Biomimetic Robotic Hand

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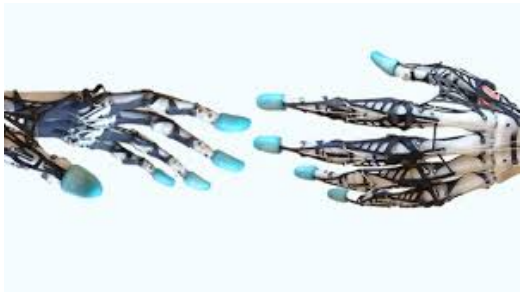
***Abstract*—A biomimetic robotic hand is a prosthetic hand whose main purpose is to closely mimic a human hand. These devices are being made in order to one day be used as a replacement for lost upper limbs so patients can experience the same level of dexterity as with a natural hand.**

I. Introduction

Current hand prosthetics available on the market give up dexterity and precision with the hand in favor of a cheaper design and easier accessibility for more patients. The main purpose of this paticular prosthetic hand is to get as close as humanly possible to recreate the minute details that the human hand makes. This more realistic approach to the prosthetic method allows the user the most lifelike recreation of a hand ever built. The creation of this technologically advanced hand is the first step in a series to allow amputees a chance to regain the dexterity and mobility like never before.

II. Methods

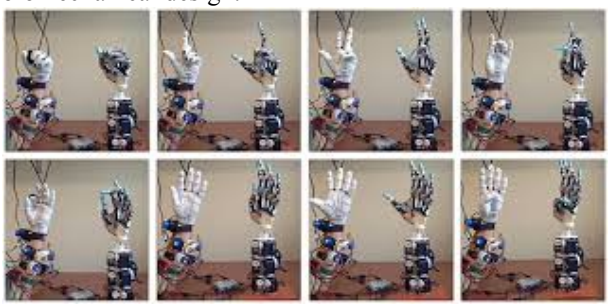
In order to create this mimetic device engineers Zhen Xu and Emanuel Todorov studied the fine biomechanics of the human hand. In the past replicating the human hand with "hinges, linkages, and gimbals" left the prosthetic not working as well as engineers would have hoped. These engineers approached the situation with a different method, one that included scanning a real human hand, then 3D printing it as artificial bones. They realized that the human hand was such a complex system that trying to redesign it would be redundant and not as effective. Printing all the bones in the human hand allows for all the joints to be present in the prosthetic.



One important difference that allows this robotic hand to be more versatile than prosthetics currently on the market is the inclusion of each of the important joints in the phalanges. Most prosthetics use two Degree of Freedom joints instead of the metacarpophalangeal joint. Although using the two Degree of Freedom joints allows for the finger to transmit rotary motion it does not let the finger twist in axial directions. Little details like this is what separates regular prosthetic from this biomimetic hand.

III. Results

Collecting results qualitatively for this device was done through fingertip trajectories which are controlled through flexion and extension motions from a Dynamixel servos through differential pulley transmissions. Movements were then tele operated through by a human in a data glove to test the trajectories of each finger as they move. The engineer used a process known as tele manipulation at which point he wore the data glove which remotely moved the biomimetic hand, and handed the device different objects to observe how the hand grasped the object. It was observed that the biomimetic hand naturally grasps onto these objects due to its natural biomechanical design.



IV. Discussion

This hand is a revolution in prosthetic design. Although it has not been implemented onto an amputee, the future looks bright for engineers Zhe Xu and Emanuel Todorov in this field. The limitations said by the engineers themselves include "lack of properly translated engineering knowledge into the human hand" and "restrictions caused by mechanical joints". The problem with the restriction of the joints may be caused by the materials being used. These engineers may need to test the biomimetic hand with other materials in order to find a good fit with the joints. In the future they plan on working on a biomimetic wrist to join with the hand for as close to a full range of motion that can be manufactured for the upper extremities.

References

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