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Upper Limb Motor Function Assessment of Stroke Based on Multimodal Data of Simplified FMA-UE Action Set

Topic: Miscellaneous

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BACKGROUND

Fugl-Meyer Assessment for Upper Extremity (FMA-UE) is a widely used clinical tool for evaluating upper limb motor function in stroke patients. However, the assessment is subjective and involves multiple tasks, making it time-consuming and prone to inter-rater variability. This study aims to propose an automated method for evaluating upper limb motor function in stroke patients by utilizing a simplified subset of FMA-UE tasks. By integrating acceleration (ACC) and surface electromyographic (sEMG) data with a deep learning model, we seek to improve the accuracy and objectivity of the motor function evaluation.

METHODS

A simplified FMA-UE task set, including representative and feasible tasks for stroke patients, was selected for evaluation. sEMG and ACC signals were collected from both healthy participants and stroke patients using eight sEMG channels and 24 ACC channels. The modified NIMFT model (NIMFT-A) was used to estimate FMA-UE scores based on action recognition accuracy, with a Leave-One-Subject-Out (LOSO) cross-validation method employed. Data preprocessing steps, including signal synchronization, window segmentation, and data augmentation (white noise addition, resampling, and channel permutation), were applied to enhance model robustness.

RESULTS

The experimental results show a strong correlation between the model's action recognition accuracy and the FMA-UE score, with the highest coefficient of determination (R^2) reaching 0.7686 in cross-validation experiments. By applying data augmentation and the LOSO strategy, the model's generalization ability across different individuals has been significantly improved. Regarding specific gesture recognition accuracy, the model's performance under different training conditions is as follows: for action segment partition (without data augmentation), the accuracy is 60.37%, with data augmentation it is 49.72%, and with LOSO training it is 76.54%; for the 1000 ms window, the accuracies are 48.37%, 50.19%, and 50.93%, respectively. Comparing the action segment partition and 1000 ms window partition methods, the results indicate that the action segment partition method is more effective in capturing critical movement phases and providing rich feature information, while the 1000 ms window partition method performs better in capturing the overall movement trend related to motor function recovery and shows a higher degree of fit with the FMA-UE score.

CONCLUSION

The proposed system offers a promising approach to automate FMA-UE assessment, improving both the accuracy and efficiency of clinical evaluations for stroke rehabilitation.

Statement of Disclosures

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