CROSSTALK REDUCTION IN EPIMYSIAL EMG RECORDINGS FROM TRANSHUMERAL AMPUTEES WITH PCA

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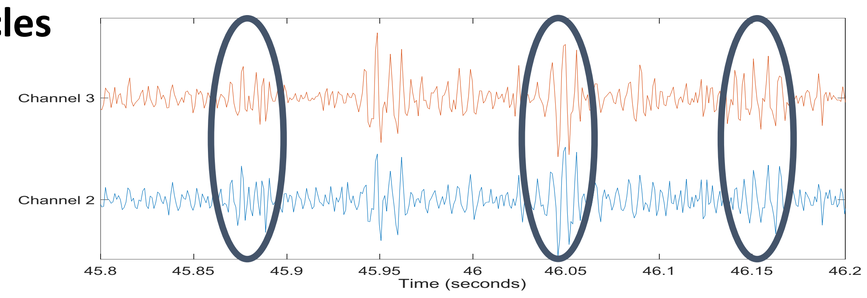
1. The problem: Crosstalk in Invasive EMG (iEMG)

- **Crosstalk = Noise in EMG recordings due to conduction from nearby muscles**



- Crosstalk can be reduced with bipolar electrodes, but they require twice as many wires as monopolar ones.
- In iEMG **it is best to use monopolar electrodes <u>if</u> the quality of the signals recorded is comparable to that of bipolar electrodes**.

2. Methods: Data

- Epimysial electrodes implanted in biceps and triceps in 2014/15
- Simultaneous recording in monopolar and bipolar configurations
- Pre-recorded data from 3 transhumeral amputees
  - 2 sessions from P1 and P2
  - 1 session from P3
- Each session contains 3 repetitions of each of 4 movements
  - Open hand
  - Close hand
  - Extend elbow
  - Flex elbow
- 1 repetition = 3 s of contraction + 3 s of rest
  - First 2 repetitions from each movement used as training set
  - Last repetition used as test set

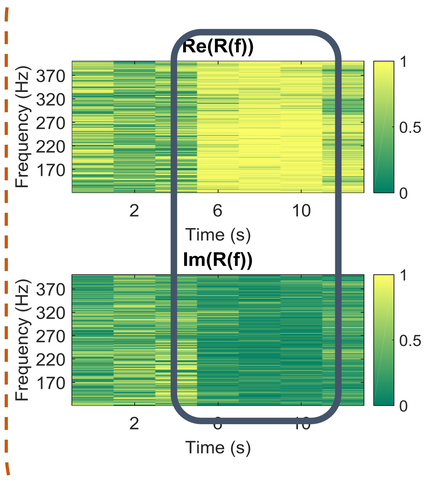
3. Results: Measuring and Reducing Crosstalk

ORIGINAL

We created **two metrics (Real-to-Imaginary Ratio [RIR] and C_{75}) based on the coherency (R(f))** to measure crosstalk taking into account that:

- Re(R(f)) is related to conduction
- Im(R(f)) is sensitive to co-activation

With Crosstalk

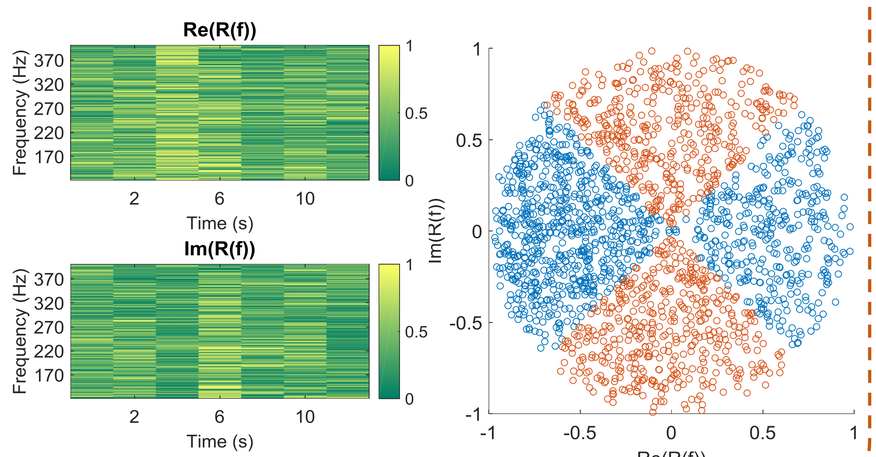


RIR = 0.78 **C_{75} = 0.93**

	RIR	C_{75}	P_x
Mean[1]	0.58	0.66	0.179
Mean[2]	0.68	0.79	--

- Mean[1] considers all pairs of electrodes
- Mean[2] includes only pairs for which initial RIR > 0.6
- P_x is the peak of the cross-correlation

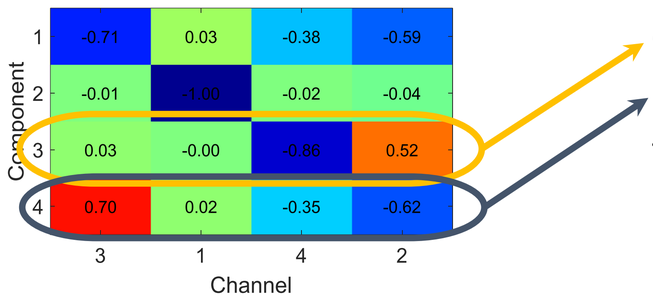
Without Crosstalk



RIR = 0.59 **C_{75} = 0.62**

PCA TRANSFORMATION

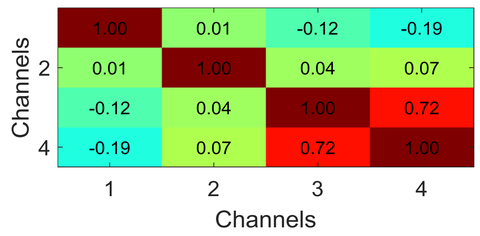
Transformation matrix



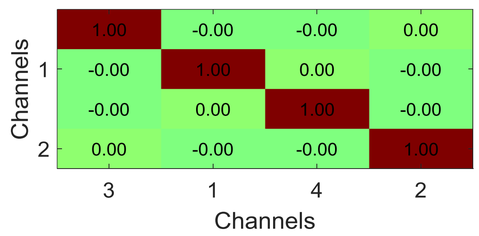
"Bipolar"
Double-differential filter between triceps (ch. 3) and biceps (ch. 2 and 4)

Correlation coefficients

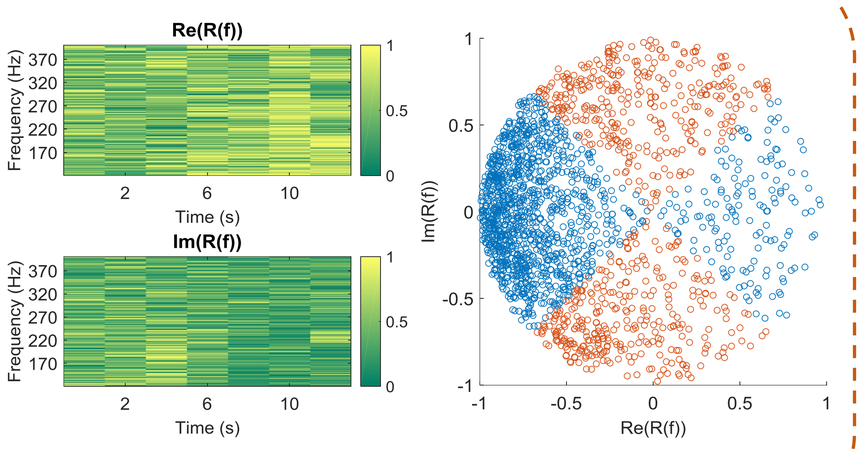
Before



After



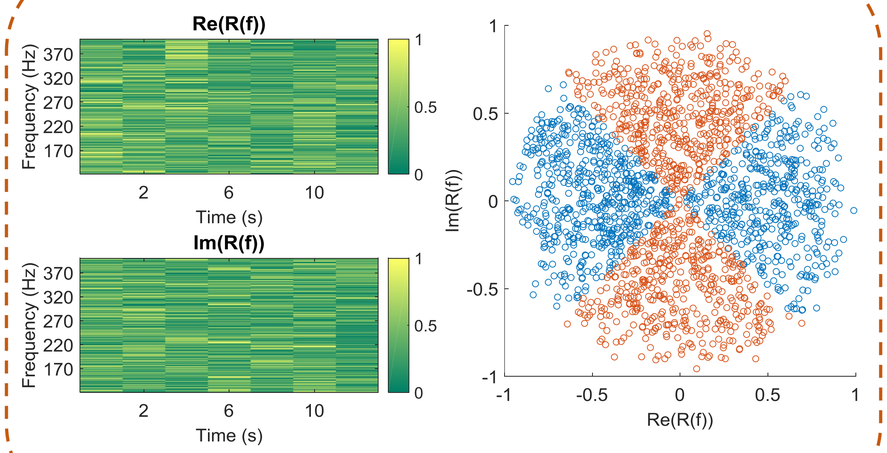
TRANSFORMED



RIR = 0.65 **C_{75} = 0.78**

	RIR	C_{75}	P_x
Mean[1]	0.56	0.64	0.133
Mean[2]	0.58	0.68	--

Mean(SNR / SNR0) = 1.44



RIR = 0.52 **C_{75} = 0.54**

4. Conclusions

- PCA can be used to reduce crosstalk in iEMG.
- Coherency-based measures (e.g., RIR and C_{75}) can be used to distinguish between high- and low-crosstalk recordings.
- We improved the SNR of the monopolar recordings by 44%.
- Pairs of electrodes with no crosstalk or with co-activation are not negatively affected by PCA.
- In the future we will study the long-term stability of the PCA transformation.

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