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Prosthetic Limbs & Exoskeleton case Study in India for the Physically Disabled persons

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Abstract

In today world we have many people have the body parts missing or they are disabled with arms or legs. Cause of the missing limbs is inborn or due to the accidental factors. An accident can happen anywhere mostly talking to the India we have accidents relating to the sectors industries as Industries Accident and Road accident, Railways Accident and during the case of the war i.e. Army fighting in border . Most of the people lost their limbs during these accidents or happening.

Keywords: Prosthetic Limbs, Exoskeleton, Physically Disabled, Accident, Innovations, Robotics, Prosthetic Devices, Rehabilitation, Armed Forces, Research And Development

Purpose

– The purpose of this paper is to review recent developments in exoskeletons and robotic prosthetics.

Design/methodology/approach

– This paper first describes a number of recently developed exoskeletons for military, civil and medical applications. It then discusses robotic prosthetics and concludes with a brief consideration of progress in brain-computer interface (BCI) technology.

Findings

– Robotic exoskeletons are the topic of a major research effort, much being funded by the US military, and aims to impart superhuman strength to the wearer. Japanese research is also well advanced and concerns a range of non-military applications, including strength enhancement and medical rehabilitation. Some products have recently been commercialized. There has also been significant progress in the development of robotic prosthetic limbs, a topic which is also attracting support from the US military. A key aim is the development of thought-controlled prosthetics which will arise from advances in BCI technology.

Originality/value

– This paper provides a detailed review of the latest developments in exoskeletons and robotic prosthetics

I. INTRODUCTION

1. Introduction to Prosthetic or Artificial Limbs

A prosthetic limb is defined as a mechanical device that is used to replace a missing human limb. The device is designed to help the user coordinate better control of an amputated limp as a result of motor control loss by a traumatic event, a congenital-related defect, or dyvascular-related. According to statistics by Ziegler-Graham, et al (2008), an estimated 1.6 million civilians were living with the loss of a limb. This research also revealed that approximately 38% of these people suffered an amputation of a limb as a secondary consequence to a dyvascular disease. Shockingly, it has been predicted that this statistic is likely to double to 3.6 million by the year 2050.
Artificial, or prosthetic, limbs are considered a key element in the rehabilitation of both people with acquired limb loss and congenital limb deficiency. These technological aids are often able to restore some of the functions, as well as offering some aesthetic approximation, of an anatomical limb. [1]
[1] An Introduction to the Biomechanics of Prosthetics https://www.azorobotics.com/Article.aspx?ArticleID=11

2. Introduction to Exoskeleton

BCI-based systems can be used to support several different clinical rehabilitation processes. People with degenerative muscle diseases such as sarcopenia can be sup-ported with robotic exoskeletons that receive movement information from SEMG electrodes. Such systems are able to support activities of daily living (ADL) and can be used to help retrain muscles by regulating support strength, similar to an electric bicycle.

II. LITERATURE REVIEW

Table 1: Some research development in the field of prosthetic and Exoskeletons

Researchers	Years	Contribution
Robert Bogue (Okehampton, UK)	**2009**	*Exoskeletons and robotic prosthetics: a review of recent developments*

https://www.emeraldinsight.com

Proposed work

Artificial prosthetic limbs Problems and solutions for connecting brains and robots Current motorized limb prostheses provide rudimentary functionality for the application in everyday life. Together with poor cosmetic appearance this is the reason why a large percentage of amputees do not use their prosthetic device regularly. This works seeks to present an overview of current state of the art research on neural interfaces. The focus lies on non-invasive recording with EMG and especially High Density EMG sensors. Additionally, different machine learning and pattern recognition algorithms for the decoding of the recorded signals are discussed. Finally, promising research directions for advanced prosthesis control brain-computer-interfaces and robotic limb prostheses.

BCI Input Technologies:

There is a multitude of methods for interfacing brains and computers that have special strengths and weaknesses and are thus used for many different applications

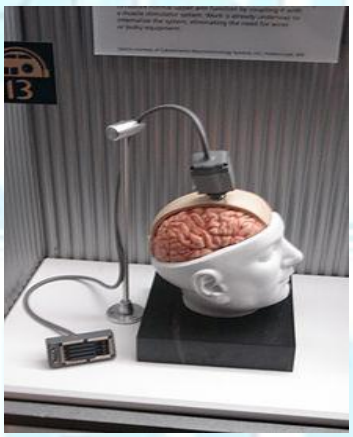

Figure: 1.1 -The Brain Gate neural interface

Figure - A tetra pelagic BrainGate2 clinical trial participant drinking from a bottle.

Noninvasive Brain Recording

Functional magnetic resonance imaging (FMRI) :
Functional Magnetic Resonance Imaging (FMRI) is used as diagnostic tool in hospitals and research. It is a variation of MRI and utilizes echo-planar imaging for fast scanning of the whole brain by means of several cross section images

Indirect Brain Recording

Interfacing technology that doesn't involve the central nervous system directly has several advantages regarding prosthetic applications.

Electromyography (EMG):

Instead of directly recording the neural activity of the brain, one can instead record the amplified electrical activity produced by muscle cells. This method is called electromyography (EMG)

Electroneurography (ENG)

In recent studies, more direct means of control and feedback have been the focus of research. While recording muscle activity is a convenient and reliable way of accessing nerve signals

Figure –illustrating the recording of the nerve signals.

Robotic Arms
Intuitively teleported robot arms are useful, when the controlling person isn't able to use direct manipulation. This, among others, is the case for robot-assisted surgery, paralyzed patients or manipulation tasks in remote hazardous environments.

EMG Method
EMG recording is the most widely used non-invasive recording technique for the control of powered prostheses.

Signal source
To extract information from muscle activity, one has to understand the basic concepts behind the signal generation. The basic functional element of a muscle is called the motor unit

Electrodes
Electrodes used in SEMG recordings can be differentiated into dry and wet, polarizable and non-polarizable as well as single- and multichannel electrodes

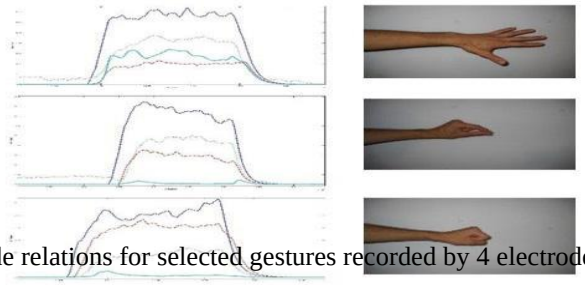

Figure -Distinct SEMG amplitude relations for selected gestures recorded by 4 electrodes placed around the forearm.

Signal contamination
To get clean and repeatable measurements, one has to factor in several possible error sources during recording sessions.

High density EMG

Current research heralds High Density (HD) EMG as the next step in signal recording, made possible by improvement in grid electrode technology and the development of more powerful microprocessors

Decoding Algorithms
EMG-based Prostheses
For the decoding of the EMG signals, different classes corresponding to different arm movements are trained by machine learning algorithms.

1. Preprocessing
2. Feature Extraction
3. Feature Classification

DECODING ALGORITHMS FOR EMG-BASED PROSTHESES

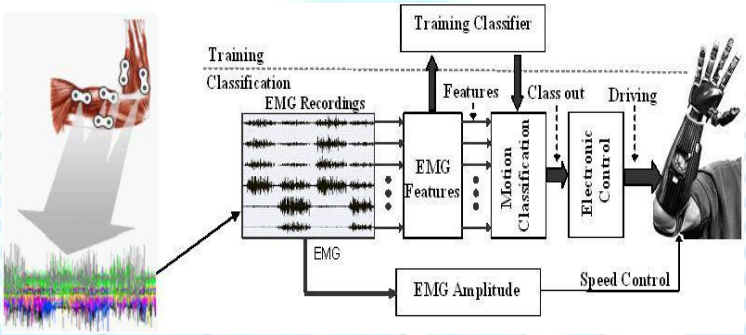

Figure - EMG-based Neural Interface

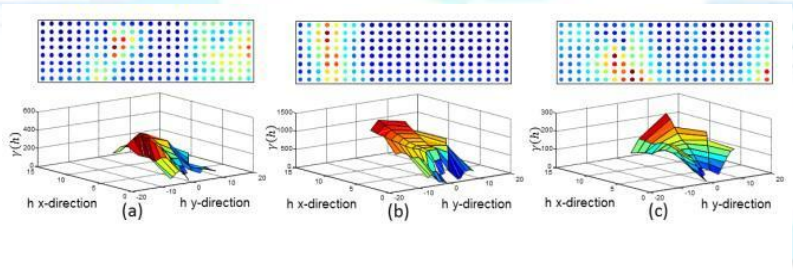

Figure - Matrix of EMG RMS values and the corresponding experimental various-programs

Machine learning approaches
Standard Algorithms
Support Vector Machine - SVM
The most commonly used machine learning algorithm for the computation of the classifier for EMG data is the Support Vector
Linear Discriminate Analysis – LDA
The Linear Discriminate Analysis (LDA) is a machine learning algorithm which can be used to end a linear classier by constructing a linear combination of features

Neuro-inspired Algorithms
Neural Networks

Inspired by biological neural networks, artificial neural networks are one of the most powerful machine learning algorithms.

Pattern Recognition

While the training phase can easily be done through, the recognition of new motion commands via EMG signals have to be online and ideally in real-time.

Summary and Outlook
Advances and Problems

The research in electric prostheses has come a long way. Until then, there do remain hurdles to be overcome. Algorithms have to be optimized for high dimensional inputs; embedded controllers have to meet rising computational demands. SEMG signal based control has to become more user friendly

Promising research Area Deep learning
Deep learning is very new area of the study which has gained significantly popularity last years

Bidirectional closed-loop neuroprostheses
Current prostheses rely solely on vision feedback to control grip strength and timing. This concept requires close attention in all grasping tasks and causes problems with choosing the right grip strength.

Multi-modal Approaches
The concurrent use of HD EMG sensors, EEG sensors and supplementary systems like eye tracking can help to increase precision and robustness, especially for ambiguous sensor data and in cases where single electrodes are malfunctioning.

Semi-Autonomous Control
As discussed in we believe that the use of advanced robotic control methods like impedance control can help to increase the performance of the neural interfaces. Semi-autonomous control also reduces the cognitive load of the subject.
https://www.nst.ei.tum.de/fileadmin/.../as/2015SS-HS-ArtificialProstheticLimbs.pdf
so, these are the recent development and the development going on the prosthetic limbs in the world . but in our India the case are different

Let's take case Study of Rehan who is resident of laxmi nagar ,New Delhi in CA building boys hostel , he is a disabled one with inborn disabilities of limbs ,
In our India the case are different just take a look on his problems , he is facing problem in automatic movements of limbs and he has to carry the supporting structure within him to walk and he uses his hand to move the supporting structure.

Figure A showing the Rehan who is disabled with leg Figure B showing the structure which are provided by the government of India which are of traditional in nature , which are not of autonomous type , and needs to do some renovations on that

Figure C showing the disability of limb which is inborn category.In the above figure it is showing that how his leg is lean and thin and how does it look like.

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Our aim is to built the exoskeleton for him or according to him like disabled one , we are analyzing that if we fit the motor and some sort of sensors and raspberry pie board in it then the motor will work and help him in movement and also we can design the 3d printing of the leg and required space for fitting motor and raspberry pie board there , such that the disabilities like him will be reduce .

CONCLUSION

As we talking about the prosthetic limbs there are many causes of the accident that can leads into the loss of limbs. Such as road accident, railways accident, industrial accidents and during the case of the war. And also the loss of the limbs are not limited up to the accidents only they are even case of inborn babies who come with loss of limbs from birth and also they the limbs disabilities occurs in case of some diseases and age old . in the case of not having the limbs then they have the prosthetic limbs which is artificial limbs which provide them to walk in case of loss of legs and in case of arms loss they can do the usual things which they would do if they the normal limbs . In case of old people and disabilities either case of inborn or accidental then they can use exoskeleton which helps them to do their normal works.

But in the today world the prosthetic limbs are not limited up to the normal works they are more advanced than the earlier which the combinations of technologies

For example a normal prosthetic eye can able to see but with the advancement in the technology they can acts as danger detection as locations finder, they aware of the danger through their prosthetic limbs, which is camera which can give access to the physical

world through the cyber space. Now they can access the things such as locations, time etc easily. For examples prosthetics arm can do the extraordinary things that cannot be done by the normal hand , they are capable of fighting like a combat , in army they can be turned on into weapons which helps the army persons , during the case of war.

So there are lots of the features that yet to be discovered and the advancement is going on through the neural networks and artificial intelligence applications on those prosthetic and exoskeleton. In near future we will see the more advancement with the use of nanotechnology and genetic engineering. Which will in the near future make the prosthetic limbs same or we can say the exact replica of the human limbs in seeing but in the features they are more advance then the normal one

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