A Review Paper on Economical Bionic Arm with Predefined Grasps and Movements

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Abstract - *The number of amputees with upper limb loss has risen dramatically in recent years. In India itself, there are 16500 amputees every year. As there are only a very few prosthetic arms commercially available that provide the basic functionality of the original arm and even if they are available, they are quite expensive. By using the latest engineering technologies, the functionalities of a prosthetic arm can be improved tremendously by implementing machine learning algorithms, image processing, and artificial neural networks, and the cost of building these arms can be reduced by using 3D printing technology. Many other sorts of study based on these technologies have been successfully executed.*

Key Words: **3D Printing, EMG signals, RF, Bluetooth technologies, Artificial Neural Networks, Machine Learning Algorithms, Computer Vision, etc**

1.INTRODUCTION

The importance and the value of a prosthetic arm can only be realized by an amputee. But these arms are not easy to make, commonly they do not have multiple degrees of freedom, are complex to use, and are costly. The engineers are continuously searching for new technologies to improve the functionalities of a prosthetic arm so that even though the person has lost one of his upper limbs he/she won't feel unnatural after wearing this prosthetic arm. To fill in this gap engineers have come up with new ideas by using the latest technologies such as machine learning algorithms, image processing, and deep learning, by using machine learning algorithms the prosthetic arm will be able to learn and predict the next set of actions and by using the EMG sensors we can record the signals that are sent from the amputee's muscles and based on the signal we can provide the desired output.

2. LITERATURE SURVEY

2.1 EMG Controlled Bionic Robotic Arm using Artificial Intelligence and Machine Learning, Farhan Fuad Rupom and Shafaitul Jannat, IEEE 2020

The authors have studied the KNN and SVM machine learning algorithms and how they can be implemented and the main aim is to build a bionic arm that can perform four-hand gestures i.e., Rock, Paper, and Spherical grip. The paper is based on the Electromyography approach along with a hybrid algorithm classification to improve the efficiency of a prosthetic system. It consists of a three-tier architecture where the first tire is the actual recording/signal capturing (EMG), tire two consists of signal processing and extracting the information needed and applying to a machine learning algorithm and to find the appropriate hand movement provided the data set, the third tier is sending this data to the 3D printed prosthetic through a microcontroller.

2.2 EMG Based Control of Transhumeral Prosthesis Using Machine Learning Algorithms, Neelum Yousaf Sattar and Zareena Kausar, IJCAS 2021

They concentrated on four distinct hand moments: elbow stretch, elbow flexion, wrist pronation, and wrist supination. For the following experiment the author has taken fifteen healthy subjects and four trans humeral amputees, the experiment focuses on a non-invasive way of providing prosthetics. The EMG signals have been achieved and recorded using a myo band, the aim is to create a data set of healthy and amputated individuals in the form of signals of the four different motions and to process this information using a machine learning algorithm and to provide an accurate output based on the corresponding EMG signal.

2.3 Wireless interface of Servo Motors using Potentiometers via Bluetooth module and RF, Ankit Gourav and Madhu B M, iCATccT 2016

The author demonstrated that a successful connection can be established between the human and the arm for this purpose there must be a reliable secure network. Both RF and Bluetooth technologies are used to communicate wirelessly between devices, but each has its own set of advantages and security features. And the typical applications of RF and Bluetooth Technologies also are different. RF is especially used for asset tracking in inventory and logistics, whereas Bluetooth technology may be a highly robust, widely accepted, and low-cost medium to speak between different types of devices.

2.4 Machine-Learning Based Muscle Control of a 3D-Printed Bionic Arm, Sherif Said and Ilyes Boulkaibet, Sensors 2020

The paper mainly focuses on how the 3-D printed Bionic arm is designed, fabricated, and optimized for a right arm amputee. Control of the synthetic bionic hand was achieved using surface electromyography data obtained by a multichannel wearable wristband in an experimental test for the user. sEMG data for a variety of gestures were acquired from a wide range of subjects for a generic control of the bionic arm. The acquired data was analyzed, and gesture-related features were extracted with the goal of training a classifier. Several classifiers, including neural networks, support vector machines, and decision trees, were built, trained, and statistically compared in this study. The bionic arm is put to the test in real time with the best classifier. Following the selection of three different types of classifiers, an offline technique was utilised to train and test these classifiers in order to determine the model that would be used for web recognition. Additional features, like as a multi-degree-of-freedom wrist connector, are required to improve the bionic arm. Two servo motors with mounts or a spherical manipulator will be used to accomplish this. The bionic arm could be mounted and dismounted using the air-ducted adjustable sockets.

2.5 Electromyography based Control of Prosthetic Arm for Transradial Amputees using Principal Component Analysis and Support Vector Machine Algorithms, K.R.L. Cabegin and M.A.V.M. Lim Fernan, IEEE 2019

The purpose of this work is to show how machine learning methods can be used to the field of prosthesis employing a microcomputer to offer real-time acquisition, processing, and prediction that leads to actuation. The authors describe how Principal Component Analysis (PCA) and Support Vector Machine can be used to create a prosthetic limb (SVM). Its goal is to imitate basic hand actions like grabbing and releasing in order to assist trans-radial amputees in doing simple activities. The first step is to extract the EMG. The PCA, in conjunction with the SVM and the Python programming language, then analyses the signal using a coded programme and supervised machine learning to make decisions based on muscle activity and to decide the proper output signal to be transmitted. The Raspberry Pi 3 would receive all of the recorded and filtered signals, which would then be utilized as input for the two distinct algorithms.

2.6 On the Use of 3D Printing Technology Towards the Development of a Low-Cost Robotic Prosthetic Arm, Alejandro Canizares and Jean Pazos, IEEE ROPEC 2017

The authors examined the possibility of developing a controlled hand prototype using 3D printing technology as a first step toward the creation of low-cost robotic prosthetics as a possible aid for low-income people with impairments. Two prototypes were created at first: a hand with five fingers controlled by a wearable instrumented glove with five degrees of freedom, and a hand-arm controlled by flexing any muscle in the user's arm via a sensor that collects (EMG) signals from the muscle. Servomotors controlled finger motions, while microcontrollers controlled the rotation of each servomotor.

2.7 Voice Controlled Prosthetic Hand with Predefined Grasps and Movements, Juan Pablo Angel Lopez and Nelson Arzola de la Pena, IFMBE Proceedings 2017

The event of a robotic prosthetic hand operated by voice instructions, consistent with many grasps and movements, was depicted in this research. The prototype prosthesis can do actions such fully grasping or releasing things, bidigital clutching pincer, or postures like thumb up and pointing with the index finger, thanks to earlier work's kinematic characterization and study of various grasps and movements. The robotic hand is controlled by a Graphical User's Interface (GUI) built in the MATLAB environment, which detects a set of five vocal commands using a man-made Neural Network (ANN) and develops a specific movement in response to each command. The voice command detections grow more accurate by raising the ANN's training parameters, such as the number of times a command is taught, the amount of LPC for each recorded command, and hence the error calculation iterations.

2.8 Design and Wireless Control of Anthropomorphic Robotic Arm, Bonny Varghese and B. Thilagavathi, ICIIECS, 2015

The planning and implementation of a gesture-controlled anthropomorphic robotic arm is discussed in the paper. The robotic arm is separated into four flexible fingers, each with three linkages, and an opposing thumb, a rotational wrist, and an elbow. Using a hand glove, the robotic arm is designed to mimic human hand movements. Five linear sliding potentiometers for controlling finger movements, as well as an accelerometer for regulating wrist and elbow movements, are included in the hand glove. Servo motors are the actuators that control the robotic arm. Cables that mimic the tendons of a human arm are used to regulate finger movements. Here the value involved was quite low and therefore the material required was quite available.

2.9 A Novel Approach of Prosthetic Arm Control using Computer Vision, Biosignals, and Motion Capture, Harold Martin and Jaime Donaw, IEEE 2014

The authors have implemented computer vision technology in the prosthetic arm to provide a fast and accurate response. The main idea of this project is to have a wearable device that captures and detects images in real-time like Google Glass or any other camera device. These detected images and objects are forwarded to the user interface, which is useful for displaying them. The EMG muscle trigger detection which is forwarded helps in selections that are to be controlled by the user. There is also muscle sensory feedback in which is also known as well. They have used a color-based blob detecting algorithm to detect and track the objects.

3. CONCLUSION

The main goal of reading this paper is to gain a better understanding of the various technologies and advancements in the field of prosthetic arm development, such as machine learning, which instructs servos to learn specific positions based on a data set provided, or neural networks and machine vision, which provide real-time data.

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