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DESIGN OF THREE FINGER GRIPPER WITH FSR

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Abstract

Technological advancement is widening up by the advent of new inventions. Robots are going to be an integral part of the completely automated industries. There are many instances where profile detection. In this paper, discussed about the three finger gripper has the abilities with this dexterous electric gripper. Three fingers gripper is extreme changeability and fixable gripping control. Its finger has several positions of geometrics and dimensions. Its specific control of crossing point allows orthodox forward motion on the finger location, rapidity and force. These fingers design in CREO 3.0 software and produced by RPT. Fingers are evaluated to check if the finger is flexible motion. The force is measured by a force sensitive resister (FSR). A force sensor is measure a grasping object whose confrontation difference between before and after force is applied. The Arduino mega controller is used for controlling the servo motor and FSR in gripping motion. This servo motor is 180˚rotation angle, Control loop response mechanism is extensively used for accurate control. The Controlled gripper finger is sensed and gripped with force which is being analyzed in the data.

Keywords: Robotic Gripper, Gripper, Three Finger Gripper, Mechatronics , Robotics..

1. INTRODUCTION

The aim and scope of this research is to build a three fingers gripper which is capable of performing to gripping operation to hold various shape of the object. This work demonstrates a gripper with serial manipulator assembly delivering a suitable level of output. Designing handling mechanism based on gripper with the solution of respective problems,which are related to absolute semi flexible of handle things. The position control in well orderly robot works repeatedly in identical working area. Gripper has made by less optimal materials and not matures enough to be used in real type application. The gripper make in 3D printing in RPT machine. Select the plastic material using 3-D printing three fingers gripper. It was action by electrical and air pressure principle that still allowed the three fingers open and close operation. It was designed to be three fingers gripper with FSR. The three fingers gripper is best option for maximum versatility and flexibility. It picks up any type of object and shape. In general, the hand three articulated fingers and grasping modes can adapt to various size and different grasped objects. Basically, there are some criteria by which the 3 fingers gripper with sensor is selected they are,

- Environmental condition
- Range

  This gripper grasp object in force limit of the sensor.
- Cost

  It should be affordable and not very high
- Slippage

1.1 Robotic Gripper

This gripper avoided slip on gripping in this earlier research paper, they created the three fingers gripper in two links gear actuation grippers, the actuation control link control in one link to another link. The gripper is pick the different shape of object or things in auto mobile parts and assembly industries. The 3 finger is avoided for slip objects in manufacturing industries. The gripper is gear and pinion, stepper motor, hydraulic or pneumatic and magnetic actuation are there. The task of gripper is grasp various shape of object in more operations. The position control of object in widely using mode is grip the big and various object on finger.

Figure: 1 Three finger gripper

In this paper design the three fingers gripper in three links on one finger gripper. In make real time model of finger design in CREO design software. The one finger has a three links first link fix with base of the gripper. The second link connect with first link, third link connect in second link, the force control of gripper is FSR is fixed in tip of finger in third link inside of the finger

The finger material is nonmetal material is like a plastic material, the finger making in 3D printing. The PLA plus material is make the finger gripper. In position control of gripper is fully electrical operation, the power source in external battery supply. The gripper is not only open and close operation is especially wide grip in big and variety of object gripping. In this gripper base mode is more multipurpose operation is suitable for objects that one dimension in long gripping. The control system is Arduino mega is comfortably control the servo motor and FSR. The finger acting on electrical motion in servo open and close grip object shape of gripping the finger. The grip value taken in FSR readings convert resistance value to force. Angle of rotation in servo motor to grip object in finger in maximum rotation is 180˚.

2. LITERATURE SURVEY

The research paper study was done in which papers related to the experiments done using finger gripper were taken. various gripping end effectors which optimal of grasp force, to ameliorate pick and place operation and attain learning and implement this study on the handle robot. Some papers related to the methods of gripping the objects and also on the general control system structure implemented on it.

Amirul Syafid,[1] studied the ensure of a robot hand position ensure that a robot hand position control and force control by use PID controller for three fingers adaptive robot gripper. The position of fingers can be sufficient controller via PID control approach. The low cost FSR sensor is competent to achieve bending control achieve compliant control of FSR sensor. Moreover, the robot hand basic grip, wide grip and scissor grip is suitable for cylindrical and spherical object. The hand pinch mode is fit for grip small object and scissor mode is use for tiny things. FSR sensor are adhered together by use double side tape then sensor placed on each robot finger tips.

Spencer B. Backus, [2] Studied the complicacy of exiting robot hand fingers greatly, ranging from simple single degree of freedom(DOF). The single joint fingers link to the prismatic actuate fingers control single actuator. The fingers pads are already tangent to things and hand behavior is very alike to concentric gripper. The adaptively of revolute joint fingers securely grip things use situation passive rotation of finger. Two or three fingers contact object, this adaptive behavior maximizes of contact area is irregular object there increase the anticipate strength of grip. The grasp strength as measure on benchmark, wrap grip of hand with high complex single joint finger.

J.A. Dominguez, R.M. crower [3], This paper discussed the robot gripper normally need to grip and manipulate loads to control the gripper. The adaptive gripper implemented in real time application, particularly when dynamic adaptive to random exterior disturb in important obligatory. The analytic approach cannot be use variables load weight and finger acceleration are unknow. The fuzzy logic controllers as be developed in gripping variables as input. Hybrid neuro fuzzy controller accommodate rapid adaptive to environment changes, the control use learning part of hybrid algorithm is based on GARIC architecture. Hybrid system is supervised learning network(SLN) basis GARIC with Hierarchical control divides a problem several sub Problem parsimonious neuro fuzzy structure for gripper control.

Marc Manz, Sebastian [4], This paper reported that Self Adaptive gripper finger mechanism is designed in sequence to grip object with equally distance and nonequally distance grasp surface. The suitable force distribution on gripping surface to providing a maximum holding torque control the Self adaptive gripper system human at inspired grip force control. The dynamic forces increase to movement of human or collision with environment the gripping force dynamically increased. The simple control structure with cascaded controller and servo control to the influence inner control loop. The analyze the switching position control to force control and vice versa.

Jagannathan [5], this paper reported that grasping object is challenge task for robots. Object contact control subtask is maintaining a applied pressure to fingers on object. The adaptive critic hybrid force or position control is introduced. The feedforward action general NN is formed adaptive neural network control components the nonlinear grip and dynamic force. Define a trajectory for arm to position around the piece apply suitable force on object for manipulating. Human finger manipulated object by using suffice force even when weight and friction of thing contact are unknown. The adaptive critic neural network gauges the system execution tunes action-creating neural network. The input signal to the arrangement creature measured in provide the closed loop stable analysis with performs assure.

Je-Sung Koh, Kyu-Jin Cho[6], this paper analyzed the under actuate adaptive gripper using flexural buckling to achieve safe and suitable grip, under actuate such as differential and compliant mechanism. We propose a simple construction and climb under actuated mechanism is demonstration on gripper. This paper biologically is modest and climbable for mesoscale application. Design principles are assumed from problem in front distance of caterpillars accomplish robust grip on most natural surface. The gripper with wide flexure is high like to achieve adaptive gripping perform in various surface. Surface roughness depends on tip radius of backbone and appropriate contact angle. The symmetric blocks, the grip force in long bending maintained in initial force vindictiveness of increase the wave. The short flexure is grip force ratio rapidly decreased of initial grip force was maintained.

Tabassum, D. D. Ray [7], this paper discus on gripper user inter face is develop the robot gripper interact with hand glove. The robot gripper control complete (GUI) in the speediness of force, partial open/close mode. Gripper connect to docks needs to initialized buttons click performs three fingers movements and check any fault or errors. The gripper basic mode open position as home position increment/ decrement scroll bar control speed and force. To compel the speed and force frame also having partial opening or closing of three fingers gripper manipulated in such fingers provide capable of doing any things competently operation. The gesticulation performs in opening and closing process is simple and conservative onward. The robotics three fingers unlocking and locking action force sensor value measure maximum grip objects size. It control is connect to PC via Modbus on RTU communication, controller has inside recall can be access through high level C commands. The input is done use PID algorithm conditional on wave program.

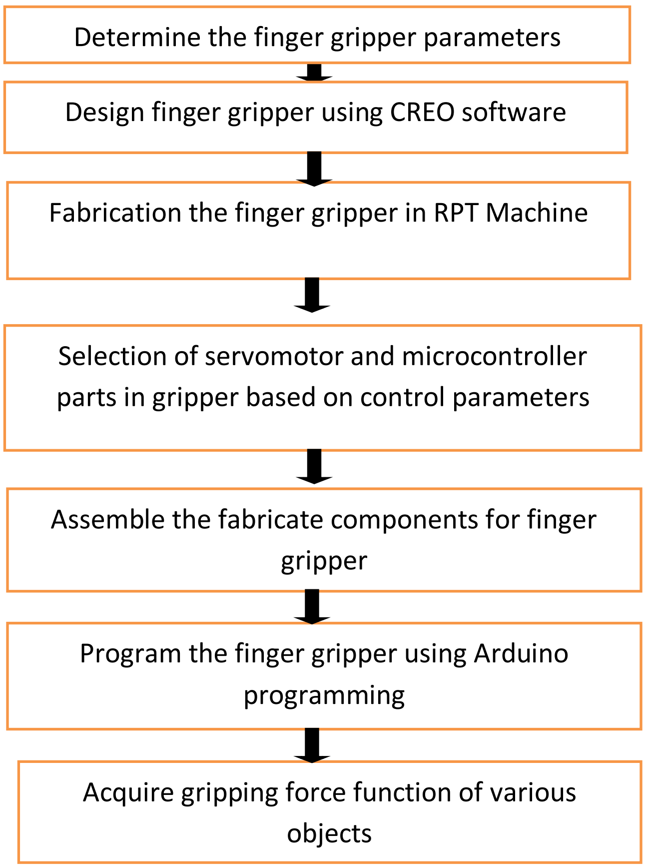
Yedige and Almas [8], this paper inferred about 3D printing been broadly distinguish as valued effectual technology for low price product of routine study and educational apparatus. The many three - dimensional things design from computer aided design (CAD) models in comparatively slight time in low price and energies. 3D-print models, research and educators can easier equipment maintain and repair, higher relevance and flexible of adaptation. The grasp 3D printing rapid prototype technology produce low cost gripper providing open source CAD model of end effector. The actuator for robot gripper model rejects for composite electronic circuit, encoder implement motor position control. Control of servo motor directly perform MATLAB or C/C++ programming environments as using ROS. The 3D print gripper model sure adaptive passive gripping and wrapping of gripping things.

Kai and Huan [9], Differential mechanism in continue difference mechanism and kinematics mechanism and introduce two CDMs. The planar and 3-D CDMs were kinematics analysis on elaborated upon differential mechanism made a pulleys and linkages to effectiveness using model structure. Three types mechanism is the pulley-based, link base designs and the gear-based designs. The compare two mechanism planer CDMs to two extensively use KDMs a winch base mechanism and alternate connection based one. Planer CDMs internally adds two “virtual or de facto” helixes upon the productions imitated by two terms in energy rise. The current strictures are considered to be establish the equivalent among planar CDM and crank/oscillate various mechanism. The power spread possessions are great reputation for any differential mechanism is properties of planar and spatial CDMs.

Zhang and Qing song [10 Presented micro gripping driven by piezo electric actuators have been large distance applied in different field demand for great accuracy. The online approximation of restrictions for ideal plant, place estimate with Kalman filter, the adaptive slipping mode control system. The concern micro gripper is structure by a flexure mechanism driven a piezoelectric stack actuator (PSA). The hysteresis as disturbance or an ambiguous, slipping mode control (SMC) provides an expedient and precise way of motion controller to oppose the model ambiguous and trouble for nonlinear system position control of piezo electrically. Kalman filter can be effectively used for constraints in dynamic forces modal measure precisely adaptive filter and long Kalman filter.

Chen and Wang [11], reported that soft robot gripper plan is accessible with three fingers and one passive adaptive tribute. Each soft gripper contains of two ellipse-profiled pneumatic slots, joint with adaptive gripper surface floral feature, the soft gripper Might complete gripping force in training. The assembly process in 3D printing and decoration of silicon rubber. The invented actuators and gripper are confirmed on clutch things of various mold and sizes, even activities of daily living(ADL). The two compartments are pressured with the similar input pressure, the deformation of the projected finger willpower be common to only-compartment actuator in through same dimensions. The two segments are triggered self-sufficiently; resultant in the θ1 and θ2 dissimilar angles, the actuator might reach bigger area than the primary mode, permitting the active limb to imitate to complex-molded substances.

3. METHODOLOGY



4. DESIGN, MODELLING AND ASSEMBLY

The exhibiting of work initialized planning first identify the model which is capable and possible for finger gripper, so decided to do finger gripper with two degrees of freedom (DOF).

4.1 Design of Robot Finger

The parts of gripper are link-1, link-2 and link-3, FSR, Arduino mega board and servomotors. The link-1, link-2 and link-3 are made with free motions where the holding objects it rotate 180 degrees actuation.

4.2 Design of Links

The material used for the manufacturing of finger links is ABS plastic P430. These material as be selected due it low weight propensity. The length of link-1 is 92mm and length of link-2 115mm and third link is 100mm of length which is maintained for equally links.

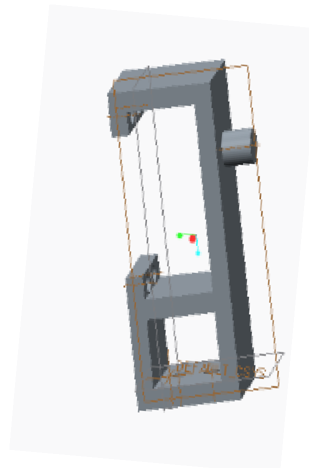


Figure: 3 Link 1

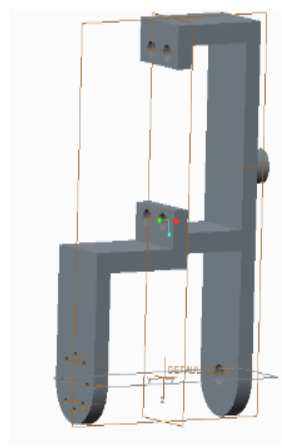


Figure: 4 Link 2

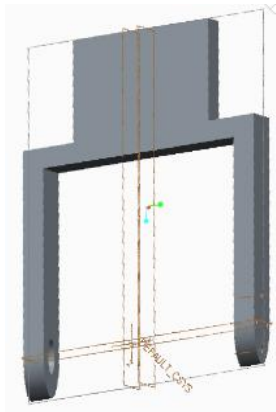


Figure: 5 Link 3

4.3 Components Assembly

Based on the literatures referred, the model of components is assembled in the link order show below in figure 4.4. Initially with a assembling link.-1 to link-2 being assemble and link-3. The first link has one servo motor and second link have one servomotor totally one finger has two servomotors. The second link fixed with first link, third link fixed with second link of assembly of finger. The FSR attach with third link and servo connects with Arduino mega and control with laptop.

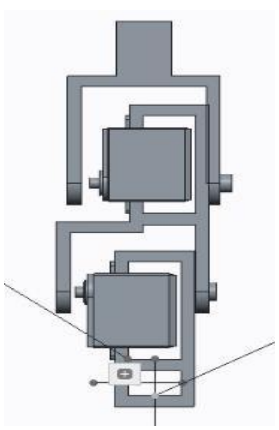


Figure: 6 (Source from reference) Single fingers to assembly

SPECIFICATIONS	DETAILS
Number of links	3
Size of link 1(mm)	35x92x24
Size of link 2(mm)	68x115x24
Size of link 3(mm)	68x100x24
Actuators	servomotor, Arduino mega
Sensors	FSR

Figure: 7 (Source from reference) Dimensions of finger

5. KINEMATIC ANALYSIS AND TORQUE CALCULATION

5.1 Kinematic Frame Diagram

The joints and links define the angle of the gripper actuation. For instance, if a person sits on a chair and tries to grab a tea cup we modify the angles of our finger in order to hold the cup firmly.

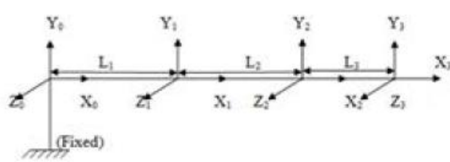


Figure: 8 Finger Frame diagram of one finger

DH (Denavit Hartenberg) formula,

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

The Applying values of each link of finger in DH table,θ

$P_x=[L_1 \cos \theta_1 + L_2\cos(\theta_1+\theta_2)+L_3\cos(\theta_1+\theta_2+\theta_3)]$

$P_y=[L_1 \sin \theta_1 +L_2\sin(\theta_1+\theta_2)+L_3\sin(\theta_1+\theta_2+\theta_3)]$

The D-H parameters values of finger

S.No	**a_i**	**d_i**	**α_i**	**θ_{i°**
1	L_1	0	0	θ_{1°
2	L_2	0	0	θ_{2°
3	L_3	0	0	θ_{3°=(θ_3+90)

Table: 1 DH finger parameter

Where, a=link length

d=link offset

α=link twist

θ =joint angle

i=links

5.2 Force and Torque Calculation

Calculation for gripper

Force required = (Load (in Newton) * Acceleration due to gravity)/μ

= (2 N * 9.81)/1

= 19.62 N

Safety of factor = Actual input gripping force/ Required output gripping force ≈ 1.4 Torque required

= Force * Distance

= 19.62 N * 62 mm

= 1.216 kg-m

Torque system (T_s) = system torque* FOS

= 1.216 * 1.4

= 1.69 kg-m

The upstairs the calculation of force and torque for respectively of finger in the system computed on standard formulas. The input values are measured or is predefined value. By calculated values of motor selection for gripper was made.

6. EXPERIMENTAL RESULT

To control the gripping motion of the gripper, it necessitates the concrete manufacture of direction and energetic parameters (e.g., position, velocity and acceleration). In the machine-driven part of view, a robotic finger duplicating a human finger is kinematic severance.

The experimental value of finger gripper is done by Lab View, and various objects of gripper holding in manual are show in figure 9 respectively.

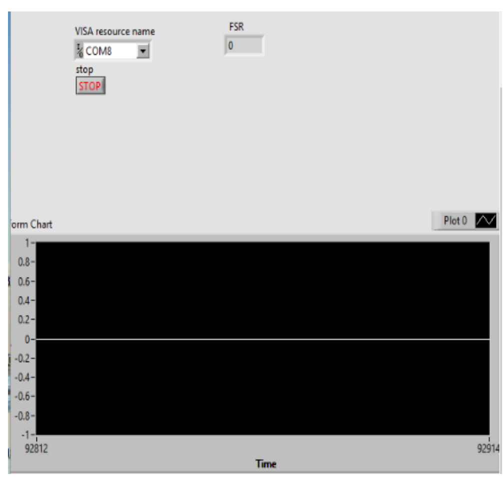


Figure: 9 under no load condition

The gripper actuated to grip as a object in this FSR reading will be to change the value zero to maximum value of the object holding pressure reading. The compressible of the object value its variable value it's come. The compressible pressure reading values to taken from show in figure 10.

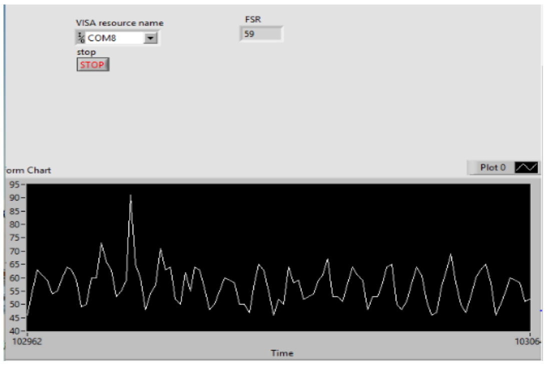


Figure: 10 compressible object value

The non-compressible object gripping value is variable in FSR reading and randomly increases in its value depending on time variable of how much time it will take to gripping parameter. The finding FSR value is depending on plot value of FSR is increasing the gripping value of the object is increasing the graph value. This value is finding on Lab View software using to find FSR value in graph will be getting easy to find a variable of things on its time depending variables of gripping objects. Each gripper links move by motor, we can easily control the movement of gripper and decrease the severance faced by a robot. The value of gripper to hold the object its takes time to measure the holding which is shown in figure 11.

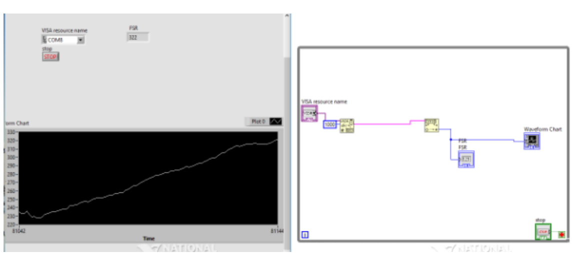


Figure: 11 gripping object value

This force value is respective to time depending upon to several values are indicating of FSR readings in the waveform. Gripper holding the object at the time to touch the FSR measure a reading, when the object to hold in how much amount of pressure will produced to grip holding a object in waveform to take a values in Lab View software.

Object	Force FSR value (N/mm)	Time (ms)
Unload	0	102
Compressible ball	89	93
Box (high load)	322	86

Table: 2 Experimental results

8. CONCLUSION

A gripper is a grip to hold the object to ability is the use of robot, and it also increases human-robot interaction. Although there is several such robotic exploiters which can grip afford to it, gripping the various shapes of the three objects. Finding the pressure value of gripper in a holding objects to holding time and amount of pressure generate. This enable to the gripper to gripping from the various objects to grip with less difficult and to also deliver satisfactory. The adjustment is a time uncontrollable task; same tuning does not work if the angle will be change for holding big shape of the objects. It's quite problematic to hold any different shape of objects.

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