Analysis of Robotic Gripper

Mrunmayee Lokhande
Mechanical dept.
Nutan College of engineering andResearch
Pune,

Pratiksha Bhore
Mechanical dept.
Nutan College of engineering andResearch
Pune,

Vaishnavi Khalde
Mechanical dept.
Nutan College of engineering andResearch
Pune,

Milind Ovhal
Mechanical dept.
Nutan College of engineering andResearch
Pune,

Sanjeevani More
Mechanical dept.
Nutan College of engineering andResearch
Pune,

Abstract:
This paper presents the optimization parameter of a bidirectional soft actuator gripper leaf evaluation the properties of the gripper leaf based on the material and wedge angle of the actuator. The systematic simulation was conducted to investigate the effect of the top wedged angle (the angle forthe wedged shape of the actuator structure) of the chamber on the bending extent of the gripper leaf when it is deflated with hyper elastic material. We quantitatively measured the deformation stress and strain on the gripper leaf. We found that the top wedged angle has a significant effect on the out ward bending of the actuator when it is deflated. The result shows that the actuator can deform much easier with a hyper elastic material base and bigger width wedge angle. Utilizing a softgripper that was built by mounting four actuators to three-dimensional- printed rigid support through various research paper reviews, we found that the prototype can grip objects ofdifferent sizes, shapes, and material stiffness in amphibious environments

Keywords— **Soft robotics, top wedged angle, grasping, Robotic Gripper**

I. INTRODUCTION

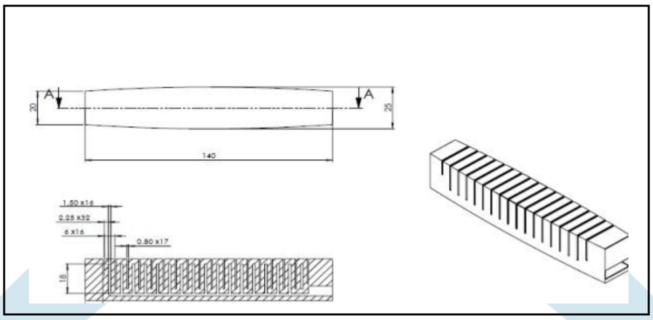
Introducing the design process for developing a soft gripper leaf (consists of several actuators or fingers. The technical requirements are the maximum weight of the gripping object not more than 1kg, the gripping capacity of 3 objects per minute. The shape of the object might flexibly be rectangular, spherical, and conical with a maximum profile size of 8 cm. The gripping process requires that food or objects, in general, will not be damaged or crushed. These requirements are built up from the actual need at the industry or situation where the object is not intended to be damaged. Based on the requirement on the size of the gripping object, the 3D model of the gripper with four actuators is built. Then, simulation is conducted with 2 different materials of silicon base (dragon skin 30) (dragon skin 10) to evaluate the gripping force of a finger on the object at different pressure levels. Using the simulation data, the correlation between the gripping forces effect of wedge angle on gripper leaf deformation on the same. Next, the dynamic simulation of the gripping process performed based on research papers is observed. The simulation allows for evaluating the ability to grasp and hold objects of the gripper in order to determine the design option that meets the requirements. Once a suitable design option is defined, the subsequent steps including structural design, fabrication and validation of the prototype are compared and analyzed based on available research papers and end up with a conclusion.

A. Silicone Rubber (Dragon Skin)

Dragon Skin is a milky, moist to-the-touch, membrane-like silicone that is often used in prosthetics, animatronics and orthopedic and cushioning applications. This material is so stretchy that a mould of it can be turned inside out without risk of tearing it. The material is supplied in two parts, one of which contains a platinum catalyst which causes the liquid polymer to cure into a solid object. Because silicone rubber flows easily and can be moulded, pressed or extruded using relatively low amounts of energy, it is a useful material for tinkering and making prototypes without specialist equipment. It is generally non-reactive, stable, and resistant to extreme environments and temperatures (from about −55°C to +300 °C) so can be used for a huge variety of things, from making muffin trays to medical implants.

B. Procedure ofANSYS

The procedure or steps used are providing the ANSYS software with the 3D model followed by entering the required material properties of Dragon skin 10 and 30 respectively in the library of the software. Below image is the meshing procedure of the 3D model after the step of providing boundary conditions and material properties required for the analysis. After running the stimulation in de-pressurizer from major deformation was observed on the end with no fix support where the major contact between material and object was supported. The maximum deformation in the unit m was reported 0.10419m/m (dragon)



C. Fabrication of the Actuator

There are two principal methods of fabricating soft grippers such as 3D printing by using hyper-elastic material and casting. 3D printing is available for fabricating the gripper of complex shape, but it is quite costly. In this study, the gripper is made by the casting method, the process of which is shown in Figure Top, bottom and lid molds are made by using the 3D printer, as shown in Figure (a), (b), and (c) respectively. The process of pouring the material, hardening and finishing process of the gripper fabrication are shown in Figure (d), (e), and (f) respectively. Eventually, the actuators are assembled to make the entire gripper.

Validation and analysis: To evaluate the working capability of the gripper and auxiliary mechanical device, a series of experimental pick-up are performed. Different types of objects including food and fruits with mass varying from 28 gram to 300 gram. The experimental tests on the gripping process of different objects are presented in Table 3. The experimental result shows that with the required air pressure of 55 ÷ 70 kPa, the developed soft robotic gripper can handle objects with a mass of up to 300 gram. The object that needs to be picked can be in different types of configuration. Also, the gripping process does not affect the food quality, for instance, it does not spoil the fruit. In particular, the productivity of the grasping process is up to 3 objects per minute, which is suitable for application in the food packaging Figures

Conclusion:

In this paper, we propose a topology optimization framework into achieve automatic design of robotic grippers. Two design examples are also presented to illustrate the automatic synthesis process. Experimental tests have shown that the 3D topology optimized grippers in the example can successfully grasp objects with different shapes. In future work, the proposed framework can be further developed to synthesize soft robotic grippers with different actuation mechanisms and task-specific grasping behaviors. Soft robotic grippers are widely used in different mechatronic systems since they show great advantages in the adaptable grasping of objects with irregular shapes. However, as many soft grippers have a monolithic structure and gain their motion from the elastic deformation, it is difficult to use the conventional rigid-body mechanism theory to synthesize the shape of the soft grippers. To cope with this problem, topology optimization is frequently employed as the

Method since it can achieve automation design of continuum structure mechanism G

REFERENCES

1. Zaki, A. M., Mahgoub, O. A., El-Shafei, A. M., &Soliman, A. M. (2010). Design and implementation of efficient intelligent robotic gripper. WSEAS Transactions on Systems, 9(11), 1130–1142
2. Brown, E., Rodenberg, N., Amend, J., Mozeika, A., Steltz, E., Zakin, M. R., Lipson, H., & Jaeger, H. M. (2010). Universal robotic gripper based on the jamming of granular material. Proceedings of the National Academy of Sciences of the United States of America, 107(44), 18809–18814. https://doi.org/10.1073/pnas.1003250107
3. Zodey, S., & Pradhan, S. K. (2014). Matlab toolbox for kinematic analysis and simulation of dexterous robotic grippers. Procedia Engineering, 97, 1886–1895. https://doi.org/10.1016/j.proeng.2014.12.342
4. Homberg, B. S., Katzschmann, R. K., Dogar, M. R., &Rus, D. (2015). Haptic identification of objects using a modular soft robotic gripper. IEEE International Conference on Intelligent Robots and
5. Systems,2015-Decem, 1698–1705. https://doi.org/10.1109/IROS.2015.7353596
6. Manti, M., Hassan, T., Passetti, G., D'Elia, N., Cianchetti, M., &Laschi, C. (2015). An under-actuated and adaptable soft robotic gripper. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 9222, 64–74. https://doi.org/10.1007/978-3-319- 22979-9_6
7. Tai, K., El-Sayed, A. R., Shahriari, M., Biglarbegian, M., & Mahmud, S. (2016). State of the art robotic grippers and applications.
8. Robotics, 5(2), 1–20. https://doi.org/10.3390/robotics5020011
9. Galloway, K. C., Becker, K. P., Phillips, B., Kirby, J., Licht, S., Tchernov, D., Wood, R. J., & Gruber, D. F. (2016). Soft Robotic Grippers for Biological Sampling on Deep Reefs. Soft Robotics, 3(1), 23–33.

https://doi.org/10.1089/soro.2015.0019
10. Hao, Y., Wang, T., Ren, Z., Gong, Z., Wang, H., Yang, X., Guan, S., & Wen, L. (2017). Modeling and experiments of a soft robotic gripper in amphibious environments. International Journal of Advanced Robotic Systems,14(3), 1–12. https://doi.org/10.1177/1729881417707148
11. Sintov, A., & Shapiro, A. (2018). Dynamic regrasping by in-hand orienting of grasped objects using non-dexterous robotic grippers. Robotics and Computer-Integrated Manufacturing, 50, 114–131. https://doi.org/10.1016/j.rcim.2017.09.009
12. Glick, P., Suresh, S. A., Ruffatto, D., Cutkosky, M., Tolley, M. T., &Parness, A. (2018). A Soft Robotic Gripper with Gecko-Inspired Adhesive. IEEE Robotics and Automation Letters, 3(2), 903–910. https://doi.org/10.1109/LRA.2018.2792688
13. Sintov, A., & Shapiro, A. (2018). Dynamic regrasping by in-hand orienting of grasped objects using non-dexterous robotic grippers. Robotics and Computer-Integrated Manufacturing, 50, 114–131. https://doi.org/10.1016/j.rcim.2017.09.009
14. Sinatra, N. R., Teeple, C. B., Vogt, D. M., Parker, K. K., Gruber,
15. F., & Wood, R. J. (2019). Ultragentle manipulation of delicate structures using a soft robotic gripper. Science Robotics, 4(33). https://doi.org/10.1126/SCIROBOTICS.AAX5425
16. Hu, Z., Wan, W., & Harada, K. (2019). Designing a Mechanical Tool for Robots with Two-Finger Parallel Grippers. IEEE Robotics and Automation Letters, 4(3), 2981–2988. https://doi.org/10.1109/LRA.2019.2924129
17. [Chen, R., Song, R., Zhang, Z., Bai, L., Liu, F., Jiang, P., Sindersberger, D., Monkman, G. J., &Guo, J. (2019). Bio-Inspired Shape-Adaptive Soft Robotic Grippers Augmented with Electroadhesion Functionality. Soft Robotics, 6(6), 701–712. https://doi.org/10.1089/soro.2018.0120
18. Sun, Y., Liu, Y., Zhou, N., &Lueth, T. C. (2021). A MATLAB-based framework for designing 3D topology optimized soft robotic grippers. IEEE/ASME International Conference on Advanced Intelligent Mechatronics, AIM, 2021-July (August), 1283–1289. https://doi.org/10.1109/AIM46487.2021.9517350