

# THE PSYONIC COMPLIANT, SENSORIZED PROSTHETIC HAND

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## ABSTRACT

We present a compliant, sensorized prosthetic hand that enables both motor control and sensory feedback for people with upper limb amputations. The hand has six powered degrees of freedom, corresponding to flexion/extension in all five fingers and thumb rotation. The dimensions of the hand are at 50th percentile female anthropometry.

The fingers of the prosthesis were designed to be compliant and can withstand sharp impact forces applied from anterior, posterior, and lateral directions. We achieve compliance in the distal and proximal interphalangeal joints through the use of a flexible bone inside of a silicone outer structure. Worm gears provide non-backdrivability to decrease power consumption when gripping objects with constant high torque. The worm gears and motors are protected from environmental shock since the compliant joints prevent damage to the gears.

Pressure sensing is achieved through a flexible printed circuit board that houses three pressure sensors and can wrap around the proximal interphalangeal joint of the finger. The finger is able to detect pressure through the use of three MPL3115A2 barometric pressure sensors (Freescale, Austin, TX) mounted on the flexible PCB. We cast the sensors in silicone (Dragon Skin 20, Smooth-On, Macungie, PA) to turn them into sensitive contact pressure sensors. The three sensors are placed over common areas of contact (fingertip, finger pad, and lateral finger) when making power and lateral grasps. The pressure readings can easily be mapped to sensations provided through vibrotactile, electrotactile, or other sensory feedback interfaces.

The entire hand can be built for less than \$1000. This low cost makes research and development of sensorimotor prosthetic hands more accessible to researchers worldwide, while also being affordable for people with amputations in developing nations. Furthermore, the hand can be easily integrated into standard sockets, facilitating long-term use and testing of sensorimotor capabilities.