IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Design and optimization of soft gripper for material handling using robotic arm

Name: Bassam Mohammed Hamood Ahmed Al-awadhi
Submitted to: Nitin Chauhan
Lovely professional university

Abstract

Various numbers of the grippers are used in different aspects of our life which use especially in industrial robotic. This article studies the real design of the grippers and different types of soft robotics and their beneficial uses for our life. Every gripper consists of different module it depend on the need of this grippers. The study focuses on the development of robotic and its interactions and how it becoming so familiar and actually needed in our life due to the technology revolution. Moreover, the article explains the intelligent response and motion characteristics of organisms of nature that have the real sources of the creation of scientists.

Key Word: Soft gripper, Flexible gripper, Actuators, grasp, and sensors**.**

1.0.Introduction

A robot in general is a machine designed to execute one or more tasks automatically with speed and precision. Indeed, there are some types of robotic using in different field of the our life. Soft robots have greatly attracted the developed world due to their soft material, compliant structure, and safe interaction with objects as well as with the environments especially they have soft grippers for robust grasping have been widely explored. A grasp is the action of carrying or taking, holding, or seizing firmly with the hand. Actually, Soft finger-based grippers that have proven their abilities to make adaption to various objects and provide safe process of interaction with humans. Indeed, the soft gripper's ability to hold objects firmly during high burst of speed and deceleration that have only been minimally explored in the field of some research. The industrial robotic arm can achieve very high acceleration during pick and place tasks. Especially in this world which is going very festally day after another because the world is going in development process in the technology field. In the fact that the process of developing a soft gripper for use in the food industry, in addition to directing hygiene issues the following obligations need to be met. First, the gripper involves the ability to handle objects without destructive surfaces or tissue. Second, the grippers have to be flexible, light, and low maintenance. So the grippers must have the abilities to ensure grasping heftiness during high acceleration where a high reaction force may occur, leading to an unstable or even failed grasp. A soft finger with a variable stiffness unit based on a layer jamming mechanism is directly printed out by a multi-material 3D printer. Multi-material 3D printing can fabricate soft actuators with a complex inner geometry and good material compatibility in an easy fabrication process. The final product achieves high fabrication accuracy with little individual differences between actuators within a short manufacturing time. The great flexibility of the design and fabrication process will make it possible to easily improve and customize the current design. The main contributions of this research include: (1) design the soft gripper with variable stiffness based on layer jamming mechanism; (2) multi-material 3D printing is used to directly print out the proposed finger and layer jamming unit without an additional casting process; and (3) development of a two-finger based soft gripper for robust grapping. A grasping strategy is suggested for the soft gripper to ensure robust grasping during high acceleration and deceleration. The gripper grasps objects in its low-stiffness condition, and then, stiffness control is applied to harden the grasp pose once proper finger position has been achieved. The concept for the proposed soft finger. The proposed soft finger can achieve a highly compliant bending motion and also has capability for stiffness variation. Material hardness transfers from a soft actuator to a hard pneumatic connector and tubing. Two airways are needed: one air inlet to inflate the soft body to cause a bending motion and one air outlet to vacuum the vacuum chamber to increase the stiffness of the soft finger.

2.0. Objectives of the study:

- This research studies the design a flexible gripper for grasping irregular objects.
- The research understands the different techniques of designing the soft grippers of robots.
- The study identifies and determines the process of controlling forces between gripper and object.

3.0. The methodology

Qualitative research methodology has been used in this study to understand the deep investigations over design soft gripper for material handing using robotic arms. It adopted the analytic method to investigate new dimensions and sequences of designing the soft gripper. The study purely based on secondary resources of articles, books, as well as scientific journals. The first method of collect and analysis of the study is to investigate the main and important of design the soft gripper. The analysis has been carried out mainly qualitatively.

4.0. Literature Review

4.1. Gripping and manipulating things

Elsevier .B.V article *Robot Gripper with high speed, in hand object manipulation Capabilities 2020* in which he discusses and design and the implementation of electromechanical robotic gripper and its high-speed, the aim of this is for grasping and manipulating the objects. The article indicates that the developed robot end-effector lies on the performance of rapid and precision in the hand of manipulation of various parts. The author explains that the motivation of for the gripper design is deeply inspiring by the industrial needs and how they can handling products with geometric features and helping in the consumer goods industry. So the using the manipulation performance of the gripper will prove that the robotics can address many challenges of consumer goods industry leading to huge economic benefits.

4.2. The flexible Gripper can handle a variety of things:

Vaidehi Pati, Narmaware, Gangwani and Raykar in their article Development of Flexible Universal Gripper for Handling Light Weight Parts of Arbitrary Shape 2020, in which they argue a variety of grippers of the end efforts which are actually used in industrial robotic which considered as manipulators to accommodate the needs of handling different types of objects which make automatic scenario. The article mentions that numerous available mechanisms such as magnetic, suction, mechanical and shape of memories. Also this paper studies the development and construction of flexible universal gripper which can handle a variety of objects without need any change of the gripper. The article proposes that a flexible universal gripper is comprehensive and inexpensive solution to handle parts of variable shape. There are three modes that all operated within the same end factor to handle different types of parts.

4.3. Pick up Unknown objects by the soft gripper:

Liu, Chen, Chiu, Hsu, Peng, and Yen-Pin Chiang article Optimal Design of a Soft Robotic Gripper for Grasping Unknown objects that discusses and presents the design of an under actuated of compliant gripper for grasping size-varied unknown objects. This article indicates that the gripper includes one frame structures as well as two identical compliant fingers, so each complaint finger can be actuated through the linear motion of the moving platform and at the same time can generate the grasping motion. In the term of demonstration of the effectiveness of the proposed design in which robotic arm pick and place a variety of objects. The article argues that an energy-based objective function in corporated with the soft-add scheme for topology synthesis of complaint mechanisms with output ports in which they developed and to design an innovative soft robotic gripper. The most focus in this article is that the two finger complaint grippers which characterized by rigid as well as flexibility that integrated gripper module which really uses a motor-driven linear for the movement.

4.4. Mechanism of gripper and its application

KiBeom Ham, Jiho Han, and Yong-Jai Park's article 2018, Soft Gripper Using Variable Stiffness Mechanism and Its Application, in which it represents soft robots and their advantages such as low weight and compact size compared to rigid robots. The article indicates that current robot hands have developed from a simple gripper design to a multi-joint gripper, which is too much similar to the human hands. Also, the method of picking is different depending on type of object and stiffness of the hand is controlled to hold the object. Seriously this research was characterized by the use of material properties, it can withstand impacts. Indeed, this paper presents variable spiffiness mechanism gripper and its principle behind the working of the variable stiffness gripper and its gripping method are explained.

4.5. Development of manipulator:

Lu Zongxing, Li Wanxin and Zhang Liping's article 2020, Research Development of Soft Manipulator: A Review in which it studies the development of Robotic interaction is becoming an increasing the excellent grasp ability of low safety and fragile objects will greatly solve the complex labour people. The article indicates that the intelligent response and motion characteristics of natural organism have always been the source of scientist creation. It also pays great attention to the Tendon drive that is considered as a mode that the fingers driven by the rotation of the motor to pull the cables. It mentions the fibre-reinforced actuator, this fibre reinforced driver is composed of three parts superplastic cavity, non-extendable limiting layer as well as fibre-reinforced driver. Moreover, it adds the importance of finger fluid-elastic pneumatic and its importance to make the bending of software which drives more anthropomorphic, scientists who have developed local fluid elastic drives.

5.0 Discussion:

Grip-building and handling progress is designed to reflect the evolution of motor control near (center of the body) to distal (wrist and fingers). This means that controlling the precise movement of the motor begins with stabilizing the movement of the entire body and arm, then extends from the shoulder to the elbow, and finally to the precise control of the wrist and fingers.

Some gripper designs are quite similar to human hands, complete with five fingers, but this is not always the case. There are two- and three-finger grippers, claw-shaped grippers, mechanical clutch types, grippers with large suction cups and even grippers are like air-filled bags. With so much to choose from, it can be difficult to know which types of robot grippers are best suited for applications.
It has separated the gripper types in the articles based on the methods used to operate the clutch, but there are other ways to differentiate the clutch types, such as shape, which results in terms such as “parallel gripper,” “soft gripper,” and “angular gripper.” Like “adaptive gripper,” “mechanical gripper,” and “gripper.”

Robots have many powerful suits, but traditional sensitivity was not one of them. Hard edges and numbers make it difficult for them to grasp, grasp, and handle a range of everyday objects without dropping or crushing them. Robots are often limited in what they can do due to how difficult it is to interact with objects of different sizes and materials, ”Ross says. “A robot with rigid hands will have much more trouble with tasks like picking up an object,” Homberg says. “This is because it has to have a good model of the object and spend a lot of time thinking about precisely how it will perform the grasp.” Soft robots represent an interesting new alternative. However, one of the downsides to their extra flexibility (or "compatibility") is that they often have a hard time measuring precisely where an object is, or even if they've successfully picked it up at all. As a human being, if you are blindfolded and pick up something, you can feel it and still understand what it is, ”Catchman says.“ We want to develop a similar skill in robots - essentially, giving them “sight” without actually being able to see. ”Recent developments in terms of actuators, sensor technologies, as well as materials science have made the clutch more reliable, faster, safer and more powerful. These developments have led to the introduction of new applications such as new movement of mobile climbing robots (for example, JPL's Rock Climbing Robot), jumping robots, space satellites, underwater robots for exploration and repair of pipelines, high-speed manufacturing, and robotic surgery. This development has opened the doors to new research on the use of new materials and designs as well as the incorporation of new technologies.
There are ongoing attempts to improve the clutch in two parts: performance and flexibility. Performance refers to accuracy, speed, readability, grip strength, durability and flexibility refer to a variety of things that can be accommodated. Most of the challenge in this aspect is whether or not things are known / unknown. When one deals with unknown objects the focus is on using the two flexible grippers, whereas in grasping the known objects the focus is on increasing performance. Achieving flexibility and performance simultaneously remains a challenge because increasing performance usually leads to decreased flexibility.
In applications, the use of more adaptive grippers such as the multi-finger gripper becomes beneficial with the cost of the complexity of control engineering. Recent developments and applications indicate that the soft clutch is one of the limits in The future is in automatic clutch for many applications. Mostly emerging applications in industry and medical. Employing these developments in the industry will improve performance significantly as mentioned; but the cost

of changing the current technology and updating it with the latest Progress is high. In medical applications and especially in the field of robotic surgery, research is ongoing Provide surgical procedures with a safe, robust and reliable mechanism.

The current state of soft manipulators has been considered. Soft robots will have important applications in areas that require compliance and soft interactions, as is currently seen in human and some industrial settings. However, its inherent lack of repeatability, accuracy and low gripping strength can be considered a limiting factor for its applications.
However, the deviation from the traditional hard robotic methods illustrated in soft robotics has a number of major advantages, which fit the needs of robotics applications in the 21st century. Soft robots demonstrate the compliance required for everyday interaction in unorganized environments. There is an increasing pressure to automate industrial and agricultural processes, requiring highly compliance manipulators who can handle uncertainty and allow the safe handling of sensitive objects. Soft robots offer these characteristics, such as the presence of many applications whose number will only increase because research and developments lead to increased speed and accuracy of these systems.
As this field progresses, there will be new challenges to be overcome to develop soft manipulators, but the current knowledge base of "hard" and "soft" manipulators will support future achievements and lead to the development of innovative and effective solutions.

6.0 Conclusion

This article pays great attention to the variable stiffness gripper was designed and fabricated in which it based on the change of tendency stiffness that obtained from the previous studies. This study has its specification because, the maximum weight the gripper was tested by varying the stiffness. Indeed, the gripping tests are conducting in special condition regarding of using various objects. The more the flexibility of segments are compressed the more is the forced generated. Also the tendency can be used to estimate the stiffness of the grippers especially when the pulling length of the timer tendon, so this is too much useful to design the variable stiffness gripper with the desired of this stiffness. To conclude with the fact that the variable stiffness gripper can be used in to many different ways in which we can demonstrate some ways of real use of the variable stiffness gripper and proposed a real guideline for designing the variable stiffness gripper of the desire stiffness. But in fact, the variable stiffness gripper is in need to make some measurement to the force of the gripper. So for the future development of the variable stiffness gripper in which the gripper sensor will be really embedded at the end tip of the gripper immediately and measuring the gripper forces.

7.0. References

1. Shimoga KB. Robot grasp synthesis algorithms: a survey. Int J Robot Res 2019;15:230–266.
2. Bohg J, Morales A, Asfour T, Kragic D. Data-driven grasp synthesis—a survey. IEEE Trans Robot 2018;30:289–309.
3. Li M, Hang K, Kragic D, Billard A. Dexterous grasping under shape uncertainty. Robot Auton Syst 2016;75:352–364.
4. Montambault S, Gosselin CM. Analysis of underactuated mechanical grippers. ASME J Mech Des 2017;123:367–374.
5. Dollar AM, Howe RD. The highly adaptive SDM handdesign and performance evaluation. Int J Robot Res 2017; 29:585–597. 6. Odhner LU, Jentoft LP, Claffee MR, Corson N, Tenzer Y, Ma RR, et al. A compliant, underactuated hand for robust manipulation. Int J Robot Res 2014;33:736–752.
7. Petkovic´ D, Shamshirband S, Anuar NB, Sabri AQM, Rahman ZBA, Pavlovic´ ND. Input displacement neurofuzzy control and object recognition by compliant multifingered passively adaptive robotic gripper. J Intell Robot Syst 2018;82:177–187.

8. Cho K-J, Koh J-S, Kim S, Chu W-S, Hong Y, Ahn S-H. Review of manufacturing processes for soft biomimetic robots. Int J Precis Eng Manuf 2019:10:171–181.

9. Hod L. Challenges and opportunities for design, simulation, and fabrication of soft robots. Soft Robot 2013;1:21–27.

10. Kim S, Laschi C, Trimmer B. Soft robotics: a bioinspired evolution in robotics. Trends Biotechnol 2018;31:287–294.

11. Rus D, Tolley MT. Design, fabrication and control of soft robots. Nature 2015;521:467–475.

12. Deimel R, Brock O. A novel type of compliant and underactuated robotic hand for dexterous grasping. Int J Robot Res 2016;35:161–185.

13. Manti M, Hassan T, Passetti G, D'Elia N, Laschi C, Cianchetti M, et al. Soft robotic gripper for adaptable and effective grasping. Soft Robot 2015;2:107–116.

14. Galloway KC, Becker KP, Phillips B, Kirby J, Licht S, Tchernov D, et al. Soft robotic grippers for biological sampling on deep reefs. Soft Robot 2018;3:23–33.