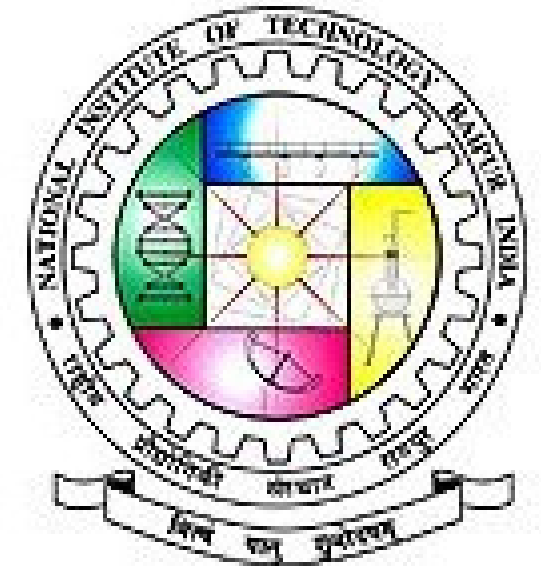
NATIONAL INSTITUTE OF TECHNOLOGY RAIPUR

Basic Biomedical Term Project



AI in Prosthetics

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Acknowledgment

I express my deepest gratitude to all those who helped me prepare and complete my Project work entitled "**AI in Prosthetics"**. First, I convey my sincere respect and deep gratitude to **Dr. Saurabh Gupta Sir, Assistant Professor, National Institute of Technology** for his inspiration, cooperation, and encouragement in pursuing my dissertation. His valuable suggestions and guidance helped me a lot to complete my work in this institution within the stipulated time. I render my sincere respect and gratitude to all the faculty members, for their valuable suggestions towards the completion of this project work. I am also grateful to all my classmates, who helped me directly or indirectly in completing my project work successfully.

Date of submission: 7th April 2022

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Abstract

Technological integration of Artificial Intelligence (AI) and machine learning in the Prosthetic and Orthotic industry and the field of assistive technology has become a boon for the Persons with Disabilities.

The concept of neural networks has been used by the leading manufacturers of rehabilitation aids for simulating various anatomical and biomechanical functions of the lost parts of the human body. The involvement of human interaction with various agents' i.e. electronic circuitry, software, robotics, etc. has made a revolutionary impact in the rehabilitation field to develop devices like Bionic legs, mind or thought control prostheses, and exoskeletons.

Introduction

Research in the field of smart prosthetics has come a long way in the last few years, thanks to the developments in the field of digital healthcare technology and the **Internet of Medical Things**.

Breakthrough in AI and Robotics has led to revolutionary physical rehab devices such as mind-controlled prostheses, and exoskeletons.

When AI is incorporated into these smart prostheses, it enables the algorithm to interpret electric nerve signals from the patient's muscles so that the prosthesis can be controlled more precisely.

How AI and machine learning are changing prosthetics

Imagine a prosthetic arm with the sensory capabilities of a human arm or a robotic ankle that mimics the healthy ankle's response to changing activity. Hollywood has long popularized imaginative versions of such ideas. While human engineering may not yet be able to produce superhero-enabling devices, prosthetics are getting "smarter" and more adaptive, approaching a reality in which amputees' artificial appendages offer near-normal function.

Bioengineers are increasingly looking to create "human-machine interfaces embodied by a prosthetic limb that feel like an extension of the body," said Robert Armiger, project manager for amputee research at Johns Hopkins University's Applied Physics Lab, where scientists have developed an arm with human-like reflexes and sensation.

The Age of Smart prosthetics

Additive manufacturing is tremendously shaping the human ability to create wearable devices. Prosthetic limbs designed and manufactured with the help of 3D printed prosthetics are an attractive option for limb replacement.

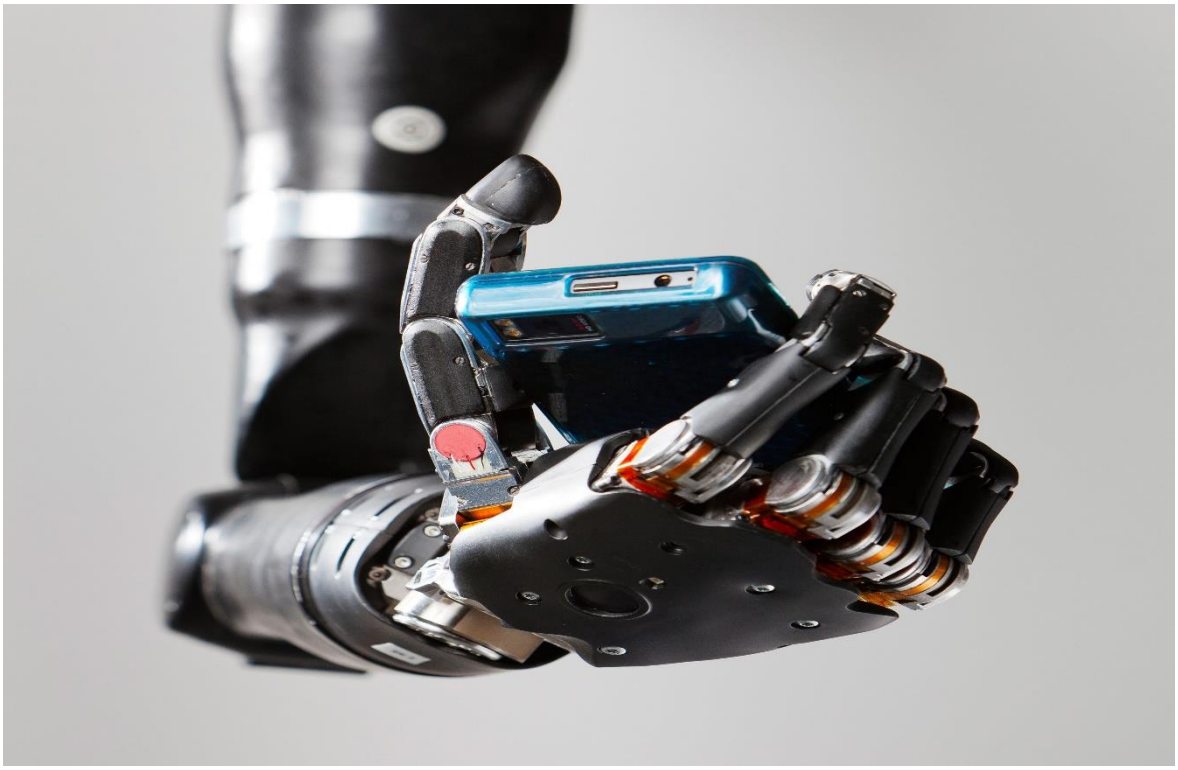
The basis of incorporating A.I. in robotic prostheses is that the algorithm interprets nerve signals from the patient’s muscles which will allow for the prosthesis to be controlled more precisely.

“A.I. has become a cornerstone of all externally powered (motor driven) upper limb prostheses R&D, but has been difficult to apply to lower limb prostheses,”

Lévay says. However, a study published in Science Translational Medicine by a team of the University of Michigan in March 2020 documents a new method to incorporate the technology with more types of prostheses.

Integrating AI into the prosthesis

Using regenerative peripheral nerve interface and machine learning algorithms, the prosthesis wearer can perform subtle movements such as picking up a fallen object or holding fingers together. This is possible because, during the surgery, a small piece of muscle is wrapped around the amputated nerve to produce amplified signals.



Thought-controlled Arms

The robotic arm being developed at Johns Hopkins APL has 26 joints and 'load cells' in each fingertip to detect force and the torque applied to each knuckle. Sensors give feedback on

temperature and vibration and collect the data to mimic what the human arm can detect. It responds to thought much like a normal arm.

- The device attaches to the user via an osseointegration implant, a small post that goes into the bone and protrudes through the skin.
- That orientation allows the device to clamp directly onto the skeletal system, giving the user a more natural understanding of how the limb is moving.
- By attaching to the bone, the perception of weight is also lower than traditional external attachments.
- Users also undergo what's called targeted muscle reintervention, which rewires the nerves in the upper arm to twitch when the user thinks of moving his or her hand. Separate sensors attach to the skin over the top of the muscles and correspond with the intended movement.

Current limitations to the mass adoption of A.I. prosthetics

Firstly, many of the developments in the prosthetics field are proofs of concept. The A. I. prosthesis from the University of Michigan depends on a wired connection to a computer. “Everything that we’ve done so far has been six feet away from a computer cart [and people come in once or twice a week for the trial],” explained Cynthia Chestek.

“We want people to be able to do this with an implantable device so we can move away from the cart”.

There’s still work to be done before this concept leaves the lab. Once it does leave the lab, the smart prosthesis will face another

slowdown as it transitions to a company and seeks approvals from regulators like the FDA. Along with this transition comes the cost factor that could limit their adoption. “The use of A. I. increases the cost of a prosthetic device significantly (on the order of tens of thousands of dollars),” György Lévay tells The Medical Futurist.

Future of AI in Prosthetics

Looking to the future, People around the world are hopeful that more sophisticated prosthetic devices are on the way, especially with greater private sector involvement, as seen with Elon Musk’s brain-computer interface firm Neuralink and Deka’s impressive LUKE Arm.

It’s the beginning of a long and winding road toward brain-controlled prosthetic hands that can leverage sensory feedback to approximate the hand’s natural dexterity. But the unmet needs of amputees, and tetraplegics especially, are many, and restoring a

sense of touch and movement to those who have had to live without them is a powerful motivating force.

Conclusion

A human being is a most intelligent and complex engineered structure created by the almighty. It is a tough challenge for the Prosthetist & Orthotist to replicate its lost anatomical structure and function. However, advancement in the field of AI and robotics has created a ray of hope for millions of persons with disabilities.

The application of AI in the field of prosthetics and orthotics is in the initial stage and not so widely practiced. Many projects using AI are in the prototype stage and not yet commercialized. The high costs of these devices are being major limitations as many Persons with disabilities cannot afford them. Government bodies, manufacturing units, and funding agencies must come forward and invest in this field so that the highest quality and latest technology must reach a larger population of disabled at an affordable cost.

References

The future of prosthetics: designing artificial limbs with the sense of touch

The Future of Prosthetics Might Be in This Mind-Controlled Bionic Arm

The Future Of Prosthetics Depends On A.I. - The Medical Futurist

How AI and machine learning are changing prosthetics | MedTech Dive