Development of a modular, low-cost, maintainable bionic hand prosthetic device

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Loss of a limb has a profound impact on an individual's activities of daily living. Furthermore, if only one extremity is injured or amputated, overuse of the remaining limb will result in deterioration of joints and muscle. For people living in developing countries cost and maintenance are limiting factors to prosthetic use: the price of a prosthetic can exceed a year's salary, and complex assembly and maintenance limit a user located in rural areas. In this work, we present a low-cost, modular prosthetic hand as a solution to this problem. The palm and main assembly of the prosthetic was 3D-printed using flexible TPU filament and Open Bionics Ada v1.1 design. Housed in the hand is a rechargeable Lithium Polymer battery and readily available power management circuits. To control the fingers, a printed circuit board, using an ATMega32U4 microcontroller, was fabricated to take sensory input from a myoelectric sensor connected to the residual limb of the amputee. Algorithms for "training" the sensor and translating sensor data into movement of the fingers were developed using readily available Arduino libraries. A linear actuator is used to control each finger. Cost of one hand totals $500 dollars with linear actuators taking $350 in total. Initial tests show the hand capable of grasping simple objects such as a bag handle or bottle of water. Attaching the prosthetic to a standard socket will allow for better mechanical understanding of the grip. Compared to commercial designs that can cost up to $50,000, overall cost was kept low, however development of custom servo designs could drastically reduce costs. Maintenance on the hand is expected to be low as all pieces, including the battery, are contained inside the sealed body. Further improvements include incorporating position feedback along with custom sensor integration.