A Pneumatic Hand Muscle Rehabilitation Training Glove Based on the EMG Signal: AI-Powered, Improved Robustness, and High Durability

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In China, those with hand disabilities or injured muscles need an auxiliary system to help rehabilitate. However, most hospitals' mechanical structures are stiff, leading the fingers to improper bend. Conversely, flexible pneumatic muscle actively bends the patient's fingers safely and effectively. Moreover, existing sEMG-controlled algorithms demand too many pathways and lack device robustness. Our project solves this problem by using three machine learning algorithms (CNN, SVM, and BP) to correspond EMG signals with gestures. Three levels of position deviation in the dataset, including 1.0cm, 2.0cm, and 3.0cm, ensure the diversity, and preprocessing methods include filters, bin means, shuffle, and random selection. The pneumatic muscle, glove, and air pump are three separate modules in this project. The pneumatic muscles can be redesigned and remanufactured to enhance durability according to the different needs. Real-Time EMG signals collected from specific muscle groups via 3 wet electrode patches can control the robot. Four gestures are tested, including fist-clenching, thumbs up, pinching, and stretching. For SVM, the best accuracy is 92 percent, and the minimum delay is 17ms, while for CNN, the best accuracy is 95 percent, and the minimum delay is 223ms. BP model is added for improvement, the best accuracy rate is 94 percent, and the minimum delay is 4ms. In conclusion, this glove based on sEMG control has the features of AI-powered, high robustness, high durability, easy operation, real-time control, passive exercise, safety, customization, adequate and affordable practices, and it can assist patients with hand dysfunction (brain damage, myasthenia gravis) to recover.

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