Chiara Mantis: Testing, and a Redesign of the Original

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CHIARA MANTIS

Project Overview

The Chiara Mantis, a hexapod robot modeled after the praying mantis insect, has been two years in the making. The goals of the original insect-inspired design were static stability, power efficiency, and range of motion. In this project we investigated an alternative design to reduce weight and complexity, reduce power requirements, and improve range of motion.

Testing

During testing of the original Mantis design, several problems arose:

- Both the legs and arms reached max torque on the first elevator servo, causing the servo failsafe to be triggered (Dynamixel MX-64 servos).
- The abdomen flexion mechanism used a jackscrew, which was slow and would require a separate device for position encoding.
- The pan/tilt assembly's tilt servo had a design flaw due to the positioning of it not being under the center of mass of the Kinect head, requiring the servo to be constantly powered.
- The four bar linkage in both the legs and arms reduced the range of motion to 90 degrees causing issues with the movement of these limbs.

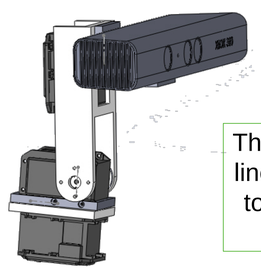
Materials

This redesigned Mantis used more off-the-shelf parts than the original, to reduce cost and complexity. Solidworks was used to design the custom parts, which where fabricated from ABS, acrylic, Delrin, or aluminum using a laser cutter, mill, lathe, and 3D printer.

Conclusion and Future Work

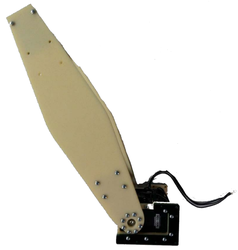
Through the process of testing and redesigning the original mantis, a fully built hexapod has been realized, resulting In reduced weight and complexity, reduced power requirements, and improved range of motion. The next step in this project is to integrate the Mantis (hardware) with Tekkotsu (software) and to create a model of the Mantis in Mirage, a virtual environment simulator, in order to start designing the motion and walking algorithms.

Original Mantis Design

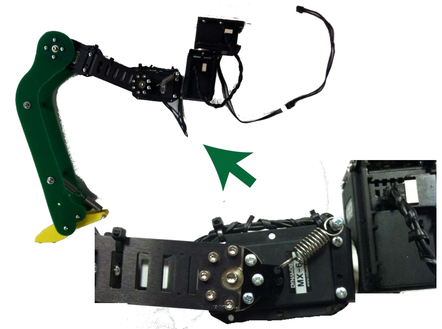


Redesigned Mantis

Redesigned the abdomen jackscrew mechanism using a Dynamixel dual MX-106 assembly in order to improve torque, speed and position encoding.

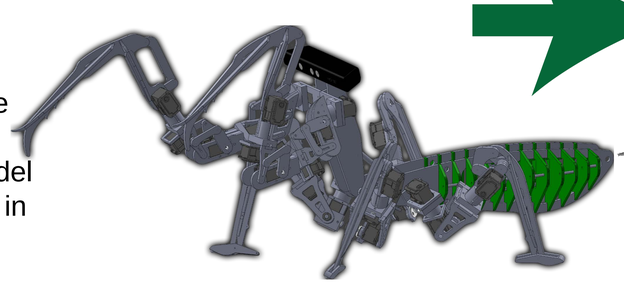


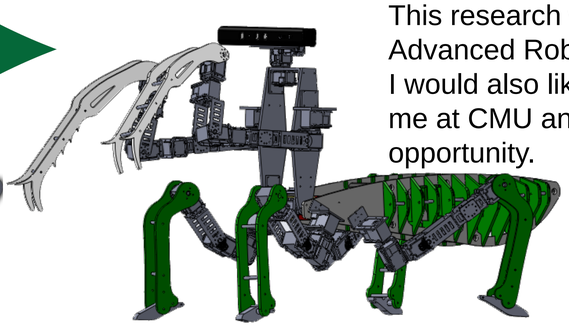
Redesigned the leg to overcome max torque issues by using off-the-shelf servo brackets to save weight and reduce complexity and also added a spring mechanism to the first elevator joint in each leg to help with the torque load. The springs also help reduce power consumption when the robot is in a static position. The 4 bar linkage was removed and the tibia was mounted directly to the servo horn to increase range of motion.



Redesigned the arm with off-the-shelf parts to also save weight and reduce complexity. Replaced the MX-64 servos in the front leg elevator joint with MX-106's in order to resolve max torque issues. The 4 bar linkage was also removed in the arms to increase range of motion.

The pan/tilt assembly was redesigned to a pan/tilt/roll and the servos were lined up with the Kinect's center mass, also a counterweight was mounted to the back of the tilt servo in order to keep the Kinect head level without keeping the tilt servo powered at all times.





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