

# Development of an Electric Prosthetic Hand with an Anti-Slip Tactile System

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## Introduction



Electric prosthetic hands are often inaccessible to amputees due to their high costs. Despite their high costs, most electric hand prosthesis lack the proper system for humanlike nonchalant grasping, resulting in higher than normal concentration to control the prosthetic hand which leads to fatigue. This project aims to develop a 1DOF electric prosthetic hand with an anti-slip tactile system that can enable amputees to grasp objects securely.

## Prosthetic Hand Design & Manufacturing

### Design

- Four-Bar Linkage 1 DOF
- 100 N Designed Grasping Force, 0.5 Second Closing Time
- Novel Sliced Bevel Gear Design

### Manufacturing

- 6061 and 7075 Aluminium parts machined with a 9 Axis CNC Machining Center to tolerance
- 304 Stainless Steel parts cut with a waterjet machine
- Other parts sourced from professional suppliers

### Control Components

- Tangential Force Sensor for Anti-Slip System
- PJRC Teensy 3.1 microcontrollers
- maxon ESCON 24/2 4Q motor driver

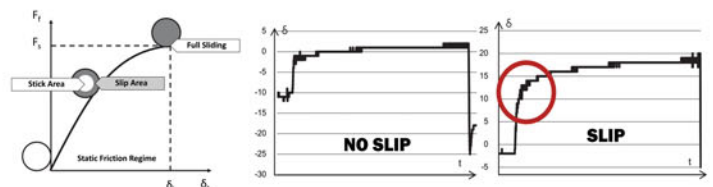


## Slip Detection & Grasp Control

In order to adequately control grasping force in the prosthetic hand, an anti-slip control method had to be implemented. A proprietary fingertip tangential force sensor based on a hall effect displacement sensor for slip detection was developed.



After the sensor was installed on the completed prosthetic hand, the hand was installed onto a robotic wrist and arm to perform preliminary tests to find the optimum slip detection algorithm. It was found that the Mindlin's theory of static friction complies with the test results and thus can be used to detect the onset of slip.



**Mindlin's Theory of Friction and Sample Data from the Sensor**

The developed slip detection algorithm was applied to a current/force control scheme in the prosthetic hand's control software. If slip is detected, the controller will increase the current limit of the motor by a gain derived from the amount of slip sensed by the tangential force sensor. A series of trials were then performed to evaluate the performance of the hand.

## Conclusion & Remarks

An electric prosthetic hand with an anti-slip tactile system was successfully developed. Although the slip detection and grasping force control is still in its infancy, there is a considerable potential to use the sensor for other methods slip detection.

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