Article can be accessed online at http://www.publishingindia.com

Artificial Intelligence in Prosthesis

Avinash Aslekar*, Samaya Pillai, Vikas Kumar***, Akshay Borde******

**Associate Professor, Symbiosis Institute of Telecom Management, Constituent of Symbiosis International (Deemed University), Maharashtra, India. Email: aslekar@sitm.ac.in*

***Assistant Professor, Symbiosis Institute of Telecom Management, Constituent of Symbiosis International (Deemed University), Maharashtra, India. Email: samaya.pillai@sitm.ac.in*

****Student, Symbiosis Institute of Telecom Management, Constituent of Symbiosis International (Deemed University), Maharashtra, India. Email: vikas.kumar@sitm.ac.in*

*****Student, Symbiosis Institute of Telecom Management, Constituent of Symbiosis International (Deemed University), Maharashtra, India. Email: akshay.borde@sitm.ac.in*

Abstract

Artificial Intelligence is the capacity for learning, reasoning, and understanding and makes the usefulness of the data available. The evolution of the small powerful computing platforms has opened many opportunities for the world of Prosthetics. This allows for more complex methods to be used to interpret the input from various sensors to build an image of the environment in which the prosthetic device is supposed to function. Not only is it possible to use mechanical sensors as input into such systems, but it is also possible to augment the control of mechanical actuators through the filtering of neural signals. The main outline of this paper is to show the importance of including AI in the procedures to plan Electromyography based model prosthetic arm, such that can emulate the activities like a genuine human arm. Current prosthetic gadgets have restricted usefulness and are taken a toll restrictive. Outlining a financially savvy prosthetic human hand is the significant concentration of this paper. This examination will fill in as a stage for future prosthesis advancement endeavors.

Keywords: Artificial Intelligence, Prosthetics, Amputee, Electromyography

1. Introduction

The meaning of Prosthesis comes from the Greek word "prostithenai "which literally means "add to" or "in addition". "Prosthesis" is an artificial replacement of any body part in the humans. It is essentially conducted for a basic functional reason in case of accidents or defects. Or sometimes for a cosmetic reason. Broadly prosthetics can be classified as Permanent or Removable. Depending on its location in the body, like hip, tooth or testicle is permanent. Whereas legs, breast etc. are removable. It can also happen that a person can have more than one prosthetic hands, which can be used for different types of tasks. With Advancements in bio-medicine and technology, there have been experiments to integrate prosthetics in tissues including even the nervous systems. These empower the nervous system functioning. This can be a big enabler in people having problems in coordinating movements as per the nervous system. There are also auditory prosthetics used for enhancing hearing in people having issues related to hearing.

John Mc Carthy, the father of Artificial Intelligence, envisioned AI as the science and engineering of infusing machines with "intelligence," with the objective of reflecting a human being's unique reasoning talents. The emergence of the digital age with data hunger, increasing computer processing power has lead firms across the globe to make conscious efforts in strengthening AI technology in their respective industries. As the adoption rate for AI expands, it would pose more challenges for the suppliers and the adopters to keep up. Since we live in the world of multi-disciplinary collaboration, the expansion in one field is likely to influence the other. In the rapidly changing consumer demands, it put the companies under greater stress to imbibe in the new technology, formulate strategies around it, all while proving efficiencies and new revenue.

2. Prosthetics Limbs

In Medical term, a prosthesis is a pretended gadget that can substitute a missing body part. This could happen

due to injury, sickness, or inborn conditions. This principally organized by a "prosthetist". The process is termed as "Prosthetic amputation". The process also involves an interdisciplinary group of medicinal services experts inclusive of specialists, physical advisors, and word related specialist, and for the most part concerning this proposal, occupations, for example, designers, program and programming engineers lastly the field of biomedicine. An appendage might be cut off or missing in light of a vein issue, (for example, atherosclerosis or harm because of diabetes), disease, damage (as in an engine of any vehicle crash or amid battle), or a defect at birth. In the USA, somewhat less than 0.5% of individuals have had a removal. In any case, the rate is probably going to increment in years to come due to the increase in weight of people. It may expand the danger of atherosclerosis as well as diabetes. A whole appendage or simply part of one might be removed. A lower-appendage removal may include parts of leg viz. a toe, a foot, some portion of the leg beneath or over the knee, or a whole leg (from the hip). A removal might stretch out over the hip. An upper-appendage removal might include at least one of the fingers, a hand, some portion of the arm underneath or over the elbow, or a whole arm (from the shoulder). On the off chance that a body part is feeling the loss of, a counterfeit gadget (prosthesis) is regularly prescribed to supplant that part. At the very least, a prosthesis should empower the client to perform everyday exercises, (for example, strolling, eating, and dressing) autonomously and serenely, and additionally moderateness and personalization. In any case, a prosthesis may empower the client to work too or almost and in addition before the removal (Issac Perry Clements, 2015).

3. Solution with AI for Prosthetics Limbs

The principal prosthetic limbs were made 700 BC. The first find was static and basically of tasteful nature. Afterward, body-fueled variations were created to furnish the user with more normal control. These prostheses are similarly shabby and take into consideration essential criticism to the controlling muscles however are stylishly less satisfying than current tasteful prostheses. Moreover, drawn out utilize applies strain and gadgets frequently require unnatural looking development, to control [MCR10]. To defeat those issues, remotely controlled prostheses were proposed after the main World War. This class of gadgets is isolated into switch-controlled and myoelectric prostheses. The principal business myoelectric gadget was created in 1960. The switch-based approach is controlled like body-fueled gadgets, and takes into consideration a fast learning stage however does not have the input that body-controlled prostheses give [MCR10]. Myoelectric gadgets depend on the electric flags that muscle action makes. At present driving suppliers of myoelectric prostheses are Otto Bock with a three-finger getting a handle on framework and Touch Bionics, whose hand-prosthesis iLimb gives five freely controllable fingers [MCR10]. By and large, prostheses are controlled by just couple of muscle gatherings. This requests complex control frameworks that enable the user to outfit the utility with restricted info conceivable outcomes. Along these lines numerous prostheses demonstration setting delicate and signals from muscles and setting are converged to take into account the correct response (Boston Globe, 2005).

4. Pattern Recognition

While the preparation stage should effortlessly be possible disconnected, the acknowledgment of new movement orders by means of EMG signals must be on the web and in a perfect world continuously. The technique that must be utilized to delineate new, unlabeled element vector to the class of the right signal, relies upon the classifier processed in the preparation stage. In the least demanding case, each class has an agent highlight design vector for example comprising of the RMS estimations all things considered. In the wake of being preprocessed and turned into highlight vectors, new EMG signs can be grouped by Nearest-Neighbor classifier (or then again k-Nearest-Neighbor, when each class comprises of a few delegate vectors). For this technique, and of a few separation capacities can be utilized, most ordinarily the Euclidean separation or the Mahalanobis remove.

On the off chance that an SVM has been utilized to figure the classifier, the new component vector must be connected to the choice capacity with a specific end goal to locate the right class of the planned motion. On account of a neural system classifier, the element vector must be connected to the info layer of the system, the subsequent class is then figured by the system furthermore, showed at its yield layer (Brain facts, 2009).

5. Difficulties with Prosthetic Leg

The prosthetic leg is the most common found amputation globally. It gives the person freedom of movement. But there are scores of problems which are generated because of the prosthetic leg. Some of the issues are: while

walking without the control and support of the leg joins, the legs may bend or flex on their own. If they rotate too much on their own, they generate a feeling of falling in the forward direction. So, the person controls the walks so as to reduce that feeling. The joints offer more resistance while walking a hill or stairs, which is overall painful. If the ankle does not provide enough movement, the person has to take the support of the healthy leg to move ahead, which is very taxing on the healthy leg and very tiring for the person. Running as an activity becomes a very difficult task for the people with a leg amputee. Running requires special limbs. The running blades worn by athletes are not suitable while standing. People using them have to be in motion constantly. For people with a prosthetic limb, standing still also becomes a challenge.

The amount of energy required for walking especially for those people who have lost a leg (from the knee), is tremendous. In comparison to those having legs, it is almost 60-80 percent more. These are termed as "trans femoral". Those who have lost their leg below knee require almost 30 percent more energy than the people with legs for walking. This is termed as "trans-tibial". This amounts to a great amount of energy as well as concentration. This ultimately can take a toll on the body. They are also required to take painkillers for the pain caused by the unnatural gait, the stance changes to their gait and the back pain. They more likely require a hip replacement or a knee replacement in their healthy leg.

Blatchford's Linx limb system utilizes data from the 7 built-in sensors. These sensors are in the foot, ankle, knee and main body of the prosthesis. They help to identify the terrain changes, the movement of the user and the activity that the person is executing. The sensors and actuators essentially imitate the nerves in a real leg. The information is sent to the microprocessor instead of the brain. The microprocessor then adapts the movement of the joins. The network consists of springs and dampers. These work on the same lines as the shock absorbers in a car, allowing the joints to absorb energy. This energy is used when the user requires to perform a movement like moving on the stairs, or generating a brake like a mechanism. This brake like occurs in positions of walking down a hill. As a result, wearers can walk more naturally and with greater stability than other prosthetic limbs allow (Saeed Zahedi, 2016).

6. Solution of Prosthetic Legs with AI

Össur started offering the Symbionic demonstrate as globally the first - financially accessible bionic leg in 2011. It speaks to a critical move in prostheses. The conventional substitutes for lost appendages and faculties. These are saturated with the device insight. A Symbionic leg is, simply put a robot. The robot has sensors that identify its condition and measure its aims, and processors. All these together decide the carbon-fiber foot as it performs any movement. A similar approach is followed for the connected prosthetic arms. Here compound calculations decide tasks like to get a handle on a bottle or when to assimilate the effect of a tumble. Vision and Auditory type prostheses sidestep flawed organs and receptors completely. These are then processed and made into an interpretation of crude sensor information into signals that the cerebrum can translate. These bionic frameworks effectively adjust to their clients, reestablishing the body structure by aiding it.

A mechanical knee regularly gets inflexible as the foot sole area lands. It thus supports the client's weight. The weight at that point opens when it is connected to the toe. The leg can squeeze due to the weight. The Symbionic Leg isn't so effortlessly tricked. Power sensors and accelerometers monitor the leg's position with respect to nature and client. Locally available processors examine this contribution at a rate of 1000 times each sec or unit time, choosing the best way to react - when to discharge strain and when to look after it.

Since the leg comprehends where it is from each walk, accomplishing a simple type of proprioception, it takes in excess of a stubbed toe to trigger a free knee. On the off chance that the prosthesis still by one means or another misreads the circumstance, the underlying reel of the client falling ought to initiate its stagger - recuperation mode.

Such automated block devices for the leg, the actuators will ease back to an end, and attractively restrain liquid in the knee will turn out to be much gooier, making opposition, as the whole framework strains to keep the individual from folding or toppling (Saeed Zahedi, 2016).

7. Problems with Prosthetic Arms

Correct duplication of so multifaceted and proficient an organ as the human hand seems to be, for every single functional reason, an inconceivability. Without the power sources, anxious affectability, and programmed reflexes accessible in the typical hand, the planner is looked with the issue of giving a prosthesis that in any event complies with outside setup of the living partner. For some reasons,

the substitution should present such a high level of constancy that it can't be recognized as a counterfeit gadget. However, outside proliferation restricts the number and sorts of controls that can be joined into a settled inside the territory.

The human hand is controlled by nearly 24 isolate muscle gatherings and is enriched with a helpful example of sharpening nerves. Movements in the ordinary are reflex or programmed, and next to no cognizant exertion is required to control the hand or fingers into a place of utility. In the amputee, be that as it may, such "personality controlled" power sources and nerve supplies are not accessible to the fashioner. Despite the fact that it is conceivable mechanically to give substitute movements to every single ordinary action, absence of sufficient control sources makes it outlandish for the amputee to work such gadget. It is vital first to decide the ideal number and sorts of advanced movements of the hand and what powers are required to work the system. It additionally is important to supply the prosthetic supplanting with a thought process source that is easy to work and, in the meantime, can give the finger powers important to productive pretension (Maurice J. Fletcher, 1955).

8. Solution of Prosthetics Arms Using AI

8.1 Bionic Arms

New research from Johns Hopkins University and DARPA reflect the reach of detecting bionic appendages. The research speaks of genuine appendage substitution. The effort with genuine amputees reveals how distinguishing bionics detecting is. Constancy in gathering controller data from the cerebrum or from anywhere in the sensory system controls the arm itself. This is a very critical step. It helps in controlling the arm. The appendage must be so exact so that it should not be able to make any harmful effect. Traditionally, this alludes to the delicate glass situation, like for example where a man with a bionic hand must handle some water immovably. It should have been done such so accurately that no water falls and so skillfully that the glass does not break. The best way to do this is to detect the amount of weight that is being connected. Also, vitally, the best way to judge the extra weight being transferred is to best decided by the mind of a human who can judge the quality of things. As of now, accessible data is marginally dubious about the location of the mind, which is being fortified to deliver the touch sensations. In any case, the people can effectively recognize the finger being contacted with close to 100% precision in the specific first preliminary, it's possible that the anodes are fortifying the segments of engine cortex as of now connected with fingers' consciousness. This separates the innovation from existing detecting innovation, which powers the person viz. amputee to create and shape new associations between new consciousness aka sensations and the new neural action and natural sensations. Several Diverse groups have contributed using a comparative methodology to accomplished and staggering starter concepts.

Obviously, having passed this kind of applied limit, the specialists begin to enhance the numbers included - number that apply to normal human recognition too. Sensation i.e. consciousness originating from a bionic source need not be speed-restricted by the dispersion of particles in an arrangement. The same goes for the tangible neurons. The neurons are temperature-constrained by the security requirements of substance. Bionic sensation could conceivably give a man a chance to put their hand on a griddle to test and check its temperature - and to judge it with their cerebrum, the same as they would do for any sensible level of warmth. They are building up the equipment important to reestablish the connection between the cerebrum and the outside world - and in the process building up the equipment important to totally change that relationship until the end of time. DARPA is financing this exploration due to the extraordinary potential it needs to enhance the lives of thousands of injured veterans - but at the same time, there's a lot of new military and mechanical incentive to be had, in any venture of this compose (Graham Templeton, September 15, 2015).

9. Conclusion

There are numerous lessons that can be learned from the past victories and disappointments of AI. To manage the advance of AI, a normal and consonant communication is required between application particular undertakings and visionary research thoughts. Alongside the phenomenal eagerness of AI, there are likewise fears about the effect of the innovation on our general public. A reasonable methodology is required to consider the related moral and legitimate difficulties to guarantee that the general public all in all will profit by the development of AI and its potential antagonistic impacts are alleviated from at an early stage. Such feelings of dread ought not to ruin the advance of AI but rather rouse the improvement of

a precise structure on which future AI will prosper. Most condemning of all, it is imperative to comprehend sci-fi from viable reality. With supported financing and dependable venture, AI is set to change the eventual fate of our general public - our life, our living condition and our economy (Hamlyn, 2017).

Limb loss is a standout amongst the most physically and mentally obliterating occasions that can happen to a man. Gratefully, the innovation has built up a considerable measure the previous decades, keeping in mind the end goal to serve individuals' needs. One of the fundamental ways is the passage of Artificial Intelligence in the field of Prosthetic appendages. In this proposition, we endeavored to complete a bibliographic review of the Prosthetics development and how AI has helped a great deal this region (Kyriazi Nefeli Evdokia, n.d.). These days and later on, there would be numerous choices for the amputees to picked, with various costs, potential outcomes and highlights. For the time being, there are a few disadvantages on extremely created Prosthetic appendages, similar to the cost. That makes the Prosthetic appendage reasonable not to anybody. 3D Printing has included and emphatically partaken in the field of Prosthetics, serving generally creating nations and individuals who can't bear the cost of the most progressive models. In any case, as we saw the innovation imported in 3D printed prosthetic appendages, is very best in class and promising for the future, as the youthful researchers and architects that include and show intrigue in this field are expanding (Brain facts, 2009).

However, numerous difficulties still exist and the improvements will be incremental. The scientists and architects are idealistic in the way such that the innovation empowers the amputees to have a typical life. Either with a bionic appendage that would speak with the best exactness with the cerebrum, or through the further advancement of 3D printing, which would empower anybody, with minimal effort to typify a counterfeit appendage, modified sufficiently keen to serve the client in the day by day needs (Kyriazi Nefeli Evdokia, n.d.).

References

Boston Globe. (5 July 2005). Cost of Prosthetics Stirs Debate. Retrieved 11 February 2007.

Brain Facts. (2009). Neuroscience Technologies: Brain Controlled Prosthetics. Retrieved from: https://ebiz.sfn.org/sso/login.aspx?vi=9&vt=115e0edf-5e7c1a6203ce54fd533a651c9ad18859651dccf2c545cbfa219f070cfdbec8a28e605c6fd09c6adf48c3f25e18ae8e1fb14c53c9eb055bc8f3b01c6f15e43816227e31b6c-4755f53144a108596b0b43908d77d151602c8fcf8f033c3&template=brainfacts&DPLF=Y

Cost Helper Health. (13 April 2015). Cost of a Prosthetic Limb. Retrieved http://health.costhelper.com/prosthetic-legs.html

Graham Templeton. (September 15, 2015). Sensing Bionics limbs are here- and they work. Retrieved from http://www.extremetech.com/extreme/214244-sensing-bionic-limbs-are-here-and-they-work

Hamlyn. (2017). Advancement in Artificial Intelligence and how it is helping in prosthetics. Retrieved from http://hamlyn.doc.ic.ac.uk/uk-ras/sites/default/files/UK_RAS_wp_AI_web_retina.pdf

Issac Perry Clements. (2015). Limb prosthetics. Retrieved from https://science.howstuffworks.com/prosthetic-limb.htm

Evdokia, K. N. (n.d.) AI and Prosthetics. Technologies enhancement and its innovation for prosthetics. Retrieved from https://upcommons.upc.edu/bitstream/handle/2117/90813/118258.pdf?sequence=1&isAllowed=y

Fletcher, M. J. (1955). Problems in designing of artificial prosthetic hands and its challenges. Retrieved from http://www.oandplibrary.org/op/1955_02_059.asp

Zahedi, S. (2016). Intelligent Prosthetics. Retrieved from http://www.ingenia.org.uk/Content/ingenia/issues/issue68/intelligent-prosthetics.pdf