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Design and fabrication of three finger adaptive gripper

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Abstract. The primary aim of implanting the robot is to reduce the human effort. Gripping of objects has been a difficult task for robots. The challenge during gripping would be to assume object and pick it [1]. In this paper, adaptive gripper has the capabilities with this dexterous adaptive electric gripper. Three fingers grippers mean maximum versatility and fixable adaptive control [3]. Its hands as wide variety of part geometrics and size. Its precise control interface allows straight forward control the finger position, speed and force or pressure. These fingers produced by 3D printing and fingers are analyzed to check if the finger is flexible. The force is measured using a force sensing resistor (FSR) [7]. A force sensing resistor is a material whose resistance changes when force is applied. Arduino controller is used for controlling the gripping action. This Control loop feedback mechanism is widely used for precise control [12]. Controlled gripper finger is sensed and gripped with adaptive force which is being analyzed in this paper. Keywords: Adaptive, Fixable, force sensor, feedback.

1.INTRODUCTION

In the earlier research, position control is widely used for pressure control to correct and repeat action. Position is controlled in the workspace because of the control of the gripper. The task for different object to pick in manufacturing industry in deburring, grinding, machining and assembly. The position control in a well orderly robot works repeatedly in identical working area. Gripper was made in less than optimal materials and not mature enough to be used in real type application. The non-metals like plastic or elastic materials are used for making the 3D prints.

In this paper, PLA Plus material is used for 3-D printing of adaptive three fingers gripper. The gripping action is based on the electrical principle that allows the three fingers open and close operation. It was designed to be fully adaptive three fingers gripper which is the best option for maximum versatility and flexibility. It picks up any type of object and shape. In general, the hand with three articulated fingers and four grasping modes can adapt to various size and different objects pick. The robot fingers are introduced to reproduce safe human alternative during the interaction. The force control, trajectory is common pressure measure in FSR sensor.



2. ROBOT FINGER

The three fingers adaptive gripper in general consist modes that can pick different types of objects. The gripper was designed for application in manufacturing and investigation reason. The adaptive robot griper is well designed for flexibility and utility. The exterior force is including inter link FSR sensor on robot finger end. 3D printing is made in PLA Plus material.

2.1 SETUP

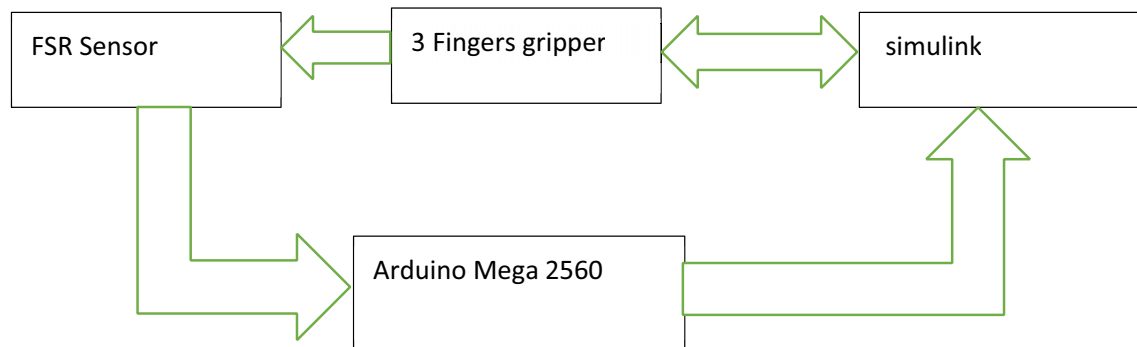


Figure 1. General setup

2.2 FSR SETUP

FSR sensor is to measure the voltage which can be converted to force (N). FSR detects the force while picking the object. Its maximum range of pressure is up to 30N and almost 2.4V. This problem reduces in proper distribution of pressure around the area of touch surface. The object's contact surface should be in proper contact with the gripper surface.

3. METHOD

3.1 METHODOLOGY WORK

In the design of the three fingers adaptive gripper, the three fingers are attached to one link. The first link is fixed, the second and third link is moveable in back and front motions. The primary step in any invention methodology sequence is the problematic identification. The second step is to optimize the gripping forces. The drawbacks of the resolution are checked for errors. They are rectified and adjusted in the design stage again to get an optimal design solution.

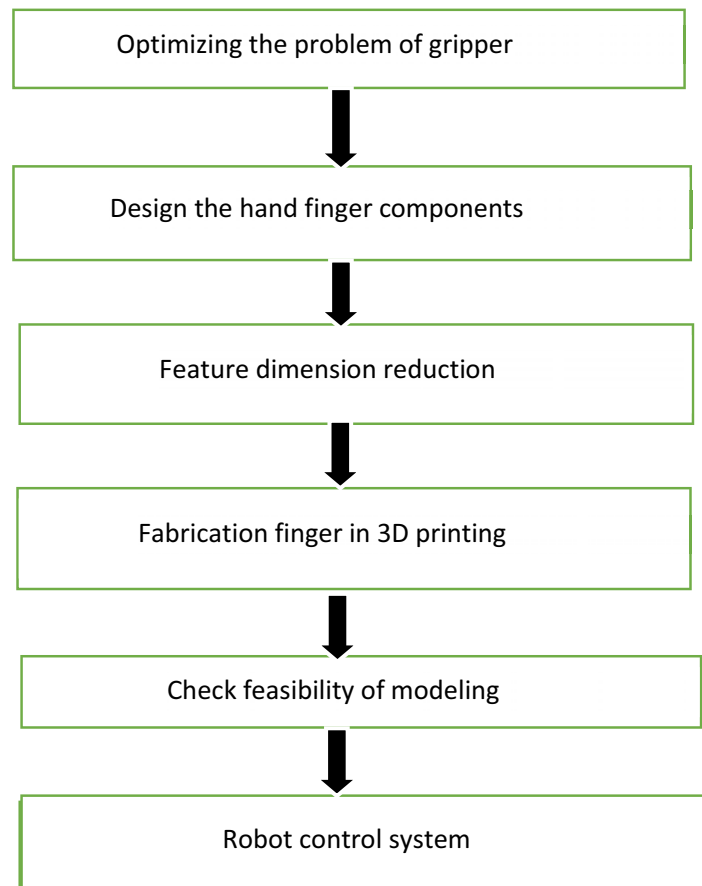


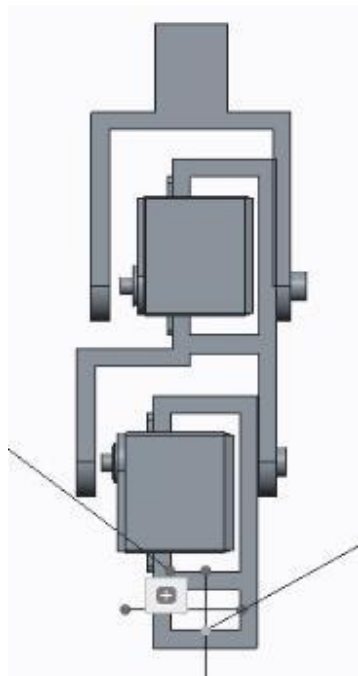
Figure 2. Method process

3.2 EXPERIMENTAL WORK

The methodology is performed on pre-process analysis of full gripping process of servo motor and FSR sensor. Servo motor operating voltage is 4.8 to 7.2, operating speed is 4.8V in .18sec/60 degree. Stall torque is 6V in 11kgcm. The power and input terminals of the servo motor signal is analog signals. Its motor's actuation is modified by angle in degree and analog signal. The controlling parts in FSR sensor and Arduino mega using the controlling system. FSR is the force measuring for the grasping object in gripper. To design a hand finger for gripper robot, various object and gripping techniques must be studied. Information about different things gripping and lifting techniques must be known for decisive which lifting technique will fit the design of the gripper.

4. Design and fabrication of the gripper

The fabrication of the gripper's 3D printing is done using PLA (Poly Lactic Acid) plus material which is 60% less than normal plastic. PLA is less breakable and durable stronger than plastic. The gripper first link is fixed with base and the second link is attached to the first link, hence the second and the third link are movable.



SPECIFICATIONS	DETAILS
Number of links	3
Size of link 1(mm)	35x92x24
Size of link 2(mm)	68x115x24
Size of link 3(mm)	68x100x24

Figure 3. Single Finger Design

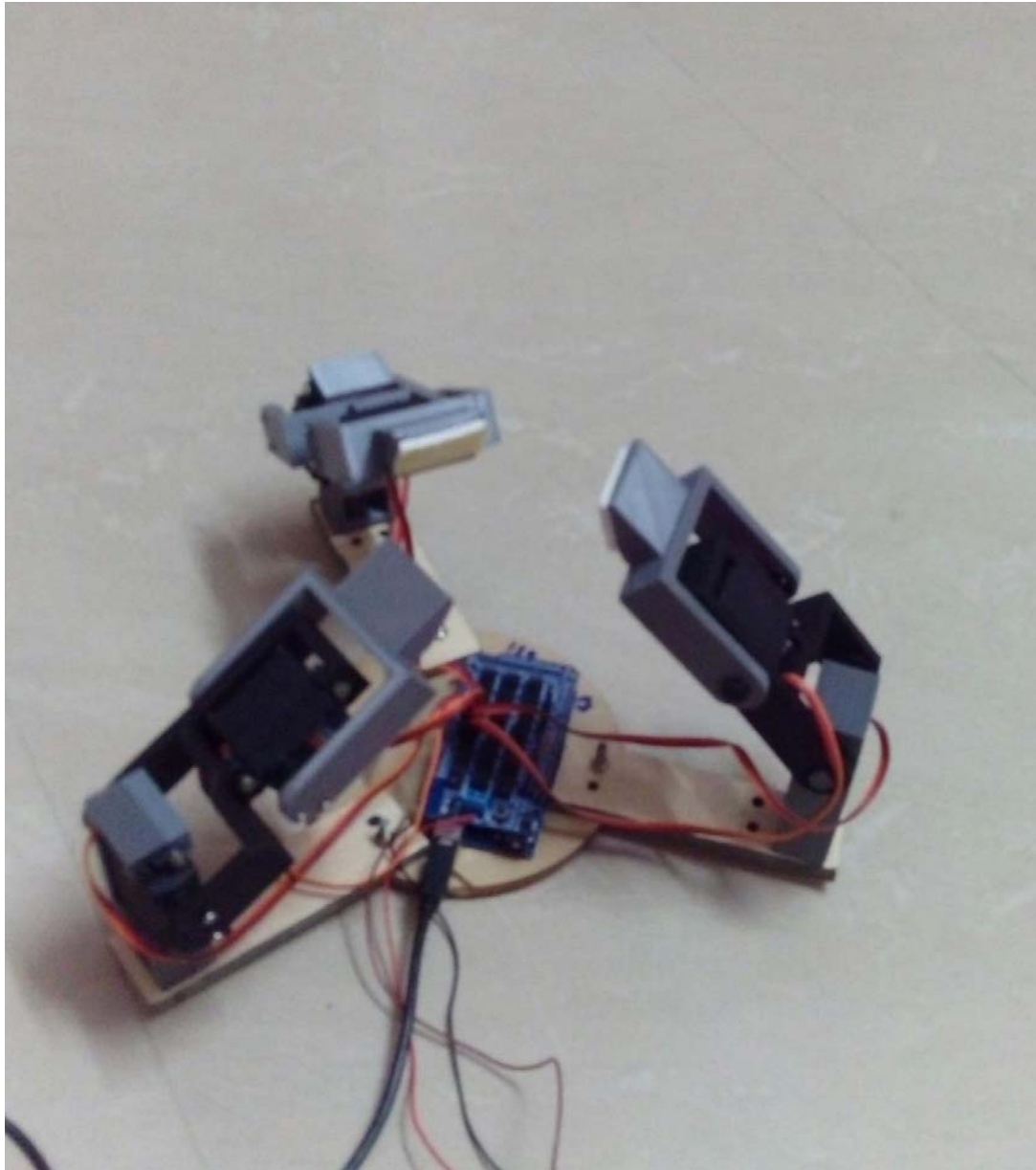


Figure 4. Fabrication of gripper

4.1 MATERIAL SELECTION

Materials not like steel exhibit elastic react for small loads. When the load is furtherance increased the material can undergo plastic deformed. Such materials are called PLA Plus materials. Uses isotropic hardening laws to define these materials hardening laws are rules that describe the relation between the flow stress and the effective strain for a material. The gripper making PLA (Poly Lactic Acid) plus material

which is 60% less than normal plastic. PLA is less breakable and durable stronger than plastic. material 3D printing fabrication.

The plastic hardening law definition of following areas:

- Test Area- creates tests to specify true stress on this material.
- Graph Area- plots the true stress and total strain.

4.2 KINEMATIC MODEL

The DH (Denavit Hartenberg) parameter 3 DOF of robot finger forward kinematics model.

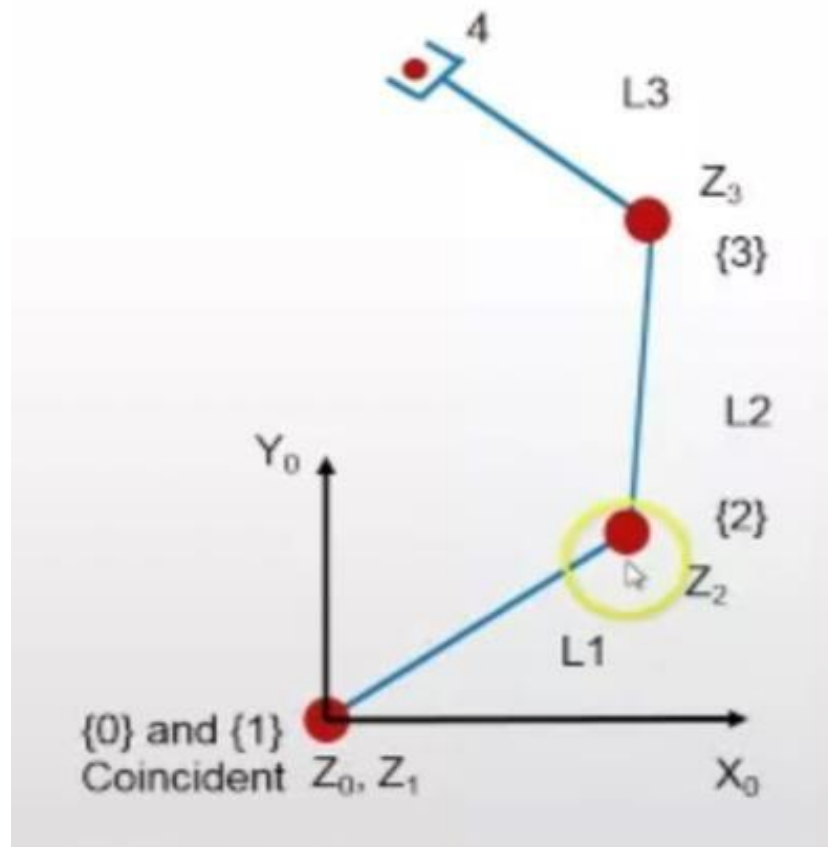


Figure 5. Kinematic Diagram

DH FORMULA

$${}^i{}^{i-1}T = \begin{pmatrix} \cos\theta_i & -\sin\theta_i & 0 & a_i \\ \sin\theta_i \cos\alpha_{i-1} & \cos\theta_i \cos\alpha_{i-1} & -\sin\alpha_{i-1} & -\sin\alpha_{i-1}d_i \\ \sin\theta_i \sin\alpha_{i-1} & \cos\theta_i \sin\alpha_{i-1} & \cos\alpha_{i-1} & \cos\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

DH parameters are,

d = offset along z to joint normal.

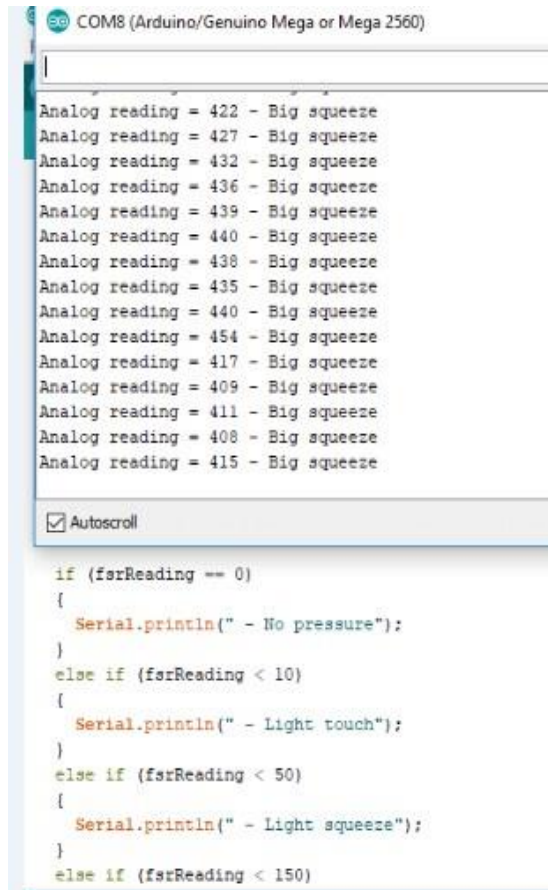
θ = angel about z , old x to new x .

r = length of the joint normal radius about z .

α =angel from old x to new x .

5. EXPERIMENT

The FSR analog readings taken for the using with Arduino mega in10k resister in finding pressure of gripping force. This value is holding object at the time measuring force value in FSR.



```

COM8 (Arduino/Genuino Mega or Mega 2560)

Analog reading = 422 - Big squeeze
Analog reading = 427 - Big squeeze
Analog reading = 432 - Big squeeze
Analog reading = 436 - Big squeeze
Analog reading = 439 - Big squeeze
Analog reading = 440 - Big squeeze
Analog reading = 438 - Big squeeze
Analog reading = 435 - Big squeeze
Analog reading = 440 - Big squeeze
Analog reading = 454 - Big squeeze
Analog reading = 417 - Big squeeze
Analog reading = 409 - Big squeeze
Analog reading = 411 - Big squeeze
Analog reading = 408 - Big squeeze
Analog reading = 415 - Big squeeze

☒ Autoscroll

if (fsrReading == 0)
{
  Serial.println(" - No pressure");
}
else if (fsrReading < 10)
{
  Serial.println(" - Light touch");
}
else if (fsrReading < 50)
{
  Serial.println(" - Light squeeze");
}
else if (fsrReading < 150)

```

Figure 6. FSR Output

6. Conclusion

The Experimental setup has been done in and relative output from FSR setup. That value obtained this for only one object. For their test is done for different object and the for a according to the object.

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