Subsystem: Claw [DEV LOG]

Arctos Autonomous
Robot 2023

Subteam: Mechanical
Project: Claw
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V1.0

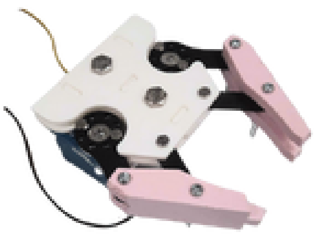
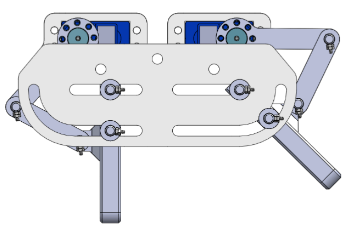
The initial design did not meet any requirements that were set and was completely scrapped before doing any further development.

V2.0

The second design iteration of the claw started with 3 concepts to develop prototypes, then decide on the best design after testing.

3 different motion paths of different complexity of mechanisms; SIMPLE, MEDIUM, COMPLEX.

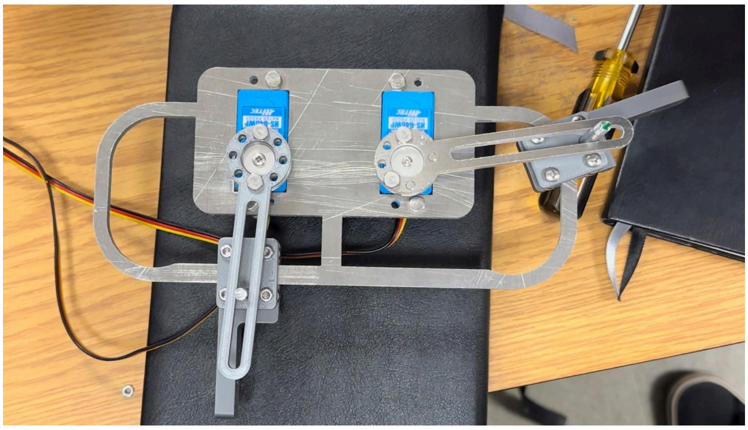
SIMPLE	MEDIUM	COMPLEX
Spur gears attached to servo with pincers directly attached to spur gears.	Parallelogram concept; each pincer is a 3-bar mechanism. Pincers move forward/closed and back/open from servo turning pin connected bars.	Precursor to current design. Insead of cart and track, used pins and slots to define movement of pincers.

SIMPLE and MEDIUM designs are well known/common mechanisms, and little was done to improve them during development and prototyping. Whereas the COMPLEX mechanism encountered a fatal flaw in design at prototyping: the pins would get stuck and not move smoothly, and/or the pincers would rotate and not remain perpendicular to the slot/track.

Determined the pin and slot are not suitable for this as they were unreliable, and a different mechanism to define movement was required.

V3.0

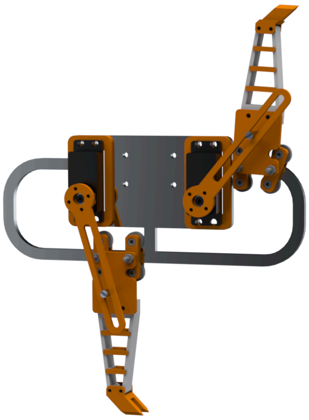
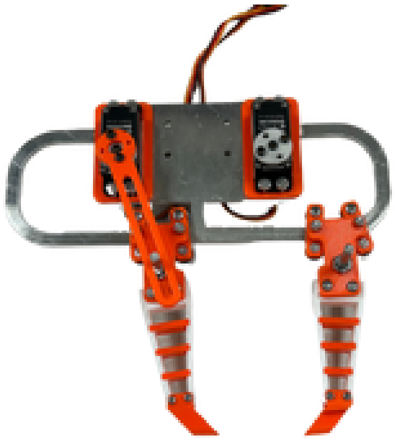


The cart and track system was developed to address the reliability concerns. This design comprises four bearings that slide along a track, enabling the claw to function as a parallel gripper. When not in use, the bearings slide along a thinner track, causing the grippers to rotate 180 degrees and fold into the robot, keeping them out of the way and preventing damage to the robot or gripper. The system is actuated by two servos utilising a pin and slot mechanism, facilitating the cart's movement along the entire track length. This mechanism grants precise control over the claw's maximum gripping force. Moreover, this design offers easy adaptability for the future; adjustments to the track length can extend the gripping range.

Once all the prototypes were functional, it was determined that v3.0 is the design which we will move forward with and develop into a fully functional claw.

Why was this design chosen? When brought forward to software substeam, they liked it because the grippers are parallel and move in a linear fashion. This made it easy to write code for. Additionally, while all three concepts were reliable, the complex design was deemed more capable.

V3.1

The first iteration of the track featured a thin track along the sides and a wider track along the gripping range. Bearings travelling along the track were “loose” along the sides, but fit precisely in the gripping range. The main drawback of this design choice is its inefficient utilisation of space; the curved portion of the track requires the claw to be much larger than desired.

In V3.1 the design was modified where each vertically adjacent bearing was linked and free to rotate about the centre of the link, this allowed the gripper to smoothly slide along the curved portion of the track without the need to make it thinner.

The slot key was originally 3D printed with PETG filament but once we started using high torque servos, the 3D printed part was not strong enough to withstand the torque of the servos and would deform at certain parts along the track. The part was modified so it was more rigid and now laser cut from acrylic.

GRIPPERS

V1.0

The first design of the gripper was 3D printed with PLA filament, the curved portion was supposed to be used to pick up the lid, and the flat portion at the bottom was designed to pick up flat objects similar to the bottles in RoboSub 2022.

V1.1

This concept design was the first of many to utilise the fin ray effect. It was 3D printed with PLA. The grippers were very thin and lacked rigidity, so we needed to use a different material, one which is more flexible so we can make the overall design more rigid.

V1.2

The outer shell material was switched to TPU, providing increased flexibility. The cross beams were constructed using PETG, and an interlocking base was incorporated to securely hold the lid obstacle in place.

V1.3

This design is inspired from a research paper on the Fin Ray Effect, The cross beams are now made of TPU and their angle increases as they move down the gripper. This gripper turned out to be significantly stiffer and lacked the deformability observed in the previous iteration.

V1.4

In the V1.2 design, cross beams with 4 knobs, locked into the TPU outer shell. However, the gripper's deformation caused the cross beams to disassemble from the outer shell. To address this, we sought a new solution. In V1.4, we used steel wire to connect the cross beams to the outer shell, but it proved too stiff and challenging to keep perfectly straight during insertion.

V1.5

In this design iteration, we reverted to using four larger knobs, which significantly improved their grip. We also experimented with increasing the outer shell's thickness to enhance deformation, but this approach made the gripper too stiff and compromised its performance.During testing, the gripper effectively picked up the chevrons in the air and securely held onto them, demonstrating successful performance. However this gripper design could not securely hold onto the chevrons in water, the surface of the TPU outer shell was smooth, causing the chevrons to slip away from its grasp.

V1.6

In the final gripper design, we incorporated grip tape on the TPU outer shell's surface to increase friction with the chevrons. When tested in water, the gripper successfully maintained its hold on the chevrons even during movement.