MODULE 3-P4: Development of human-robot interface for upper limb assistive robots

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1 Introduction

Assistive robots such as exoskeletons and intelligent prostheses are designed to assist patients in daily activities and help to improve their quality of life. However, the current active assistive robots are still not widely accepted by users due to the lack of a reliable and intuitive controller which can detect a subject's intention and provide the assistive motion in a natural way.

We propose an intuitive control system that can predict the end-effector position in planar space, as shown in Figure. 1.

- The main objective is to utilize the onset motion to predict the user's target reaching or placing location.
- We investigate different sensory interfaces and multiple learning-based intention prediction models for reaching and placing tasks.

2 Robot hardware

Proximal Arm Extender

3 Interfaces architecture

Different sensory interfaces are utilized in the experiment:

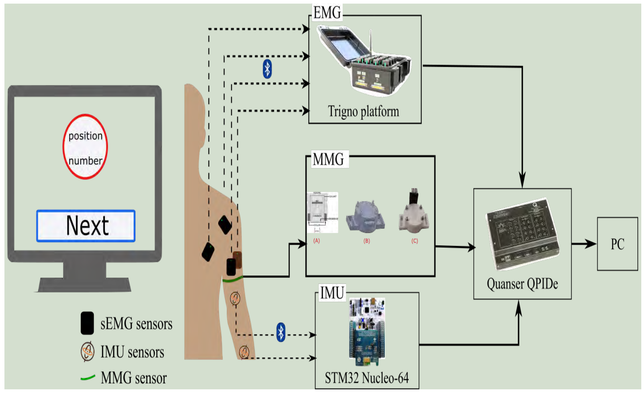

Figure 1: The electromyographic(EMG) and Inertial measurement unit (IMU) are wirelessly, and mechanomyography sensor(MMG) data are captured via wire. The data is input to the DAQ Quanser, which allows the data to be stored on a PC.

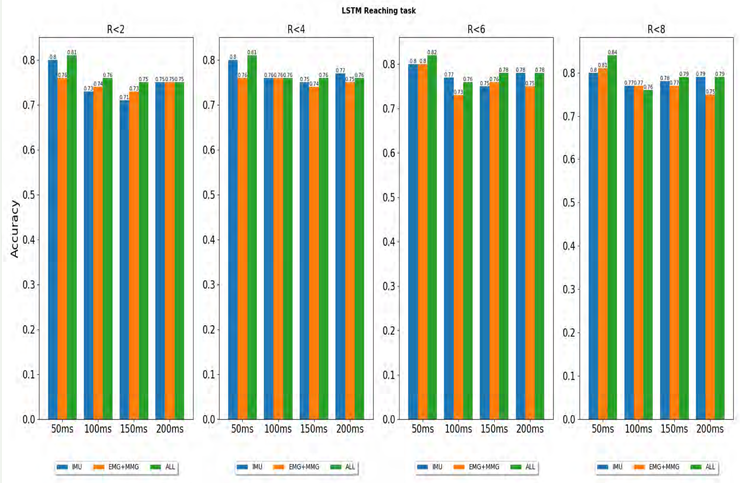

Figure 2: Prediction accuracy of the "Reaching" task for a different combination of input features across all subjects. The performance of analysis mainly targets on LSTM model. The blue bars represent the results that only use Kinematic input features labelled as IMU. The orange bars refer to the physiological features input only, labelled as EMG+MMG. Results with the combinations of input features are shown in green (labelled as all)..

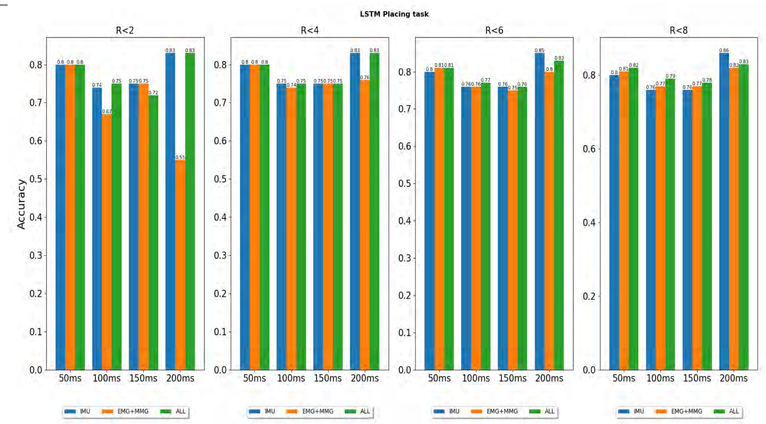

Figure 2. Prediction accuracy of "Placing task" for different combination of input features across all subjects. LSTM model is the main model to be analyzed in this section. The blue bars represent the results only use Kinematic input features labelled as IMU.

5 Conclusion

In this project, we proposed a novel human-robot interaction strategy for upper limb assistive robots, which can predict the end-point position using human intention in planar space.

- The Recurrent Neural Network (RNN)-based model has better prediction accuracy than other traditional regression models.
- Moreover, the time window selection of proper onset motion can enhance the prediction performance. Most importantly, only using IMUs as a human-robot interface is sufficient to detect human motion intention in this scenario.

6 Future work

1. Focus on further improving the prediction performance and implementing the proposed approach in an online system with an upper limb exoskeleton or prosthesis.
2. Develop force interfaces that can be embedded in the robot itself. Using an adaptive admittance controller to adjust different levels of assistance.

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