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Servo operated three finger sensitive gripper with pressure feedback for Irb1410 robot

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ABSTRACT

Commercially available robotic hands are often expensive, customized for specific platforms and difficult to modify. The servo operated three finger sensitive gripper with pressure feedback for IRB1410 Robot presents the design of a low-cost three finger gripper that can be created through fast and commonly accessible rapid-prototype techniques. The project establishes the design of an adaptive three-finger gripper utilizing RPT design components and flexible joints. Grasping force of a gripper plays a major role for holding any complex shaped objects. Force acting on the object can be known by placing the sensors on the outer surface of gripper fingers. Movement of the fingers are controlled based on the force required for grasping the object which in turn depends on the physical make over and type of the object. For precise movement of fingers, servo motor operated mechanism is used.

KEY WORDS: RPT Technology, three finger gripper, CAD designing, STL.

1. INTRODUCTION

Pressure Sensitive Robot grippers often play a major role in handling sensitive or brittle objects. This is due to the gripping force that exerts on the lateral surface or interior surface or the object. This force can be controlled using a feedback sensory device which is the input for the controller used to operate the gripper. These grippers are manufactured by various methods; Rapid prototyping is one such effective method for quicker designing Rapid prototype is a group of techniques used to quickly fabricate a scale model of a physical part of assembly using three dimensional CAD models. Construction of the part or assembly is usually done using additive lever manufacturing technology. Rapid prototyping is the speedy creation of a full-scale model

Finger Design: Finger design plays a major role in designing the gripper. It consumes more time to design because of its complex design. Normally to design a finger you need have a good view of the designed part, so that you could perceive the finger properly form different angles. So the solid works software was choose to design the gripper where time consuming for designing the fingers becomes less compared to other designing methods and in solid works, we have the tool to view the designed model in 3D view. In solid works we can even choose the material of the finger and it's easy to model the part compared with other designed software.

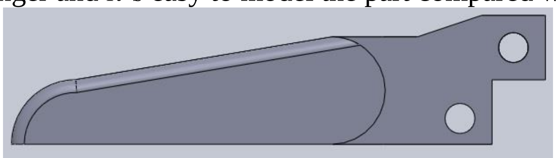

Fig.1. Front finger designed in solid works

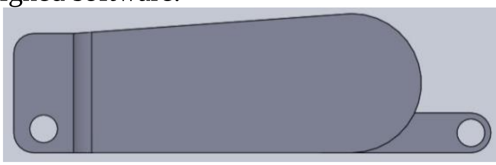

Fig.2. second finger desihned in solid works

Gears: Gears play a main role in motion of the gripper.in order to design gears you need to refer gear calculations. There are lot of parameters that are to be considered while designing gears like load, torque etc. Designing a gear in CAD software is a challenging task, but in solid works you have a separate gear tool box where you can get the desired gear by specifying the values to tithe solid works toolbox generates a gear as per the given values. The values of the small gear have been taken as per the design requirement and as we need to get the change in the fingers with less amount of force applied on the gear, we go with bigger gear where by moving slightly we get the required motion at the fingers.

Gear calculations: T1/dp1 + T2/dp2 (to find the no. of teeth in t2),
Assume T1 = 12, 12/dp1 + T2/dp2, 12/60 + T2/95=19 (T2)
Dp1=60 (Assume), Dp2=95 (Assume), Dp1/Dp2 = rpm1/rpm2, Assume rpm1=10, rpm2=6.25

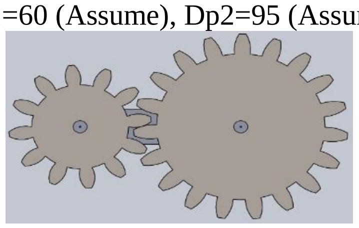

Fig.3. gears

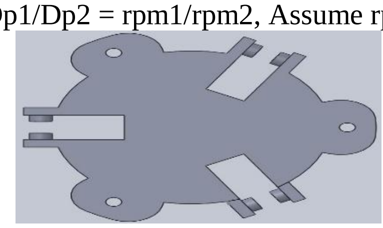

Fig.4. base above

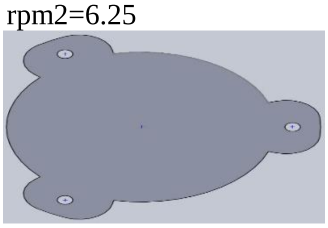

Fig.5. base below

Base: Base has been made as per the robot arm size. The size of the arm of robot is 15cm and hence the base was made to that size. Keeping base in concerned, rest of the parts have been made. We have made two bases, one is placed above and one is placed below.

Rapid Prototype Technology: Rapid prototyping is a group of technology used to quickly fabricate a scale model of physical part or assembly using three dimensional computer aided design data. Construction of the part or assembly is usually done using 3D Printing or additive layer manufacturing technology. Ones the design is ready, it is converted into STL file.

STL Format: STL stands for Stereo Lithograhy.it is a file format native to the stereolithography.STL format is called with various names such as standard triangle language and also as standard tessellation language. This file format is supported by rapid prototype and 3D printing. We submit the design to the rapid prototype machine by converting the solid works format to STL format.

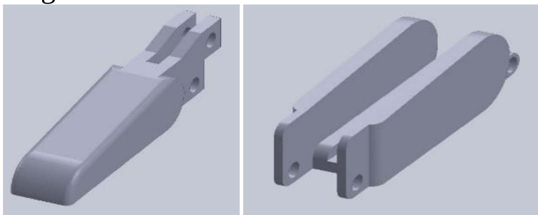

Fig.6. front and back finger

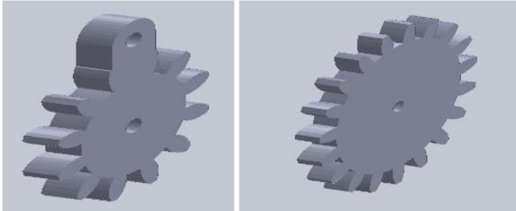

Fig.7. Small and big gear

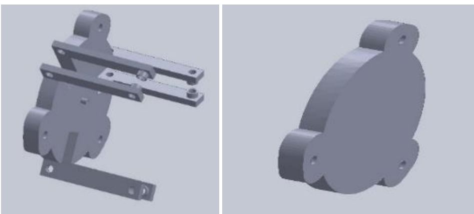

Fig.8. Base above and below

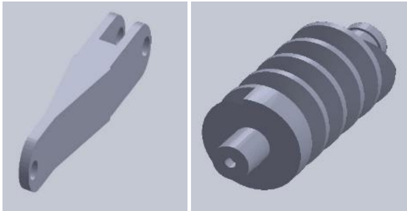

Fig.9. Link and worm gear

Gripper Assembly: The assembly consists of a base, three 2-degrees of freedom under actuated fingers, gear train set to the base. The fingers are attached in a circular way 120 degrees apart from each other. Worm gear is placed between the 3 gears such that it moves all the three fingers. The worm gear is attached to the motor and went the motor rotates it rotates the worm gear and which in turn rotates the spur gears and as the gears rotate they provide motion to the finger. As the finger moves it grips the object.

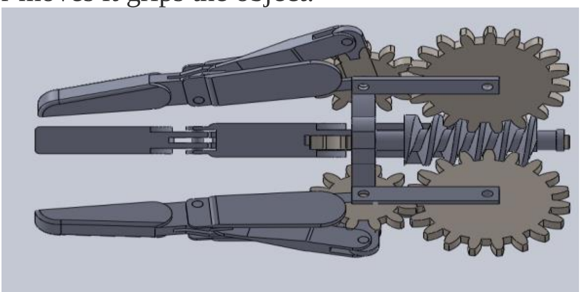

Fig.10. assembly of gripper in CAD software

RPT Parts:

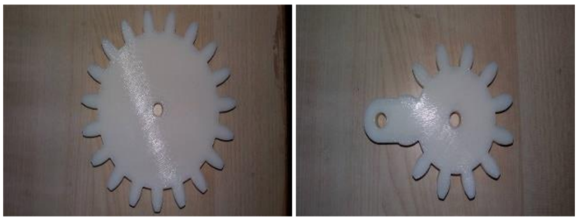

Fig.11. Small and big gear

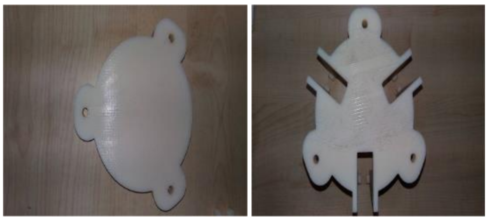

Fig.12. Base above and below

Fig.13. Link

Fig.14. Front finger

Problem Statement:

- Although they have come up with the gripper, but they haven't performed any force analysis and calculations in reading gripper force.
- They have designed the gripper in order to grasp the objects of same weight.

- Commonly gripper are made using metal and cost consuming is high, which is commonly seen but manufacturing a gripper using plastic material within a short period of time and with less cost compared with normal grippers is rare to found.

Design of Three Finger Gripper: The gripper is designed by taking proper dimensions using cad software. We have designed the various parts of gripper separately using cad software. Ones the design has completed, we convert the cad file into STL format. The files are then sent to the RPT lab where the design is processed into hardware. The design in cad software should be with proper dimensions. Ones the design is complete, we assemble the components and further we place tactile sensors on the top of the fingers by which we can get the force applied on each object.

Material used: The material used to manufacture the gripper is a type of plastic material like that of abs plastic. It has the capacity to withstand small weight.

RPT Technology: The RPT machine takes the model which we have designed and provided in STL format. It reads the file and produces the file exactly as hardware by cutting the plastic material as per our design.

Tactile sensors: Pressure based tactile sensors were implanted on the finger face. When it grasps the object, it provides the information on amount of force applied on the object. so that we can have the control on force for various objects. The tactile sensors reading can be taken using Arduino mega board with and UART interface to the labview software, where the data values are read through VISA port with a baud value of 9600. Using Labview software we can extract the force applied on each actuated finger by which we can obtain the live force that is applied on the gripper finger under operation.

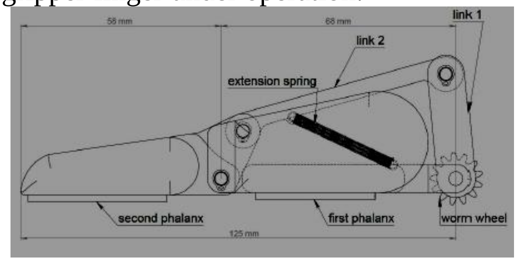

Fig.15. Line diagram of the finger

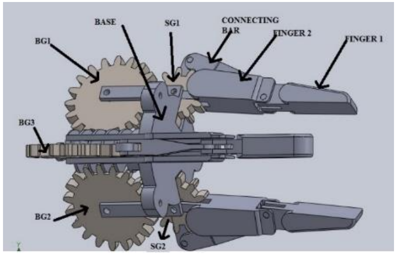

Fig.16. CAD assembly

CAD model of the Gripper:

Components	Number of Components
BG-Big gear	3
SG-Small gear	3
Finger 1	3
Finger 2	3
Base	1

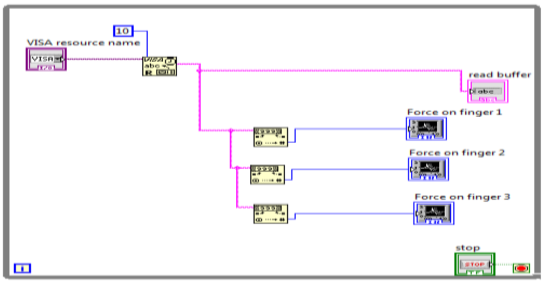

Fig.17. LAB view block diagram for obtaining force measurement

In LABVIEW We create the cell for three fingers individually and connect the arduino to the VISA port. Through read buffer the values from arduino are read to the VISA port and the force applied on each finger can be viewed.

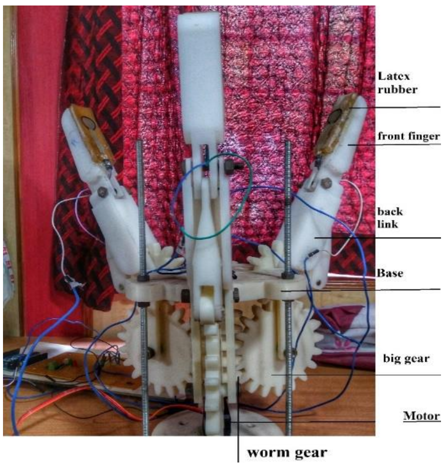

Fig.18. Three finger gripper

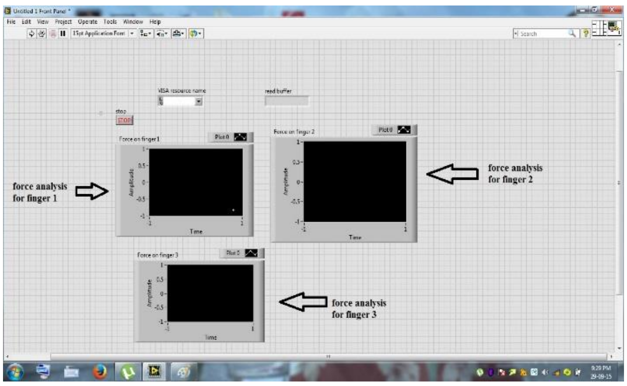

Fig.19. Sensing the force from each finger using LAB view

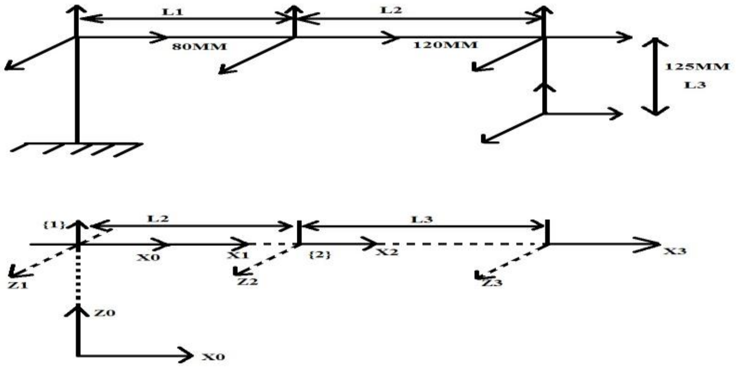

Fig.20. Frame diagram

Fig.21. Assembled gripper with IRB1410

Table.1. Link values

Link	ai	Ai	di	θi
1	0	90	80+	θ1
2	L2	-90	110	θ2
3	L3	0	125	θ3

Table.2. D-H Parameters

D-H Parameters	
Joint Parameters	Link Parameters
Joint distance-di	Link length-ai
Joint angle-θi	Twist angle-αi

2. CONCLUSION

The design of the three finger gripper which enables handling lighter and brittle objects with a gripper force feedback. Rapid prototyping method of manufacturing provides us with greater flexibility in reconfiguring the gripper and avoids the complexities in fabrication of miniature parts like gears and linkages. It can be further concluded that this design can be adopted for handling light weight parts where pressure impact during gripping process plays a vital role.

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