

Workshop on Actuation & Sensing in Robotics

Session C - Prosthetics

C1

Sensing and actuation of a transradial hand prosthesis

Christian Cipriani, M. Controzzi, M.C. Carrozza
ARTS Lab, Scuola Superiore Sant'Anna, Pisa, Italy

The hand is a powerful tool and its loss causes a severe psychological and physical drawback. Despite the significant impact of losing a hand, numbers of amputees requiring a prosthesis are too small to push manufacturers to innovate their products, so that both control interfaces and mechanisms have almost not changed in the past 40 years. A new anthropomorphic transradial prosthesis named SmartHand has been designed and developed. It is a five fingered self-contained robotic hand, with 16 degrees of freedom, actuated by 4 motors. Underactuated fingers and differential mechanisms have been designed and exploited in order to fit all functional components in the size and weight of a natural human hand. The hand is able to perform everyday grasps, count and independently point the index. It integrates 40 proprioceptive and exteroceptive sensors both employed for implementing automatic control and for delivering sensory feedback to the amputee, by means of suitable afferent interfaces [1]. This is possible due to a customized embedded controller, able to execute control loops and bi-directionally exchange information with the external world. The weight of the hand is similar to the natural hand weight and comparable to actual commercial prostheses (hand 530g plus 145g for the standard wrist attachment). Speed is comparable to commercial prostheses: the hand fully opens/closes in 1.5 seconds, being able to stably grasp up to 3.6 kg objects and lift a 10 kg suitcase.

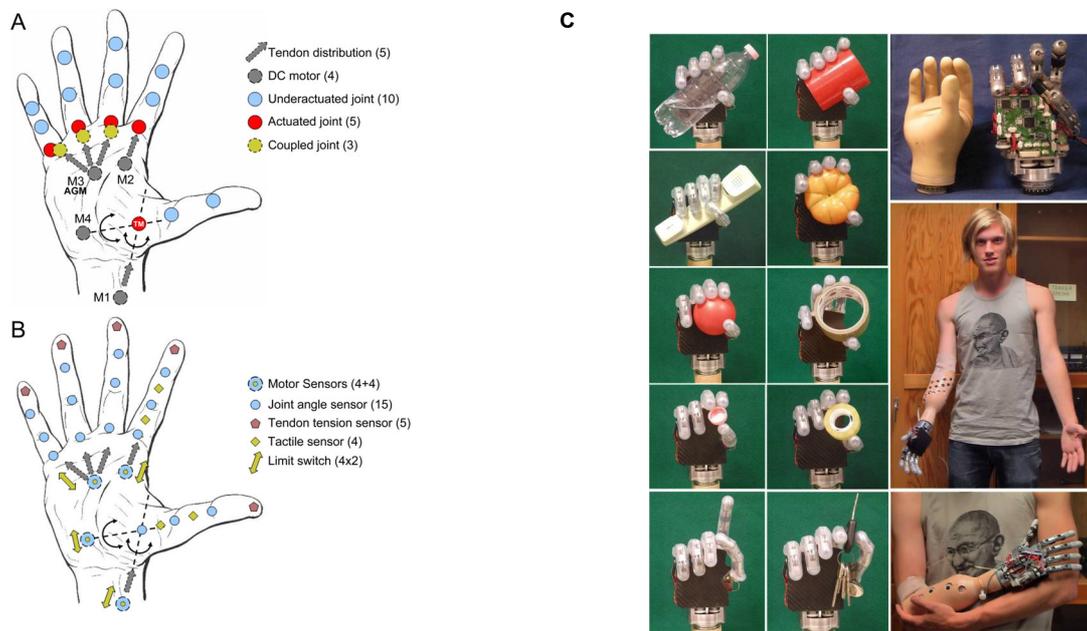


Figure - SmartHand architecture (number of elements used are given in parentheses). A) Distribution of DoFs, tendons, joints and actuators (AGM = adaptive grasping mechanism, TM = trapezio-metacarpal joint). B) Distribution of sensors. Motor sensors are 4 current plus 4 position sensors. C) Left columns: the SmartHand with silicone tubes on the fingers in the three basic prehensile patterns: power, precision and lateral grasps. Right column: SmartHand in comparison with a commercial prosthesis and fitted on a transradial amputee.

- [1] C. Cipriani, M. Controzzi, and M. C. Carrozza, "Objectives, Criteria and Methods for the Design of the SmartHand Transradial Prosthesis," *Robotica*, vol. 28, no. 6, pp. 919-927, 2010.