MECHNICAL GRIPPER DESIGN FOR HANDLING SOFT OBJECTS WITHOUT USING ELECTRONIC SENSORS

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ABSTRACT
Robotic arms are widely used in manufacturing, in military applications and emergency rescue missions to increase efficiency, accuracy and gain ability to manage large weights, reach hostile environments etc. Robotic arms designed to lift sensitive objects require particular attention to develop a sensitive gripper that is capable of handling an object without damaging it. The work presented in this paper focuses on designing robotic hand for a gripping and placing mechanism to lift sensitive objects primarily through the mechanical design, and without using electronic sensors for simplicity and ease of troubleshooting. The proposed design contains a cylindrical robot with mechanical gripping structure developed using Zinc-Aluminum with pick and place capability. The ability to handle irregularly shaped objects is a particular advantage of the proposed design.

Keywords: Robot arm, Grip, Mechanical hand, Soft object, Pick and Place

1. INTRODUCTION

A robot is an Electromachanical device that carries some level of artificial intelligence, and is capable of handling pre-programmed tasks. Some example applications of robotics are spot welding, painting, picking and placing, and water jet cutting, dispensing, handling parts. Using robotics in a manufacturing environment increases the efficiency and reliability of production while enhancing the capacity work over long periods of time. Most of the automobile industries use robots for their production.

Robotic arms are widely used in manufacturing, in military applications and emergency rescue missions to increase efficiency, accuracy and gain ability to manage large weights, reach hostile environments etc. These replicate the manual movements and manual object handling with higher lifting, capability and ability to repeat movements. The key objective of this research is to design and develop a robotic arm with a gripper capable of handling soft objects without damaging the object. Some techniques that can be used for this purpose are vacuum grippers, Adhesive gripper mechanisms or magnetic devices. The disadvantage of vacuum grippers is that vacuum gripper, they require a constant supply of compressed air and usually they wear out before most other grippers. The Universal Gripper is another option, which is a new concept made by using everyday ground coffee and a latex party balloon. Although this may seem simple this gripper has the ability to take the shape of the object it has to handle and change its shape according to it. Pneumatic elastomers are another approach which can be used for soft grip.

However, in order to design a low complex and easy to troubleshoot gripper, a mechanical solution was studied. The advantages of the mechanical gripper are that they can grab odd shaped parts, no need for compressed air, and that this gripper can rotate the part after gripping it. In contrast to hard robotic arms, no complex precisely tuned control with sensors is necessary.

With the objective to design a mechanical hand which can grab a soft object, the proposed mechanism drives two hands like structures that move in opposite direction in open position and vice versa in closing position in order to pick the object. In this method the object is grabbed using the mechanical hands and then is lifted up using the vertical movement of the cylindrical robot.

The rest of the paper is organized as follows. Section 2 present the design and implementation while results are

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2. DESIGN AND IMPLEMENTATION

The design we created is mainly focused on grabbing a soft object without damaging it. This consists of two arms and the arms are made out of Zincalume metal. We chose zincalume because it is light weight and easy to deform into a desired shape. Also zincalume doesn't chemically react with food. We used Aluminum, Zincalume and S-lon materials for the robot parts. We used 4 limit switches in order to control the mechanism of the components 3 & 4 as shown in the diagram. Also we used 2 plastic gear motors for components 3& 4, 1 metal gear motor for the rotation of component 1 and three 9v batteries.
The processes we used for assembling were welding and joining the parts by using nuts and bolts.
Degree of freedom (DOF) is a joint on the arm, a place where it can bend or rotate or translate. This is another main factor which we considered when we built our design.

In this structure we created it has threedegrees of freedom. Those are moving up and down, moving up and down for the arms, and rotating about the Y- axis.

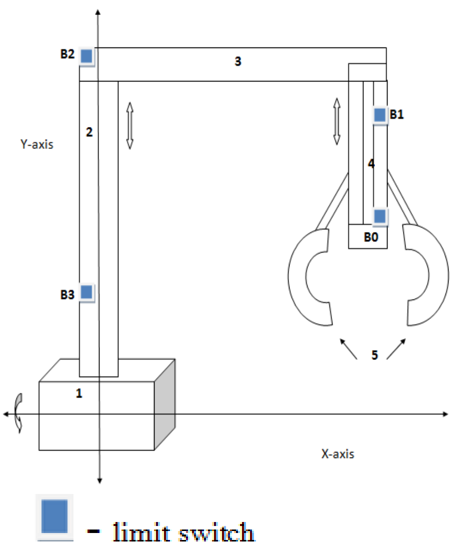
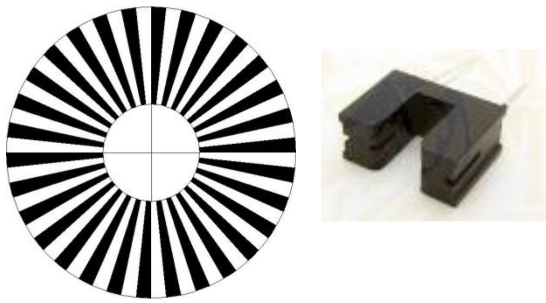


Figure 1: Design and Degrees of freedom. First degree of freedom is shown by the component 2 which will move along vertical axis and other will show from component 4 which also move in vertical plane and last one is at the base which will rotate along y-axis.

The component 1 as shown in the figure 1 is the base and it has the ability to rotate 360□ about its axis. Both components 3 & 4 will move along the printer in up and down directions along component 2 as desired by the situation. The arms will open when the screw which is placed in component 4 is rotating upwards. Once a soft object is placed below the gripper the component 2 moves down the gripper can be used to grab it using the component 5.

Once the object is grabbed by the gripper the component 2 moves upwards. After it moves up the component 1 rotates to the given number of degrees. It also has the ability to place the object.



(a) (b)

Figure 2: (a) encoder, (b) U-shaped IR sensor

The figure 2(a) shown in the diagram is an Encoder. The main function of the encoder is to detect the rotating angle. Here, the minimum angle that can be detected is 12□. This is calculated by taking the product of the count of the black strips with the specific angle (12□).The IR sensor is used to get the count of the black strips.

The equation is given below.

Specific angle = 12^0
Rotating angle = specific angle*Count

2.1 Mechanical Structure of the Gripper

The maximum mass of the object that can be lifted by the hand is70g. This mass is derived by considering the mechanical structure and corresponding calculations.

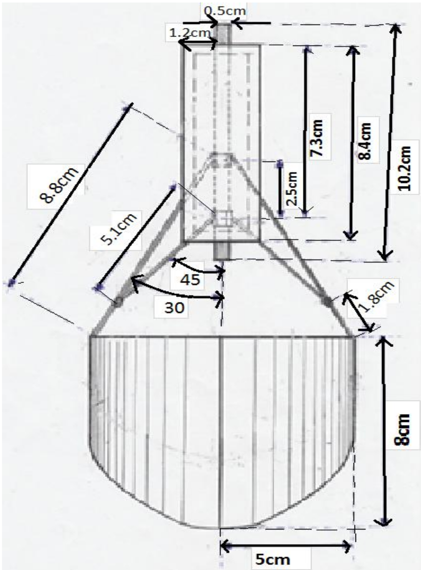


Figure 3.a: The dimensions of the gripper at the fully closed position.

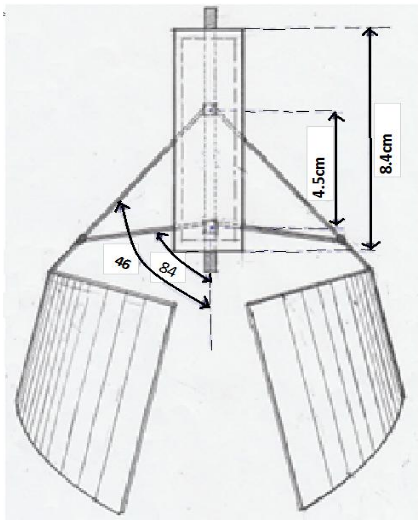
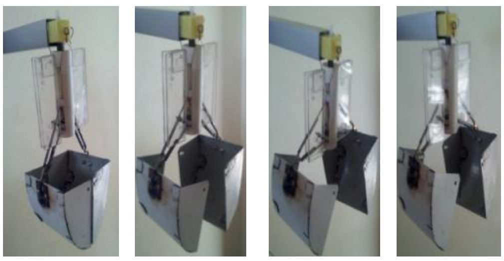


Figure 3.b: The dimensions of the fully open gripper.



(a) (b) (c) (d)

Figure4: Figure (a) The completely closed position of the gripper. Figures (b) and (c) shows slightly opened positions of the gripper and figure (d) shows the completely open position of the gripper.

When considering the structure of the gripper we mainly thought about the grippers' ability to grab a soft object without deforming objects original shape. In order to perform this task we designed the structure of the hand to open and close accurately.

2.2 Torque

About x axis, torque = 0

About y axis, torque = m3g*x3 + m4g*x4

= (m3*x3 + m4*x4)*g (1)

= 0.6272Nm

We used the magnitudes of the torques to calculate the dimensions of the structures accurately so that we can achieve our goal more precisely. In this manner we also came to know about the speeds of the movements of different components so that the mechanism works smoothly.

2.3 Overall Block Diagram

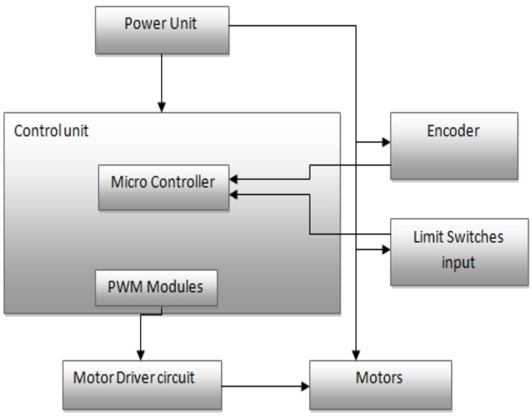


Figure 5: System architecture of the proposed gripper and pick and place mechanism.

3. RESULTS AND DISCUSSION

The gripper can be used to pick an egg using a mechanical mechanism. Here, the main specialty is that a sensor will not be used in this mechanism. The hands will move in an accurate manner if the speed of the motor is maintained accurately.

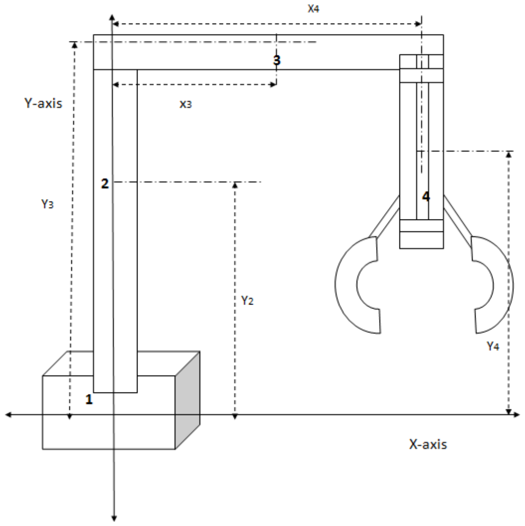


Figure6: Indicating dimensions that are needed for center of gravity calculations.

Table 1: The distances of the along the x-axis to the center of mass of the object.

	Distance along x-axis to the centre of mass(cm)
X1	0
X2	0
X3	13.3
X4	26.6

Table 2: The distances of the along the y-axis to the center of mass of the object.

	Distance along y-axis to the centre of mass(cm)
Y1	0
Y2	24.5
Y3	44
Y4	33.75

Table 3: The mass that are used in equation (2) and (3).

	Mass(kg)
m_1	1.948
m_2	0.724
m_3	0.120
m_4	0.180

2.4 Centre Of Gravity (COG)

$$\overline{X} = \frac{(\sum_{i=1}^{4} mixi)}{\sum_{i=1}^{4} mi} \qquad (2)$$

$\overline{X}$ = 2.15cm

$$\overline{Y} = \frac{(\sum_{i=1}^{4} miyi)}{\sum_{i=1}^{4} mi} \qquad (3)$$

$\overline{Y}$ = 9.8cm

4. CONCLUSION

We intended to design this mechanical arm with gripper mainly because it satisfies the given objective with a simple mechanism within the given period of time. With the help of pick and place mechanism the material handling has been easily carried out. The variation in the mechanical structure and the angle of rotation can be altered. After an object is picked up, it can rotate itself with the object and place the object at a point location and this location should be given initially in the code. This technology makes the operation of a production line more flexible and time oriented. In comparison to other models with similar objectives in the engineering field, this is cheap and very easy to troubleshoot. Parts can be replaced easily when needed. Each member of the team dedicated themselves to achieve their individual targets during the time period. In future, we hope to develop this mechanism so that it uses sensors to detect a given location and then moves towards the location to pick an object. This procedure can be followed to place the object too.

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