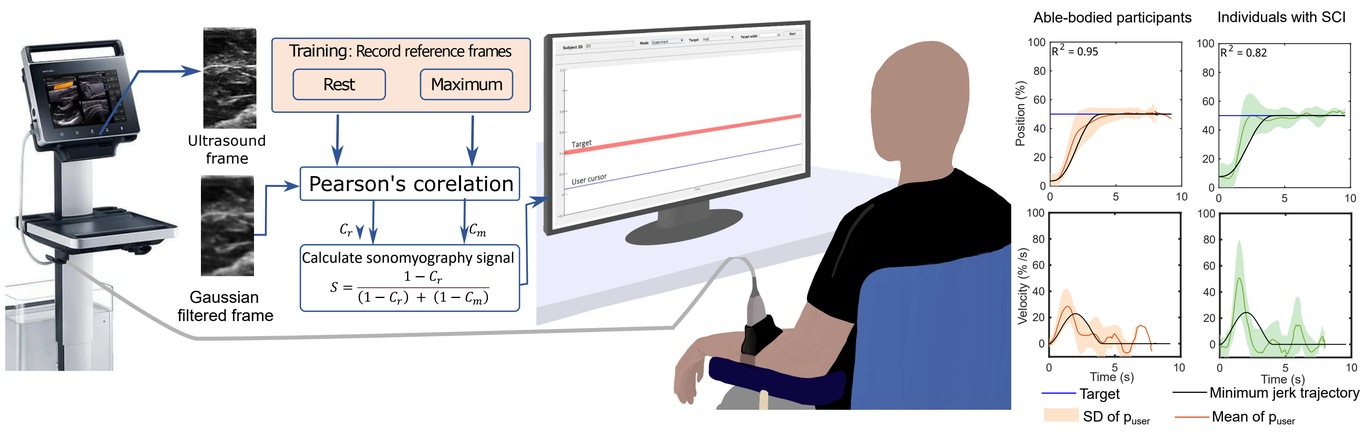
Sonomyography-Based Muscle Interface for Decoding Hand Grasps in Individuals with Incomplete Spinal Cord Injury

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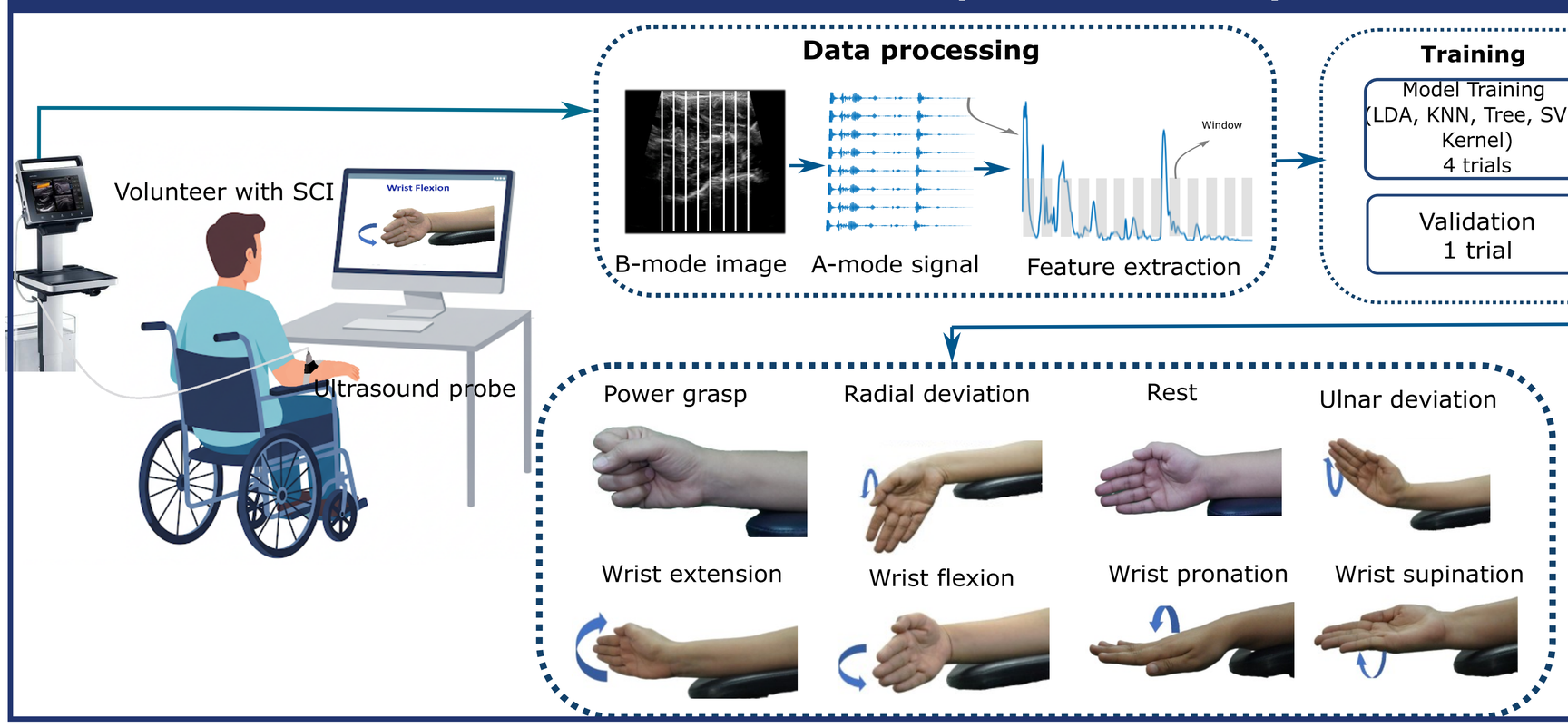
Sonomyography enables control of muscle computer interface



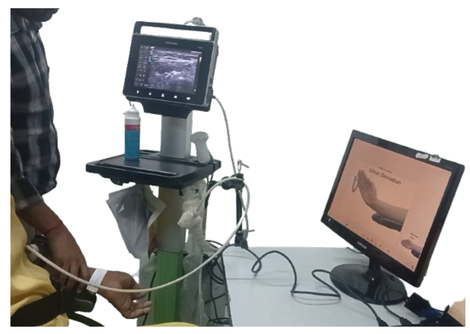
Objective

Evaluate machine learning models and features for classifying intended grasp patterns in individuals without voluntary hand movements.

Experimental setup



Data collection



Non-disabled volunteer



Volunteer with SCI



Results

Non-disabled volunteers

Features	LDA	KNN	Decision Tree	SVM	Kernel
Mean	85.50 ± 10.39	84.59 ± 9.20	73.45 ± 7.45	86.76 ± 8.12	87.08 ± 7.20
Standard deviation	78.89 ± 13.97	84.46 ± 8.43	69.67 ± 6.36	84.98 ± 6.06	83.42 ± 6.18
Histogram	69.41 ± 13.96	78.31 ± 12.61	58.55 ± 15.36	75.31 ± 12.78	12.75 ± 1.01
Linear fit coefficients	59.12 ± 15.29	75.85 ± 10.02	61.99 ± 10.67	74.77 ± 10.52	48.31 ± 11.10
Log detector	82.85 ± 11.80	83.13 ± 8.89	79.24 ± 8.25	87.09 ± 9.42	85.44 ± 7.18

Volunteers with SCI

Features	LDA	KNN	Decision Tree	SVM	Kernel
Mean	70.40 ± 13.66	61.18 ± 23.09	56.31 ± 9.00	71.05 ± 16.30	65.23 ± 19.75
Standard deviation	55.36 ± 13.41	59.29 ± 21.56	43.73 ± 9.11	60.26 ± 15.92	58.68 ± 20.97
Histogram	51.68 ± 15.57	53.35 ± 10.79	43.79 ± 18.84	52.01 ± 13.84	12.95 ± 0.45
Linear fit coefficients	37.29 ± 13.14	59.96 ± 20.10	46.85 ± 13.86	61.53 ± 20.59	35.57 ± 15.59
Log detector	71.16 ± 14.64	61.01 ± 22.56	57.17 ± 7.63	71.73 ± 15.05	65.21 ± 19.51

Model

Conclusion

Sonomyography with SVM classifier, using mean and log detector features, can detect gestures in SCI patients lacking voluntary hand movements.

SVM with log detector feature:

Non-disabled volunteers

True Class \ Predicted Class	1	2	3	4	5	6	7	8
1	87.5 ± 24.9	0.4 ± 2.0	8.2 ± 17.2	0.4 ± 2.3	2.0 ± 8.6	1.3 ± 6.8	0.3 ± 1.6	0.0 ± 0.0
2	3.3 ± 17.5	91.2 ± 21.3	3.9 ± 9.1	0.0 ± 0.0	1.3 ± 4.4	0.2 ± 1.1	0.2 ± 0.9	0.0 ± 0.0
3	10.9 ± 28.6	6.7 ± 25.6	74.1 ± 41.2	1.8 ± 9.3	3.4 ± 18.5	2.8 ± 15.4	0.3 ± 1.9	0.0 ± 0.0
4	0.0 ± 0.0	0.1 ± 0.7	5.9 ± 18.8	88.9 ± 24.9	2.7 ± 11.8	0.0 ± 0.0	2.4 ± 8.2	0.0 ± 0.0
5	0.3 ± 1.2	3.0 ± 14.1	2.2 ± 9.2	4.6 ± 18.1	86.6 ± 28.9	1.1 ± 6.3	2.2 ± 7.1	0.0 ± 0.0
6	2.6 ± 8.7	1.5 ± 7.4	2.4 ± 4.4	1.3 ± 7.2	5.9 ± 20.9	85.8 ± 25.0	0.5 ± 3.0	0.0 ± 0.0
7	0.0 ± 0.2	0.0 ± 0.0	2.5 ± 5.2	4.7 ± 17.9	5.2 ± 19.7	0.0 ± 0.0	87.6 ± 27.1	0.0 ± 0.0
8	2.6 ± 13.2	0.1 ± 0.5	1.3 ± 4.2	0.0 ± 0.0	0.1 ± 0.8	0.6 ± 2.1	0.0 ± 0.0	95.3 ± 16.7

Volunteers with SCI

True Class \ Predicted Class	1	2	3	4	5	6	7	8
1	80.4 ± 36.1	9.4 ± 31.0	2.7 ± 7.8	0.0 ± 0.0	2.2 ± 8.4	5.3 ± 20.6	0.0 ± 0.0	0.0 ± 0.0
2	1.7 ± 6.5	52.9 ± 48.5	24.4 ± 39.1	0.0 ± 0.0	0.0 ± 0.0	16.4 ± 35.8	0.0 ± 0.0	4.6 ± 17.8
3	0.0 ± 0.0	20.5 ± 38.8	59.4 ± 50.4	13.8 ± 36.5	0.0 ± 0.0	6.3 ± 24.3	0.0 ± 0.0	0.0 ± 0.0
4	0.0 ± 0.0	0.0 ± 0.0	22.2 ± 40.5	59.9 ± 48.1	17.9 ± 34.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
5	0.0 ± 0.0	0.0 ± 0.0	10.9 ± 27.5	9.2 ± 20.2	72.0 ± 38.4	8.0 ± 30.9	0.0 ± 0.0	0.0 ± 0.0
6	0.0 ± 0.0	6.3 ± 23.3	11.4 ± 25.4	0.0 ± 0.0	4.8 ± 18.7	77.1 ± 38.4	0.0 ± 0.0	0.5 ± 1.9
7	5.6 ± 15.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	2.9 ± 8.1	0.0 ± 0.0	91.5 ± 14.3	0.0 ± 0.0
8	0.0 ± 0.0	15.0 ± 36.8	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	10.6 ± 28.0	0.0 ± 0.0	74.4 ± 41.1

Predicted Class

Funders and collaborators

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