MYOELECTRIC PROSTHETIC HANDS: PERSONALIZING PROSTHETICS THROUGH INNOVATION

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Abstract

In our rapidly advancing world, the need for more complex and developed prosthetics is growing exponentially. Prosthetics not only give people physical capabilities that were missing, but also provides them confidence and a sense of normality.

The static, unmoving prosthetics of the past have failed to provide a personalized and practical experience for the recipient. Out of the most common prosthetic procedures, hand prosthetics are the most demanding of advancement. This is due to the extreme inability to complete daily tasks without them. Scientists and engineers have been researching ways in which prosthetic hands can move, feel, and grab objects with the versatility and utility of a real human appendage.

Myoelectric technology, which came about within the last century, has served as the best solution to the problem of unmoving prosthetics. Myoelectric prosthetics are a relatively new innovation that uses biosensors that are naturally created by human muscles to control the prosthetic hand device.

Myoelectric prosthetics fall under the field of bio-mechatronics, which is the use of science, combined with knowledge of the body's muscle, skeletal, and organ systems in order to fix the loss of body parts or a defect in them. Specifically, these hands are artificially created and are controlled by sending electric signals that are naturally generated by the users very own muscles. In the United States alone, there are over two million people living with limb loss. This statistic proves the urgent necessity for advancement in the American prosthetics industry.

Sustainability

To ensure a product becomes and stays successful a company must focus on sustainability to make this happen. A key way myoelectric prosthetics maintain sustainability is by using rechargeable batteries.

- Rechargeable Batteries
  - Lower Environmental Impact
  - Last up to 2 to 3 years
  - Can be recycled once used

The high quality and advanced materials of myoelectric prosthetics is a large affect on the environment and the market. Materials used to make the components are mainly metal and electrical equipment that leave a harsh impact on the environment if not taken care of properly. These materials also come at high prices that steer some customers away.

- Bebionic3 hand and socket is made from expensive carbon fiber

Some companies have been able to produce products at lower costs that are much more affordable for consumers.

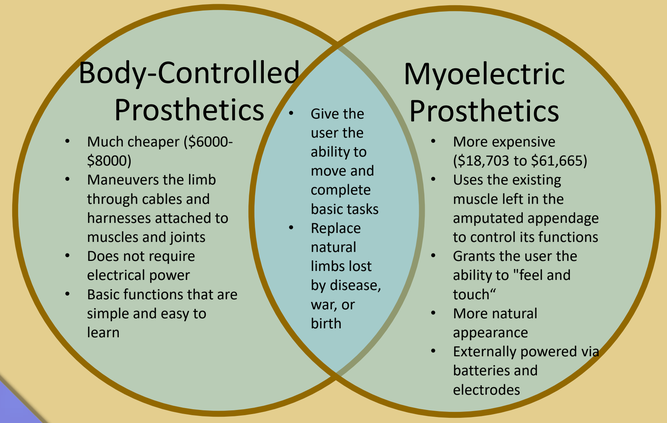
- Open bionics 3D prints prosthetics from plastics

Myoelectric prosthetics have proven their long-lasting future presence on the market by selling at such high prices. As advancements in this technology continue, cheaper process and materials will lower costs greatly. More affordable myoelectric prosthetics will increase their popularity, creating a more wider consumer base. Through their short history, myoelectric prosthetics have been a high ticket item, but as the product grows it give hopefulness to a greater future for this product.

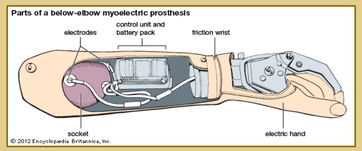
What Are Myoelectric Prosthetics?

A prosthetic is an artificial extension of the human body that replaces a missing body part. Its function ranges from the purely cosmetic to emulating a fully functioning body part. The prosthetic that captures both functions is the myoelectric prosthetic. Myoelectric Prosthetics are advanced prosthetics that use biosensors to detect muscle and nerve activity to control an electrical prosthetic that moves in a life like motion. Electromyographic (EMG) devices are the biosensors used to detect the bio signals generated by the user. EMG sensors utilize epidermal electron systems (EES) to link with the skin to read and amplify electrical signals from muscles The contraction and relaxation of muscle fiber produces electrical activity that an EMG device measures then produces into movement. EES is a complex system of very thin gold wires interconnected with electrodes placed precisely on the skin.

The main competitor to myoelectric prosthetics is the body-controlled prosthetic.



The unique feature to myoelectric prosthetics is it grants the user the ability to "feel and touch"; which is possible by grip patterns. Grip patterns, also known as grasp patterns, are the basic movements and individual abilities of the fingers that come unique to myoelectric prosthetics. The grip patterns are triggered via the patient by flexing certain muscles within their residual limb. Movements picked up by the EMG are translated into the grip pattern the user wants to do. Grip patterns are the essential movements that make up the human hand and grant the life like capabilities of a myoelectric prosthetic.



History

The prosthetic industry, which dates back to 1500 BC, has been constantly evolving from its humble beginnings as wooden toes in ancient Egypt to the advanced bionic limbs of today. For the longest time prosthetics were mainly used as placeholders for a dismembered limb. The only advancements came from adaptation to hold a shield or weapon in battle. Ambroise Pare (1510-1590), considered to be the father of modern amputation and prosthetic design, made important- contributions to lower and upper prosthetics. His work on improving amputations made the fitting and designing of prosthetics much easier thus giving him the basis he needed to design his revolutionary above-the-knee prosthetic that has the locking knee and suspension harness design that is still used today. A future for myoelectric prosthetics came to light in 1949, when the first model of an electrically controlled prosthetic arm was developed. This lead to a greater focus in understanding sensory feedback to improve myoelectric prosthetics. Many advancements, setbacks, changes in focus and improved technologies arrived that gave way to the "first bionic arm" in 1993. Since then, myoelectric prosthetics have continued to evolve to become more responsive, ergonomic, and stronger.

Future

One of the more prominent group of activists for prosthetic improvement would be war veterans who have suffered from disfigurements. Their collective disappointment towards the performance of artificial limbs was heard by the government which spawned a multitude of organizations designated to furthering the advancement of prosthetics. Governmental agencies often fund small organizations that are working on creating innovative technologies in prosthetics. The advancement of prosthetics has brought hope to the future of prosthetics. The continual activism for the advancement of prosthetics and private businesses continuing to advance the technology will bring future interest and investment into the industry. However, prosthetics may not be a necessity in the future as the advancement of limb regeneration is progressing. Tissue and limb regeneration to this scale has not become a reality yet, but some bioengineers and medical experts believe that body tissue regeneration is a possibility by the time the century is over. Advances of artificial tissue technology have rapidly increased throughout the years and have the possibility of surpassing the need for prosthetics. These advancements pose a question of whether prosthetics will not be necessary in the future.

Ethics

With most engineering innovations, there are expected ethical dilemmas that arise when a new idea is introduced. This is no different with myoelectric prosthetics. The inhabitants of the world have become accustomed to static prosthetics over the course of almost three millennia. This long duration of time created a norm that people are still uneasy about leaving and exploring myoelectric prosthetics.

As we have seen with other modern technologies like smart phones and the world wide web, some people have major difficulties understanding how the devices work and how to take advantage of its full power. This is especially evident with young children and people of advanced age, who are the most susceptible to limb loss. Another dilemma lies in public fear of the potential threat of a technologically-based Armageddon where robots, machines, and devices all conspire against the human race and take over the world. With this fear, regardless of how illogical it may be, many are uncomfortable with the idea of having "smart" prosthetics in that they are capable of doing much more than the prosthetics of the past.

The final major ethical dilemma is in the costs of the prosthetics. It is without surprise that prosthetics that can sense biosignals are more expensive than those that cannot. There is a lot of discussion in whether people of lower incomes will be able to afford such prosthetics, and if the people cannot afford them, whether continuing in future development will be creating a socioeconomic divide. Additionally, if companies are not able to profit from these products, they may not be able to be successfully produced commercially

In the Real World

In the 2015 World Series, a little 7-year-old girl named Hailey Dawson, pictured above in Figure 6, proved the importance and the power behind a myoelectric limb by tossing the first pitch of the game. Not only was Hailey able to fully complete the task as if she had a natural human appendage, but she was also able to do so with a sense of confidence that is so important to amputee patients.

Nigel Ackland lost his hand in a working incident that left him dismembered from the elbow down. After his injury he was left depressed and out of work, but thankfully to the Bebionic3 myoelectric prosthetic, his faith in life was restored. He has now returned to work and is a part time motivational speaker.