form of program. While, the object

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 11, 2019 (Special Issue)

moves across the sensor the image will be seen and will be compared with the fed images and finally the particular pneumatic pressure has been selected and has been given automatically from the result of comparison. The different pressures have been given to different materials by observing the image of the material.

The model program of our Humanoid hand is as shown in fig.1.8.1,1.8.2,1.8.3.

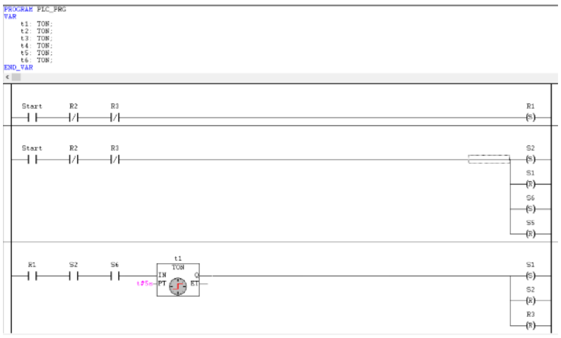

Fig1.8.1: PLC program1

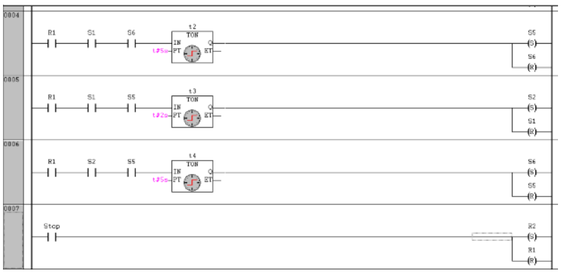

Fig1.8.2: PLC program2

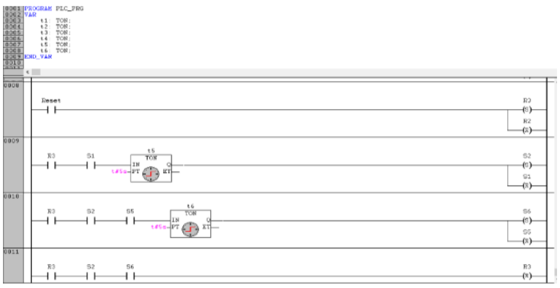

Fig1.8.3: PLC program3

Acknowledgment

This work has received funding support from the Institution of Engineers(India) under IEI. grant for R&D project entitled "Development of Smart Humanoid Flexo Grab".

Project id : RDUG2018035.

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