World Academy of Science, Engineering and Technology
International Journal of Cognitive and Language Sciences
Vol:16, No:01, 2022

Applying Biosensors' Electromyography Signals through an Artificial Neural Network to Control a Small Unmanned Aerial Vehicle

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Abstract : This work introduces the use of EMGs (electromyography) from muscle sensors to develop an Artificial Neural Network (ANN) for pattern recognition to control a small unmanned aerial vehicle. The objective of this endeavor exhibits interfacing drone applications beyond manual control directly. MyoWare Muscle sensor contains three EMG electrodes (dual and single type) used to collect signals from the posterior (extensor) and anterior (flexor) forearm and the bicep. Collection of raw voltages from each sensor were connected to an Arduino Uno and a data processing algorithm was developed with the purpose of interpreting the voltage signals given when performing flexing, resting, and motion of the arm. Each sensor collected eight values over a two-second period for the duration of one minute, per assessment. During each two-second interval, the movements were alternating between a resting reference class and an active motion class, resulting in controlling the motion of the drone with left and right movements. This paper further investigated adding up to three sensors to differentiate between hand gestures to control the principal motions of the drone (left, right, up, and land). The hand gestures chosen to execute these movements were: a resting position, a thumbs up, a hand swipe right motion, and a flexing position. The MATLAB software was utilized to collect, process, and analyze the signals from the sensors. The protocol (machine learning tool) was used to classify the hand gestures. To generate the input vector to the ANN, the mean, root means squared, and standard deviation was processed for every two-second interval of the hand gestures. The neuromuscular information was then trained using an artificial neural network with one hidden layer of 10 neurons to categorize the four targets, one for each hand gesture. Once the machine learning training was completed, the resulting network interpreted the processed inputs and returned the probabilities of each class. Based on the resultant probability of the application process, once an output was greater or equal to 80% of matching a specific target class, the drone would perform the motion expected. Afterward, each movement was sent from the computer to the drone through a Wi-Fi network connection. These procedures have been successfully tested and integrated into trial flights, where the drone has responded successfully in real-time to predefined command inputs with the machine learning algorithm through the MyoWare sensor interface. The full paper will describe in detail the database of the hand gestures, the details of the ANN architecture, and confusion matrices results.

Keywords : artificial neural network, biosensors, electromyography, machine learning, MyoWare muscle sensors, Arduino
Conference Title : ICHSI 2022 : International Conference on Human System Interaction
Conference Location : New York, United States
Conference Dates : January 28-29, 2022