Design and Development of Compliant Robotic Gripper By 3D Printing Technology

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Abstract :

Micro gripper is an important device in micro operating system. It can co nvert other types of energy into any type of energy and create a clamping force with the required clamping force, making it widely used in the manufacturing a nd assembly of electronics, biomedicine and optics. The performance of the mic ro clamp depends on its electrical characteristics, driving conditions, process str ucture, etc. It depends.

In this project, we use 3D printing technology to develop a compliant gripper for micro-object manipulation. We studied different types of 3D printing materials. We also studied Pro-series software for mathematical and structural designing and simulation for redesigning. The resulting design of the gripper can be done by using TPU plastic.

Keynote :

Robotic Micro Gripper, 3D Printing, Additive Manufacturing, Complaint Technology.

Introduction :

Micro fixtures play an important role in micro manipulation and micro as sembly projects. Microclamps with various actuation principles have been repor ted in the literature, such as electrostatic microclamps [1], electrothermal microc lamps [2], and piezoelectric microclamps [3]. Piezoelectric actuators in particul ar [4], [5] have attracted much attention due to their advantages of subnanomete r positioning resolution and fast response.

In the article “SOME ASPECTS OF MULTI-FINGERED GRIPPERS” the author discussed some aspects of multi-finger grippers. In addition, they have also discussed some limitations of this type of gripper. As this gripper is joint, so this type of Gripper could drop parts with loss in air pressure as this type of gripper is air pressure control. This type of gripper can only be for a singular purpose. In another paper “Magnetic Gripper Using Magnetic Switchable Device” where authors worked on magnetic grippers. The attraction gripper are simple in nature. There are two main problems with such end effecto

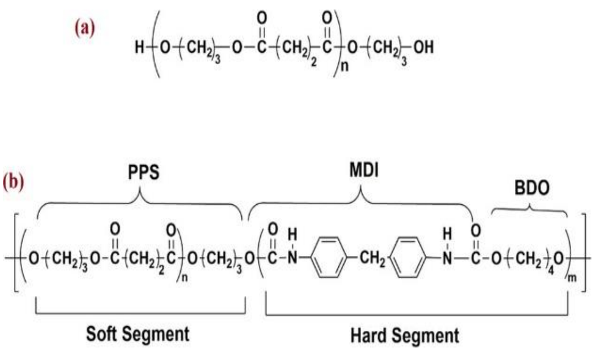
rs. For a magnet to work, the object it holds must contain a ferromagnetic material such as iron or steel. The magnetic field produced by the end effector will permanently magnetize the object it is holding. While this sometimes doesn't cause a problem, it can cause problems in others.
Among the poor design of the robot arm, the ratio between the weight of the structure and the force it can withstand is important, and both are linked to the most commonly used materials such as aluminum and steel. Our aim is to improve these two factors by using ABS plastic in the design and construction of 6 degree of freedom robot arm structure. TPU plastic is lighter and most conventional material.

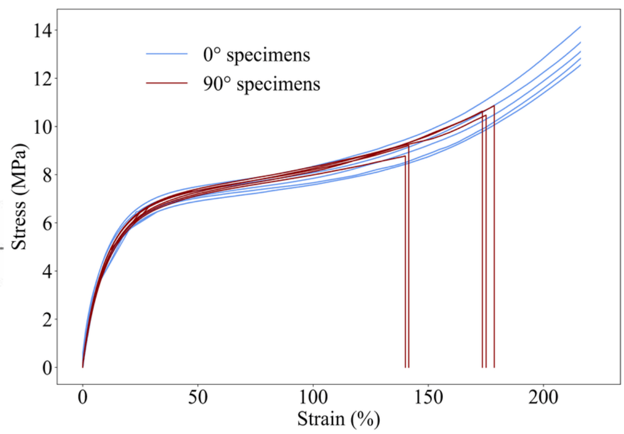
Material Selection :

Low elastic modular materials and smart structures are due to the features that enable soft robots to work by adapting their bodies to dynamic environments, causing lossless deformations thanks to their soft eyes. In this project, we chose TPU for the clamp design and PLA for the arm design.

Thermoplastic polyurethane (TPU):

Thermoplastic polyurethane (TPU) is a durable and flexible thermoplastic elastomer. It has many physical and chemical properties combined for application. Its products fall between plastic and rubber. In terms of practical use, TPU has the necessary properties such as flexibility, good tensile strength, tear and damage resistance.

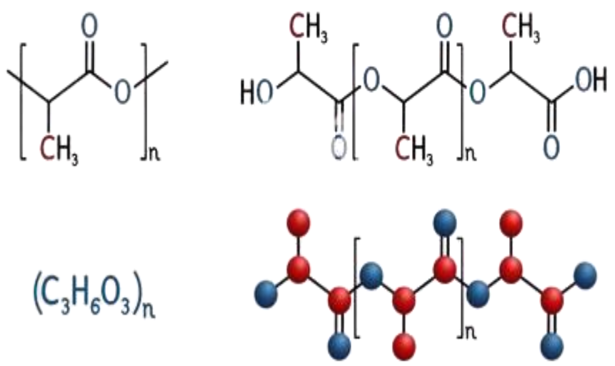


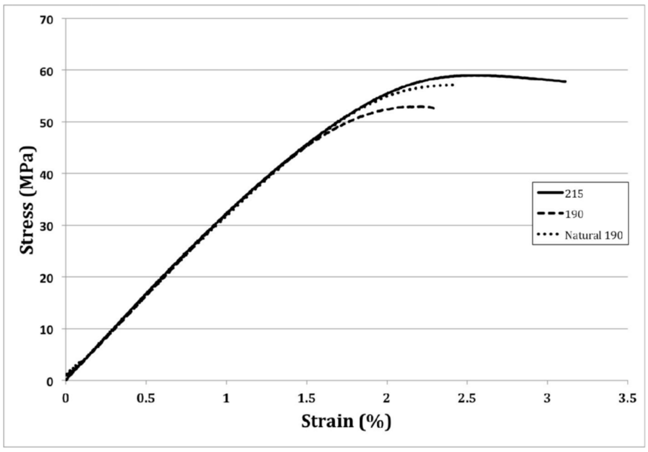


Polylactic acid (PLA) :

PLA is a userfriendly thermoplastic that is stronger and more durable than ABS and nylon. PLA has very low temperature resistance, making it one of the easiest materials for 3D printing. Unfortunately, its low melting point also causes it to lose almost all of its hardness and strength at temperatures above 50 degrees Celsius. Additionally, PLA is brittle, resulting in poor quality and bad effect.

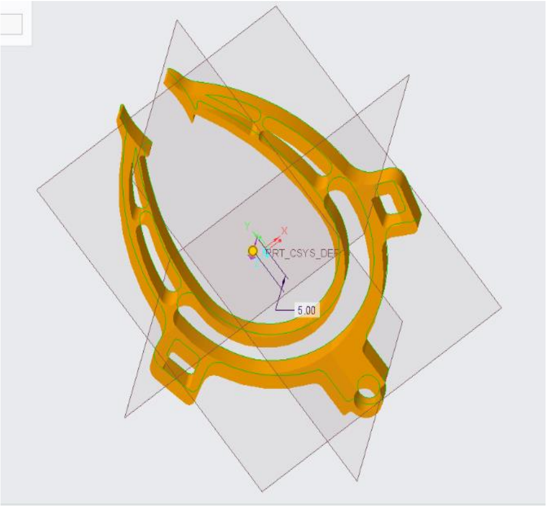
While PLA is the strongest of our plastics, its poor chemical and thermal proper ties make it almost exclusive to popular applications.



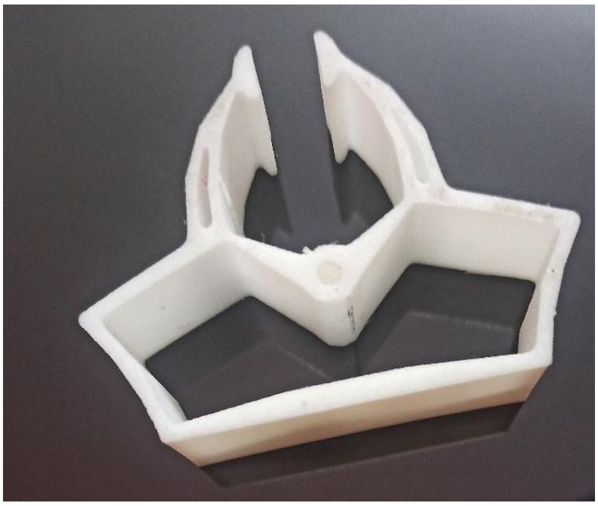


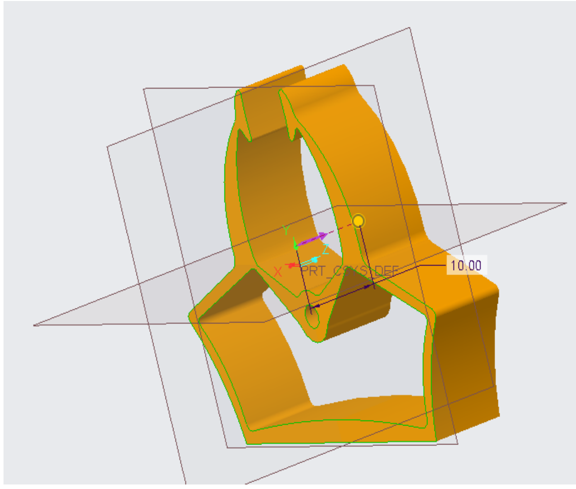
Mechanical Design and Analysis :

The first iteration of the robotic microgripper consisted of two parallel arms connected by a flexure mechanism. The flexure mechanism was designed to allow the arms to move to each other, enabling the gripper to open and close. The prototype was 3D printed using ABS material. The gripping force was measured using a force sensor. Due to its small size and high material density, the gripper doesn't work



In the second iteration, the flexure mechanism was modified to provide more flexibility, allowing the arms to move more freely. The gripper was also equipped with two fingers with serrated tips to improve the gripping force. The prototype was 3D printed using TPU material. We are planning to work the gripper using a servo motor, and the gripping force was measured using a force sensor. The results showed a significant improvement in gripping force compared to the first prototype.

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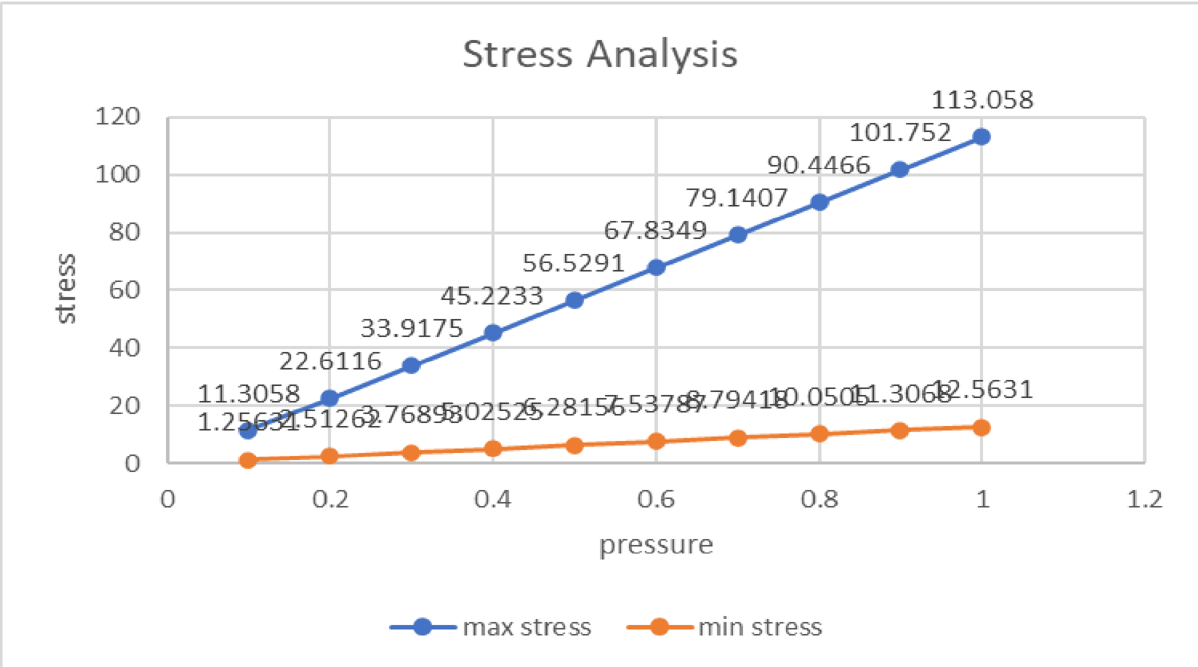
Stress Analysis
stress
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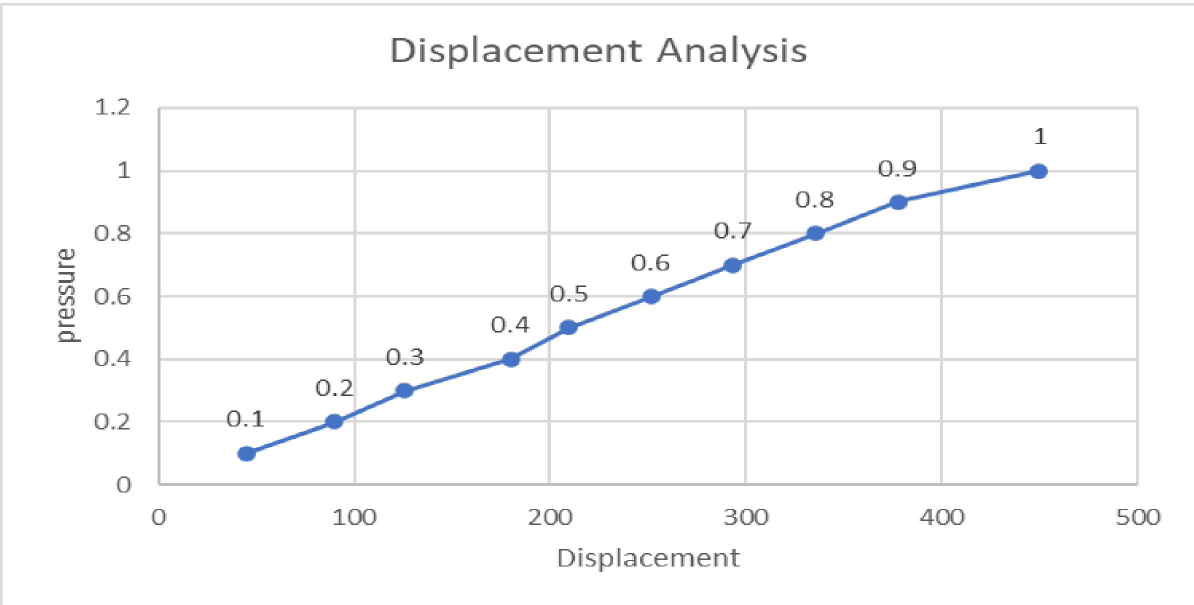
Displacement Analysis
pressure
Displacement
0
0.2
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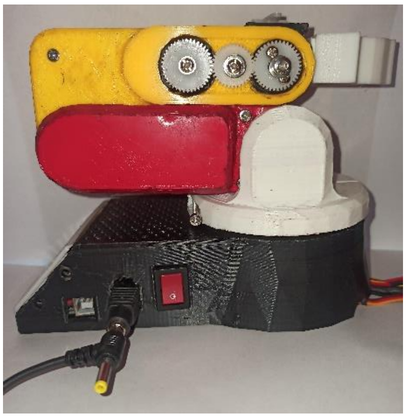
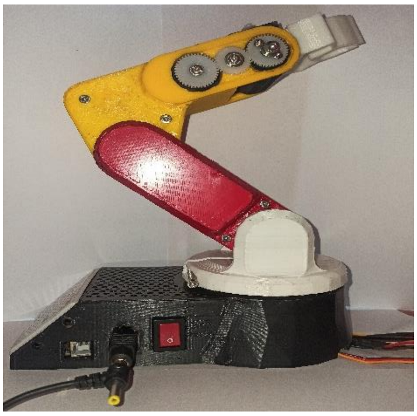
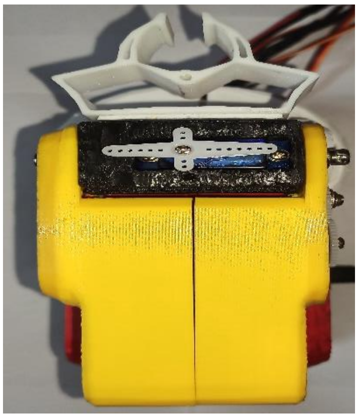
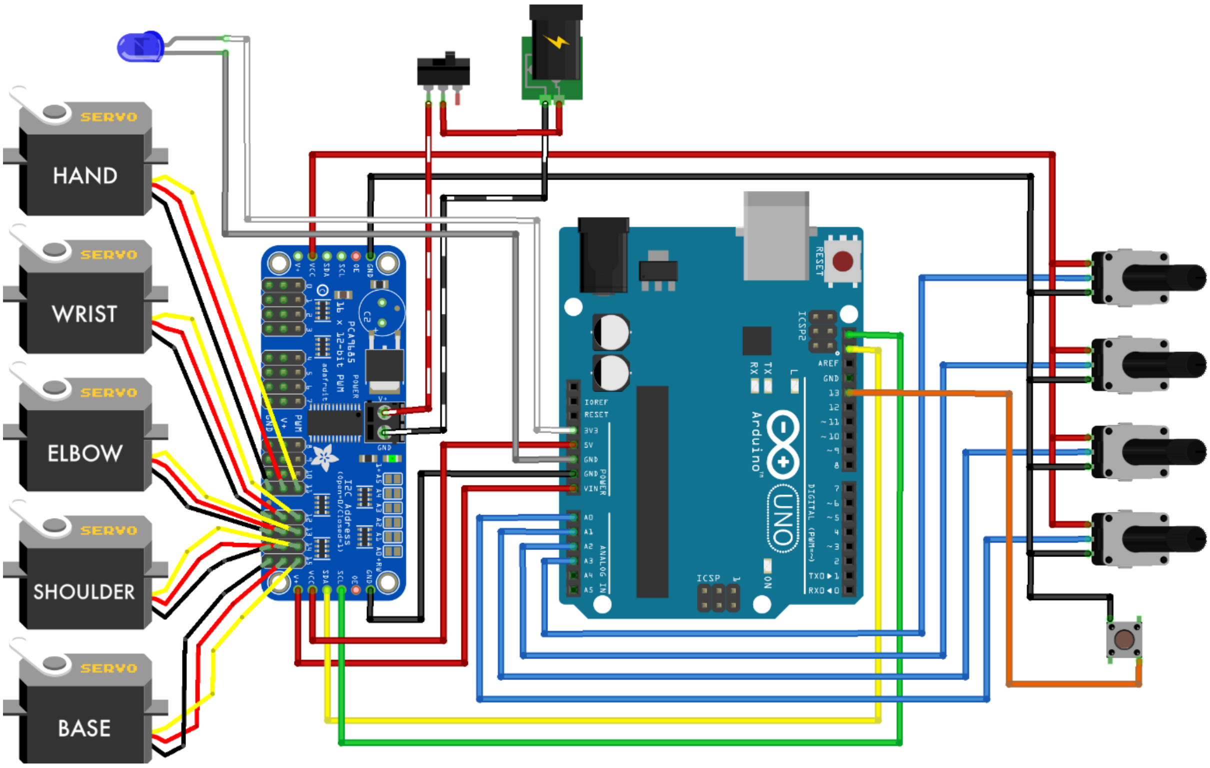
1

Arm Designing and Electrical Circuit :

A 4-degree-freedom robotic arm, as its name suggests, boasts four independent axes of movement, enabling a range of complex manipulations. Compared to simpler 3-DOF arms, these dexterous machines unlock new possibilities in various fields. The robotic arm is constructed with lightweight yet durable materials to ensure efficient movement and reduce inertia. The 4-DOF configuration providing flexibility in reaching targets from various orientations. The joint mechanisms utilize high-torque actuators and advanced gear systems to enhance payload capacity while maintaining accuracy.



This circuit is used to control the 4-DOF robotic arm controlled by an Arduino Uno. It uses a PCA9685 16-channel I2C PWM driver to control five servos. The PCA9685 is a popular choice for controlling multiple servos with an Arduino because it frees up the Arduino's PWM pins for other tasks. The circuit is being powered by a 12V power supply that is connected to the Arduino's Vin pin. The

servos are also powered by the 12V power supply, but they are regulated to 5V using a voltage regulator. The voltage regulator is necessary because servos typically operate at 5V.
The five servos are connected to the PCA9685 driver on the I2C bus. The I2C bus is a two-wire serial bus that is used to communicate between devices. The Arduino Uno communicates with the PCA9685 driver over the I2C bus to send PWM signals to the servos.
The buttons on the breadboard are connected to the Arduino's digital pins. The buttons can be used to control the movement of the servos. For example, a button could be used to move the servo that controls the shoulder joint of the robotic arm.
The circuit also includes an LCD display. The LCD display can be used to show information about the robotic arm, such as the current position of the servos.

Conclusion :

After completing the first stage of this study, we can conclude that 3D pri nting robot grippers will be the most effective products in the future due to their low cost and wide range of uses. Flexible grippers can be used to grasp small o bjects with high efficiency and can adjust contact points and working fingers.
In conclusion, the development of a robotic microgripper used as a model demo nstrated the potential benefits of this approach for precise and subtle manipulati on of small objects. The compatible structure of the gripper provides flexibility and flexibility, allowing it to hold and control objects without damage or defor mation.

The project was successfully designed and constructed using the following stan dards. The project highlights the importance of considering several factors when selecting clamps for a particular application, including size, shape and material, as well as output line, clamping force and adaptability of the clamp.
Overall, the creation of robotic microjaws using the same design has potential a pplications in many fields, including biomedical research, industrial automation, and micromanipulation. This program lays the foundation for research and deve lopment in this field with the ability to improve the precision and complexity of small manipulations in a variety of applications.

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