Designing a Robotic Arm Prosthesis With the Integration of FDM 3D Printing, Haptic Feedback, FSRs, and Machine Vision

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Current prosthetic arm technology often lacks intelligent dexterity, haptic feedback, and are lucratively expensive ranging from 20,000 to 100,000 dollars. The engineering goal of this project was to design a smarter, dexterous, and cost-effective robotic arm prosthesis with the integration of machine vision, haptic feedback, and FDM 3D printing. As the user reaches toward an object, a camera attached to the wrist runs a TensorflowLite machine vision model that identifies the object class, its confidence, size, orientation, and context behind the class of object. This information determines the optimal grasp type, force, and hand motion. This is sent over through serial communication to a custom PCB which then controls all sensory input. The user initiates the grasp through an EMG sensor which detects muscle stimulation. An onboard accelerometer/gyroscope and distance sensor determines the position, movement, and distance to the target object, giving context to the desired task. For haptic feedback and force regulation, force-sensitive resistors were used which simultaneously sends signals to the vibration motors attached to the bicep, also giving the user a sense of touch. This system allows the prosthesis to intelligently determine grasp type and wrist movement using machine vision and its various sensors, as well as giving the user haptic feedback. It carries out tasks with 16 DoF, a 0.28-second flexion speed comparable to a human, and 15 newtons in each finger. At a cost of only 500 dollars, it is one of the most advanced, cost-efficient, prosthetic arms available today.

Awards Won:

Second Award of $2,000