ChatEMG: Synthetic Data Generation to Control a Robotic Hand Orthosis for Stroke

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SCAN ME

Task: Intent Inferral for Stoke

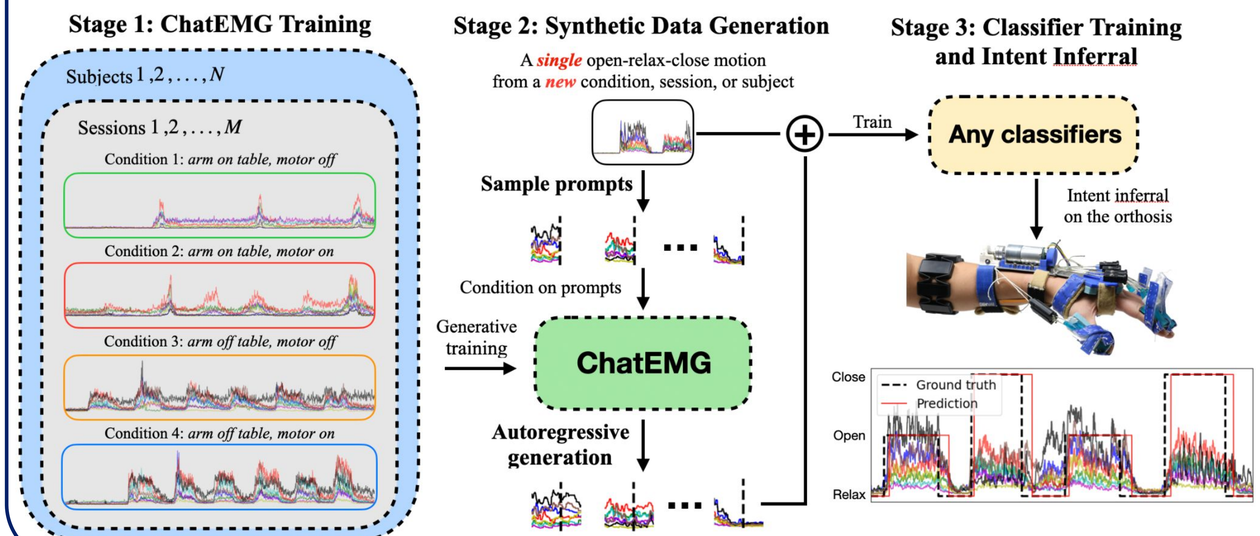
A robotic orthosis or prosthesis collects a set of biosignals from the user, and uses them to infer the activity that the user intends to perform, so it can provide physical assistance.

Challenges

1. It is extremely difficult to collect data from stroke subjects. 2. EMG signals exhibit significant variations across different conditions, sessions, and subjects, making it hard for classifiers to generalize.

ChatEMG handles these challenges through synthetic EMG data generation.

ChatEMG: an Autoregressive Generative Model for EMG Signals



ChatEMG takes in a prompt of EMG signals and generate the next signal autoregressively.

Stage 1

ChatEMG is trained on large offline data from different conditions, sessions, and subjects.

Stage 2

We use ChatEMG to expand a limited dataset from new context with synthetic samples.

Stage 3

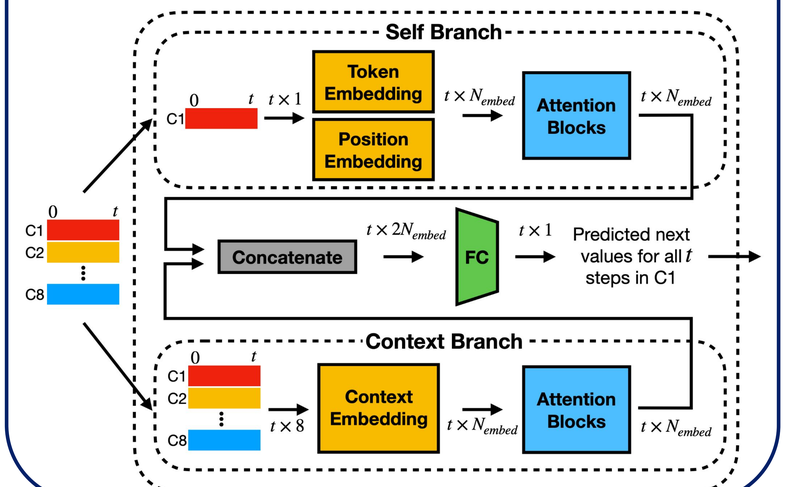
We train intent inferral classifiers using both the synthetic samples and the original limited dataset.

ChatEMG Model Architecture

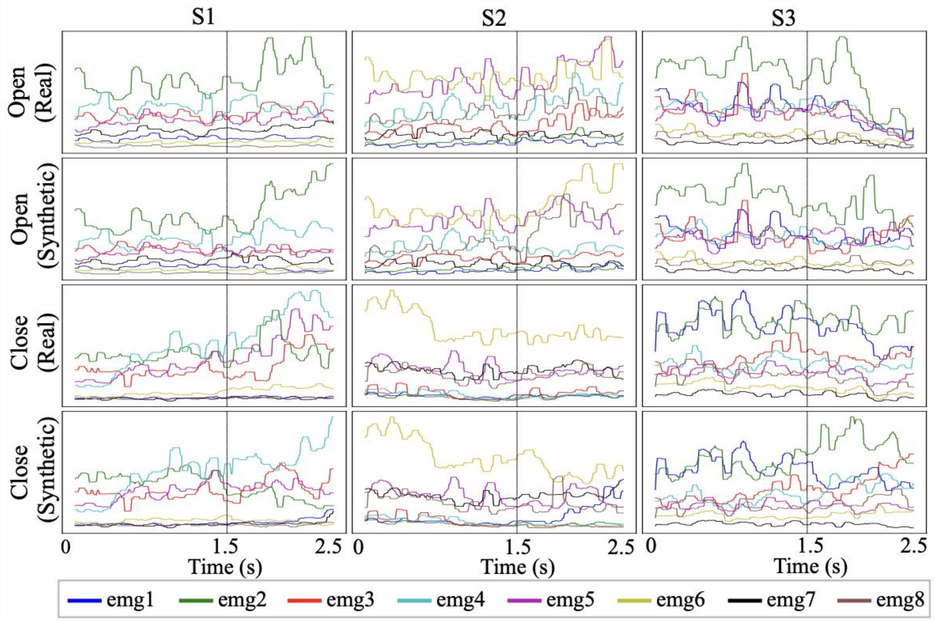
ChatEMG is based on decoder-only transformers.

It has two branches: the self branch that takes in the first channel (C1) and the context branch that takes in all 8-channel EMG signals.

It predicts the next EMG signal for the first channel. In order to get the full 8-channel data, we rotate the input channels 7 times.



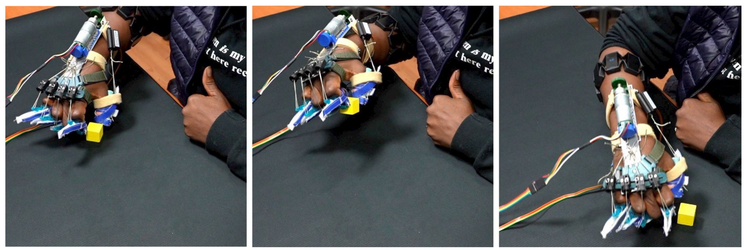
Results and Discussion



ChatEMG can capture the characteristics of EMG signals, such as the amplitude, frequency, fluctuation pattern, etc. ChatEMG can also maintain the relative position of different channels very well.

The synthetic samples generated by ChatEMG are classifier-agnostic and can improve intent inferral accuracy for different types of classifiers.

ChatEMG leverages a vast repository of offline data via generative training, and can generate condition-, session- and subject-specific synthetic data via prompting.



We are the first to deploy an intent classifier trained partially on synthetic data for functional control of an orthosis by a stroke survivor.