DEVELOPMENT AND ANALYSIS OF FACIAL SURFACE EMG CONTROLLED DRIVE SYSTEMS FOR WHEELCHAIRS

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ABSTRACT

This paper presents the development and analysis of a facial surface electromyography (sEMG) controlled drive system, designed to convert any manual wheelchair into an automated one. This proposed portable system aims to enhance mobility for individuals with quadriplegia. This method uses three sEMG signals as inputs for an interface that translates facial muscle activity into control commands for the wheelchair. The system focuses on the left and right transversus menti muscle and zygomaticus major muscles, which can produce distinct and controllable contractions. The signal processing involves the extraction of key time domain features such as Mean Absolute Value (MAV), Root Mean Square (RMS), Integrated EMG (IEMG) and Zero Crossing (ZC) to capture the essential characteristics of the EMG signals. Windowing techniques, including disjointed and overlapped windows, are applied to enhance feature extraction accuracy. These features are then used to train and test different regression models like Random Forest, Support Vector Machine (SVM), Multi-Layer Perceptron Neural Network (MLPNN) which is used to predict continuous control variable angles of wheelchair. The models compared with different overlaps to find the best model and best overlaps. Once the commands are determined, a relay module can be used to control a motor, for driving the wheelchair. This modular system is compatible with any manual wheelchair, providing an affordable alternative to fully automatic wheelchairs. By transforming standard wheelchairs into automated systems using facial muscle signals, this sEMG-based control method offers a cost-effective, intuitive, and efficient solution for individuals with quadriplegia, significantly improving their mobility and independence.

Keywords: EMG, Signal Processing, quadriplegia, Random Forest Regression model, SVM, MLPNN

INTRODUCTION

The challenges faced in mobility do a lot to determine the overall quality of life of people with severe disabilities, particularly for those who have quadriplegia. [1] The rising rates of these disabilities have created more need for innovative solutions like the electric-powered wheelchairs (EPWs) that help enhance the users' autonomy and locomotion. This review of the literature begins with a discussion of the underlying medical conditions for which people require assistive devices, and the need for effective mobility interventions. [2] Yulianto et al. [1] developed a wireless EMG signal-controlled wheelchair for quadriplegic patients to solve the problems of the mobility of people with severe disabilities. The system is designed to work with surface

EMG sensors to pick up muscle signals from the patient, thereby allowing the patient to control the wheelchair without the physical wiring. This wireless innovation not only improve the autonomy and mobility of the subject but also can be considered as a reasonable and economical way to improve the life quality of the people with quadriplegia. The authors also mention the potential of the system and the need

for its improvement concerning the real-time responsiveness and the level of user personalization. Bouyam and Punsawad, [3] proposed a control system of wheelchairs that uses facial and lingual commands and is controlled by a human-machine interface using piezoelectric sensors. This method of operation is designed specifically to help people with mobility disabilities to control the wheelchair properly using their face and tongue movements. Mahmud et al., [4] explained A process, and Control, of a multi-modal human-machine interface for controlling smart wheelchairs. The system has been designed to incorporate