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PHARMA USABLE ROBOTIC GRIPPER DESIGN AND FABRICATION BY LOCAL MATERIALS

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ABSTRACT
In the experimental work, grasping and manipulation of deformable objects by a three fingers robotic gripper has been carried out. The required fingertip grasping forces and velocities vary with change in object size due to deformation has also made. The variation of the internal force with the change in fingertips and object contact angle has been investigated in details. From the results it is concluded that it is very difficult to manipulate an object if the finger contacts angle is not between 30^o and 70^o, as the internal forces or velocities become very high outside this range. Hence, even if the object is inside the work volume of the three fingers it would still not possible to manipulate it. A simple control model is proposed which can control the grasping and manipulation of a deformable object. Experimental results are also presented to prove the proposed method.

Keywords: Motor Shaft; Cuff; Threading Mechanism; Three Fingers; Pulse Controller.

1. INTRODUCTION
Grippers can be the most intensive design components of an assembly system. Although grippers are widely used for automated manufacturing [1], assembly and packing, the design of grippers are often ad-hoc and suboptimal. In industry, 4 DOF robots, such as SCARA arms, and 1 DOF parallel jaw grippers are common due to their low cost and high reliability[2-4]. Not all gripper types can be used in every process. In the food and pharmaceutical industries for example, hydraulic activated grippers are forbidden since there is a risk of oil spilling and contamination. In many clean room industries vacuum and pneumatic grippers are also not recommended since they can create flow of particles in the air. Grippers used in less clean environments like foundries, machining and welding are exposed to dirt and particles so they must be protected. Corrosive or toxic environments in nuclear or chemical industries also create special considerations for protecting the gripper to ensure its stability and safety of use. In most applications the gripper must be failsafe**.** Dropping a banana on the floor has no serious effect but spilling chemicals or radioactive materials can be catastrophic and/or toxic in some cases [5-6].

The combination of these two devices is cinematically limited to orienting parts in the horizontal plane. Zhang and Goldberg gave an algorithm to design jaws based on trapezoidal modules that will align parts in the vertical plane and grasp them in form closure. The algorithm finds jaws that achieve maximal contact at the final grasp configuration to maximize resistance to applied forces [7]. For many industrial applications, it may be preferable to use jaws with smaller contact area, for example to minimize gripper weight for high-velocity transfer. Precisely compel with the specified maximal contact geometry. In this project, variations in jaw shape and define a tolerance class for jaws based on maximal and minimal contact areas [8-10]. The goal of the project is to design a prosthetic hand for users with transradial arm amputation. The design criteria are cost effectiveness, which means a limit of money for this project, fast and viable fabrication such that can be accomplished within resources available at Rutgers and easy maintenance [11-14]. This project does not focus on creating the most sophisticated system, but the one that is robust enough to perform routine tasks that disabled people would have trouble completing. The prosthetic hand should be able to manipulate objects ranging from the size of a golf ball to a water bottle while having enough dexterity to move each finger independently [15-18]. The arm will have 3 fingers that are connected to the cuff, which in turn will be connected to the arm of the patient. The design has to warranty an easy replacement of the finger if it is damaged or worn out. There are two parts in this project (a) Construction of Robotic gripper, (b) Controlled of the Robotic gripper.

2. EXPERIMENTAL SETUP

The robotic gripper consists of five main parts.

1. Three fingers
2. Three connecting rods
3. Motor
4. Motor shaft
5. Cuff

The whole set up is housed in the cuff which provides structural support as well as protection for the components.

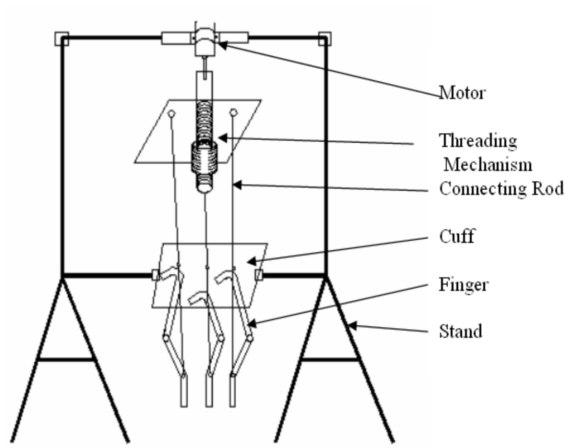


Fig 1. The schematic diagram of the setup.

The main parts of the robotic gripper has been discussed below-

2.1 Motion Transferring Element

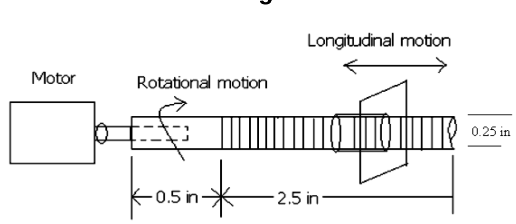


Fig 2. Power shaft of the gripper.

The motor is the main component to supply mechanical power of the gripper. The motor gives rotational motion and this element converted this rotating motion to longitudinal motion which supply force to the finger to grasp or release the object.

2.2 Connecting Rod

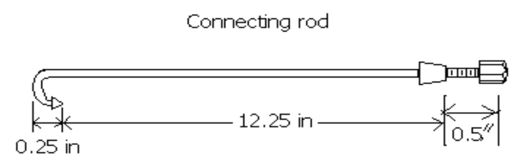


Fig 3. Connecting rod.

The connecting rod is one of the most important parts of the robotic gripper .It's design is very simple but it is most difficult to manufacture. There are three connecting rods which is used in this project is 13 inch long and made from 1/8 square rod. This section in which one end is connected to the cuff and the other end is connected with finger.

2.3 Finger Design

Three fingers are used which grasps the objects. Finger design is an essential piece of the project. Three fingers can grasp an object such as a bottle of medicine or tennis ball. The gripping force provided by the fingers should be enough to hold the object steadily while it is being transported. Another possible application of the finger would be to hold a circular door knob and be able to provide enough grips as to turn the knob without slipping. The fingers also have to possess some flexibility at certain points. When the shaft pulls on the finger, the finger rotates exhibiting gripping motion instead of breaking. Therefore the main criteria for the fingers are to be tough, relatively strong, durable and flexible. The finger itself consists of several parts shown in the figure bellow:

Material: Sheet metal (MS)

Length: Each finger is made by two parts;

1. One part's length is 3 inch
2. Other parts length is 2 inch and 3 inch

Finger is constructed from two types of part. One part provides structural rigidity to the finger and allows it to be housed in the cuff as well as to grip the object. It is also strong enough as to withstand the forces that the connecting rod applies forces since the force is significant. Other part making that is able to withstand the stress; however would become a problem. Therefore, making part-1 which ensures the finger can withstand a larger force. Although the shaft will still exert a large force, once the assembly is completed, additional testing will be done to determine if part-1 needs to be reinforced to make sure it functions in a reliable manner. It is particularly important for part 1 to be as hard as possible, since that is the part that will be in contact with the cuff. Inside 1 there is a square opening that connecting rod passes through. As of right now, there is no particular design for the lining of the opening in part-1. According to the results of testing that will take place once the mechanism is assembled. With a screw that is more resistant to friction than other that of use. The two parts of finger and the full finger are shown bellow with their dimension.

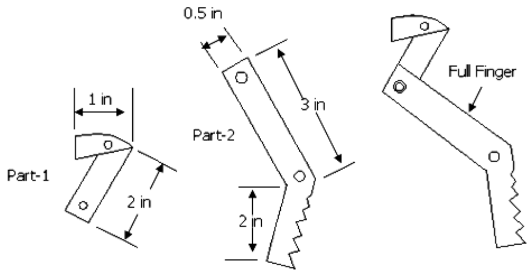


Fig 4. Finger of the robotic gripper.

The second part is used to provide enough flexibility for the finger to bend without putting too much stress on the structure. Parts 1 and 2 will act like joints for the mechanism. Part 2 is used to provide flexibility and certain degree of compliance for the gripping surface. Without 2 the finger would not be able to grip an object such as a bottle since it would just slip out of the grasp. Interconnection between the parts is an essential part of the fabrication. It is discussed in detail in later on manufacturing and assembly.

2.4 Threading Mechanism

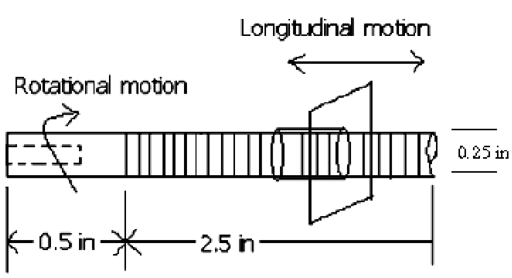


Fig 5. Threading mechanism.

Threading mechanism is the most important part of this project. The threading area is 2.5 inch external thread and 1 inch internal thread. By this threading mechanism rotational motion of motor is transferred into longitudinal motion. When the thread is moved upward, it forces the fingers to grasp the object. When the thread is moved downward, it forces the fingers to release the object.

3. WORKING PROCEDURE

The robotic gripper consists of four main parts: three fingers that grasp the object, one steeper motor that provide rotational motion, three connecting shaft that convert rotational motion of the motors into linear motion of the fingers. The whole setup is housed in the cuff which provides structural support as well as protection for the components. When the motor rotates, it creates a rotational motion which is converted into a longitudinal motion of the shaft by a threading mechanism. Fingers contact if the shaft moves inward into the cuff which results into gripping motion. On the other hand when the shaft moves out of the cuff finger is forced to expand. The gripper is manipulated by controlling the direction and the rotational speed of the motor. It enables us to preprogram the module to run preset routines.

Fig 6. Robotic gripper gripping a Ball.

Fig 7. Robotic gripper gripping a Bottle.

This robotic compliant gripper that is able to pick up an object the size of a bottle or a tennis ball. We managed the task and performed testing to verify that the design goal is realized. The tests were very basic in nature and consisted of the hand gripping a bottle and a tennis ball. Assembly line reliability can be increased if grippers are carefully designed to capture and align parts. Gripper design depends on the mechanical properties of the part as well as its desired orientation. An optimal gripper design is an arrangement of trapezoidal gripper modules that maximizes contacts between the gripper and the part at its desired final orientation over the constraints that the grippers will capture and rotate the part to its desired orientation and achieve grasping. This resulting design is varied by physical experiments.

4. CONTROLLING OF THE ROBOTIC GRIPPER

For this project, expectation is to have a stand-alone demonstration of the finger movements. If this design were to be implemented in the real world a much more involved myo-electric control system would need to be implemented. Therefore it is decided to use a simple programmable microcontroller. There were two types of microcontroller used in the controlled system is PIC16F877P and microcontroller PIC16F690-I/P DIP. These microcontroller automatically generated PWM (Pulse Width Modulation) signal which is used to control the direction of the motor i.e. opening and closing the fingers. Another element which should be considered is the impedance control aspect. That means if a conditional parameter is exceeded motors will stop to prevent damage to the fingers. The controlling circuit has shown below figure 8.

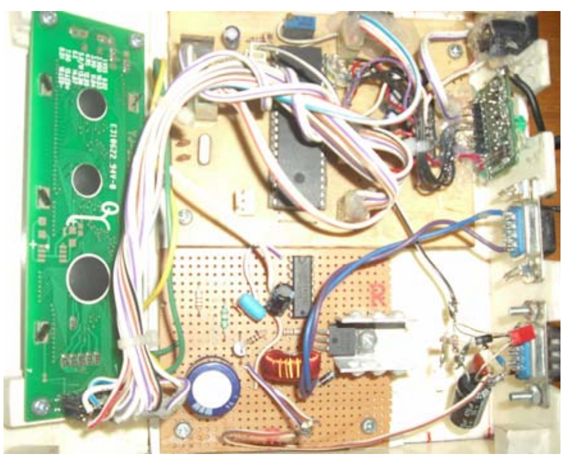
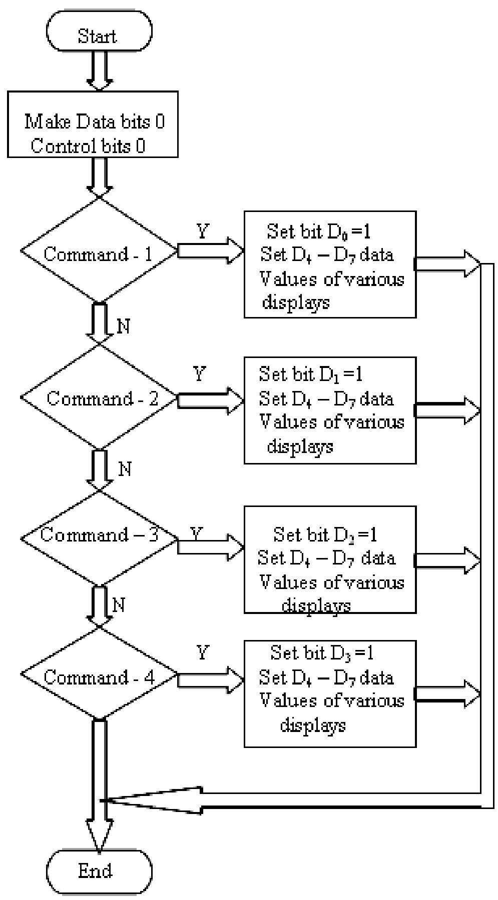


Fig 8. Controlling circuit for robotic gripper.

Normally two types of transistors are used in this circuit. One transistor is C828 and another is BC547 and another two types of IC, LM7805 and IC, (4050N, 2Q2222A) used in the controlling circuit. In this design, each output of the chip forms a complete vertical side of the letter 'H', with the motor still being in the middle. Because a side is now a single output, short-circuits can't form from the top of a side to the bottom of a side. No matter what the inputs, all power must travel from one side to the other through the motor. A mechanical switch, relay or logical gate could be used to turn the inputs on and off. It would work just fine at providing no movement (on/on or off/off), forward movement (on/off), or reverse movement (off/on). To provide power levels in between (like 50%), rapid pulses of on or off can be provided by pulse-width modulation using a chip or timer. An important note regarding current rating: The plastic DIP package can only dissipate enough heat when the power usage is below 730 mill watts. Therefore, it isn't possible to continuously run the chip at both the maximum voltage (12V) and maximum amperage (1200mA) rating. That would result in 14.4watts of power usage.

5. PROGRAM ALGORITHM

This part is heart of the project as it combines the whole thing. As stated earlier the interfacing the interfacing is done through the parallel port. The software needed for the interfacing written in Visual basic programming language. A suitable program has been created for the controlling of the motor in Visual basic language.



6. DISCUSSION

It is very difficult to characterize the grasping proprieties of the grippers with uncountable shape uncertainty. Therefore, intend to quickly check the orient ability of grippers during interactive design cycle. Algorithms with low complexity, such as those described in this paper can provide rapid feedback to designers. A rigorous parametric tolerance has class to address the shape uncertainty of the grippers. The tolerance of the jaws in terms of toppling graph parts has motion trajectory and form closure. The fast checking algorithm use it to compute the tolerance class. The algorithms and illustrate are used with physical examples.

7. CONCLUSIONS

The robotic gripper is used for getting continuous work without fatigue. This robotic gripper is mainly designed for pharmaceutical industries where different shapes of bottles are filling by chemicals or life saving drags without contact of human beings hands for germ protection. This type of robotic gripper can hold the bottles, carry the bottles from one place to another, leveling and packaging also carried out. So it can modify and use to help for human beings. In the future, the study of sensitivity to change in friction coefficient and consider alternative materials for gripper jaws. The sensitivity in jaw shape normal to the contacting surfaces, which may justify use of deformable materials such as rubber for the contacting surfaces. The idea is to design gripper that is also robust to variations in part shape.

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