Holding, Grasping and Sensing of Prosthetic Robot Arm Like a Real Human Hand, a Journey Beyond Limits: An Extensive Review

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Abstract. This paper provides a comprehensive survey on the current state of prosthetic robotic arm; focusing on grasping strategy, sensing technologies, and control system. Numerous studies have been carried on prosthetic robotic arm field in improving its functionality. Mechanical/ prosthetic robotic arm is built to function as real—human-hand like for various fields like medical and industrial purposes. Starting from the design to details of every single compartment of the arm, up to providing the most needed function according to the purpose of the prosthetic robotic arm was built. The implementation method and system control/architecture used are with proven experimental results that indicate each study's outcome is the primary concern. Although each developed prosthetic robotic arm differed between each other based on their purpose and technology used, aiming for the optimal design similar to human's hand proves challenging for researchers, especially when it comes to the issue of practicality in whether it can be used to accomplish regular tasks a standard arm are able to.

Keywords: Prosthetic Robotic Arm, Force Actuators, Neural Network.

1 Introduction

Hand loss can severely affect a patient's life by limiting the ability to perform different physical movements and affecting its independence in the long run. It is estimated that nearly 3.10 million people have been living with upper limb disability since 2016 [1]. Prosthetic care, economical and affordable devices can improve the quality of life for disabled patients. However, nearly 38 million patients in developed countries lack access to affordable prosthetic devices. Unfortunately, the rate of limb loss is significantly higher in developing countries, including 2.40 million patients with upper limb amputations. Undeveloped health care systems have worsened the situation for patients

where it is estimated that nearly 2.7 million people in developing countries have partial hand amputations due to traumatic labour injuries and diseases [2].

The weighted prevalence of having any disability in the United States is shown in Figure 1, showing their citizen's higher prevalence of disability. Amputations are performed as a lifesaving surgical procedure to decrease long term complications after upper body extremity injuries like a neuroma and wound complications. Nearly 1.7 million people in the United States are living with limb loss. It is estimated that, yearly there are 50,000 to 100,000 amputations in the United States [2]. Amputations can significantly impact personal quality of life and functionality in daily life activities. Length preservation in the upper extremity has supreme importance. An extended lever-arm permits more massive force generation, which can further be utilized to energise prosthetics with a small force on underlying soft tissues. Therefore, it is essential to consider optimal treatment after analysing the remaining body part [3].

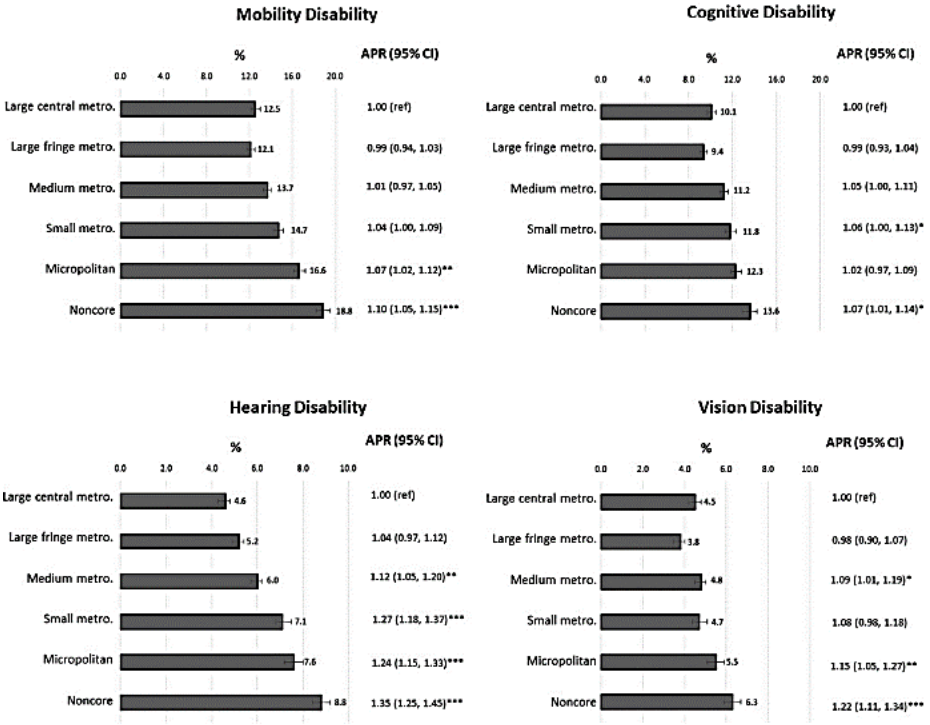

Fig. 1. Overview of disability in the United States [2].

Partial hand amputation, shoulder disarticulation, transhumeral and transracial are included in main types of upper limb amputations. Upper limb Prosthetic devices can help amputees perform daily activities [4]. Two main types of upper limb prosthetics, including passive prosthetic, functional and active prosthetics, are externally powered or body-empowered devices. A practical prosthetic robotic arm can only ease specific movement in achieving tasks. Besides that, the strength of the hand grip is a significant

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