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Research Article

Hybrid Deep Learning Approaches for sEMG Signal-Based Lower Limb Activity Recognition

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Lower limb activity recognition utilizing body sensor data has attracted researchers due to its practical applications, such as neuromuscular disease detection and kinesiological investigations. The employment of wearable sensors including accelerometers, gyroscopes, and surface electromyography has grown due to their low cost and broad applicability. Electromyography (EMG) sensors are preferable for automated control of a lower limb exoskeleton or prosthesis since they detect the signal beforehand and allow faster movement detection. The study presents hybrid deep learning models for lower limb activity recognition. Noise is suppressed using discrete wavelet transform, and then the signal is segmented using overlapping windowing. Convolutional neural network is used for temporal learning, whereas long short-term memory or gated recurrent unit is used for sequence learning. After that, performance indices of the models such as accuracy, sensitivity, specificity, and F-score are calculated. The findings indicate that the suggested hybrid model outperforms the individual models.

1. Introduction

Lower limb activity recognition (LLAR) has increased in popularity due to its ability to monitor or identify daily lower limb human actions in a range of applications such as elderly health monitoring, surveillance and security systems, human fall detection, and so on [1, 2]. The two methodologies utilized for acquiring human activity data are visual and wearable sensors [3]. Wearable sensors such as inertial measurement units, goniometers, and sEMG electrodes are placed on the subject's body for data collection [4]. The vision-based approach has limited capability in terms of applicability, security and complexity [5]. Wearable sensors have seen significant technical advancements in recent times. It results in a lower overall cost, making it more accessible. Popular sensors used in wearable research for activity recognition include inertial measurement units, accelerometers, gyroscopes, electromyography, and barometers [6]. EMG sensors are better than others since they can predict movement in advance in a very short amount of time. Out of these sensors, the EMG sensors are superior because they can anticipate movement in advance in a very short amount of time [7, 8]. Neuromuscular activity generates the biological signal known as the EMG signal. It can be detected by the electrical currents in muscles during the muscle contraction. Surface (non-invasive) EMG and intramuscular (invasive) EMG are the two approaches that are employed for the recording of the EMG signal [9]. Intramuscular electromyogram (iEMG) signals are captured by placing the wire electrodes within the muscles, whereas surface electromyogram (sEMG) signals are captured by placing the surface electrodes just above the muscle's surface. The following are the advantages of sEMG over the iEMG [10]: