Design and Development of an Adaptable Gear-Based Upper Limb Prosthesis Using Additive Manufacturing and a Novel Visco-Elastic Material

Lothamer, Benjamin (School: Mid-Prairie Home School Education Center)

Developing functional prostheses, especially for the upper limb, has historically posed challenges. Amputation of the hand due to military injury, disease, or other trauma carries significant psychosocial implications, warranting exploration within orthotics and prosthetics. Timely access to prostheses influences patient usage, rehabilitation, cost-effectiveness, and healthcare burden. Problem: This project addresses key issues with current market devices and cable-driven prototype, focusing on the accessibility and cost-effectiveness of upper-limb prostheses aiming to decrease wait times while ensuring better functionality and reliability over cable-and counter-driven designs. Engineering Design Process: Research and development of this device encompasses considerations of anatomy, physiology, prosthetics, biomechanical engineering, robotics, psychosocial factors. Employing computer-aided design and programming logic, the project develops a novel adaptable gear-based system, reducing wait times for these devices through iterative design processes, leveraging off-the-shelf products, and FDM 3-D printing and visco-elastic material. Solution: The current iteration features a custom passthrough adaptable gear-based system, allowing the hand to passively adapt to objects, completing the 7 primary grip patterns more effectively. Each finger is individually controlled by a brushless servomotor allowing greater control of device. Additive manufacturing techniques explored to reduce cost, emphasizing readily available off-the-shelf components for efficient replacement part sourcing using a novel visco-elastic material. Applications include usage as a training device, temporary prosthetic at military/veteran hospitals, and as a more accessible, cost-effective permanent device.

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