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REVIEW ARTICLE

Human lower limb activity recognition techniques, databases, challenges and its applications using sEMG signal: an overview

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Abstract

Human lower limb activity recognition (HLLAR) has grown in popularity over the last decade mainly because to its applications in the identification and control of neuromuscular disorders, security, robotics, and prosthetics. Surface electromyography (sEMG) sensors provide various advantages over other wearable or visual sensors for HLLAR applications, including quick response, pervasiveness, no medical monitoring, and negligible infection. Recognizing lower limb activity from sEMG signals is also challenging owing to the noise in the sEMG signal. Pre- processing of sEMG signals is extremely desirable before the classification because they allow a more consistent and precise evaluation in the above applications. This article provides a segment-by-segment overview of: (1) Techniques for eliminating artifacts from sEMG signals from the lower limb. (2) A survey of existing datasets of lower limb sEMG. (3) A concise description of the various techniques for processing and classifying sEMG data for various applications involving lower limb activity. Finally, an open discussion is presented, which may result in the identification of a variety of future research possibilities for human lower limb activity recognition. Therefore, it is possible to anticipate that the framework presented in this study can aid in the advancement of sEMG-based recognition of human lower limb activity.

Keywords Human lower limb activity recognition · Surface electromyography signal · Machine learning techniques · Biomedical signal processing · Human-machine interaction

1 Introduction

In recent times, Human Activity Recognition (HAR) has attracted the attention of researchers, particularly because of the advancements in computer vision, artificial intelligence approaches, availability of wearable sensors, and the Internet of Things. HAR recognises a variety of human actions, including walking, sitting, running, standing, sleeping, showering, driving, and cooking. Numerous HAR applications can be found across a variety of disciplines, including healthcare monitoring, smart homes with aided surveillance, and tele-immersion applications [1, 2].

The HAR's goal is to analyze people's daily behaviors through observational data collected from them and their neighboring environments of living. It is a challenging problem because of the several difficulties inherent in HAR. However, the difficulty level associated with these obstacles varies according to the activity being considered. Based on the difficulty level and activity length, HAR may be categorised into five distinct types of activities, as shown in Fig. 1 [3, 4]:

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