Electromyogram (EMG) For Prosthetic Fingers Control

❑ Problem definition

Identifying the movement of each finger and use that to control prosthetic devices movements.

EMG signals recorded from amputees residual muscles have been extensively investigated as a source of control for prosthetic devices, denoted as myoelectric control.

we use different machine learning classification algorithms such as SVM, KNN on the recorded EMG signal.

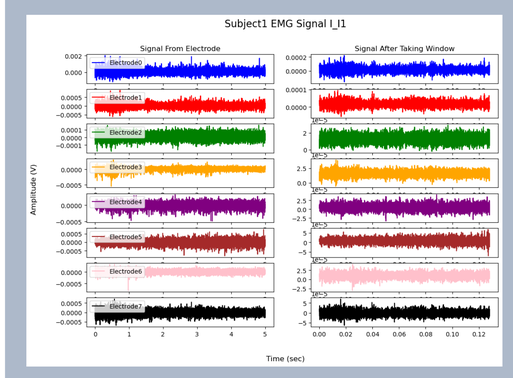
various features in time and frequency domain were extracted, using features selection methods such as Wrapper Method we managed to drop unrelated features.

❑ Data visualization

Eight subjects, six males and two females, aged between 20-35 years were recruited to perform the required fingers movements.

The datasets were recorded using eight EMG channels as shown in Fig.1, the EMG signals were then bandpass filtered between 20-450 Hz with a notch filter implemented to remove the 50 Hz line interference.

We visualized our records here is an example of subject 1 1st trail records of movements and a 192ms window of each record. Example of one electrode in the following image.



❑ Features:

To depict the EMG activity, different time-domain features were recovered

I. Extraction

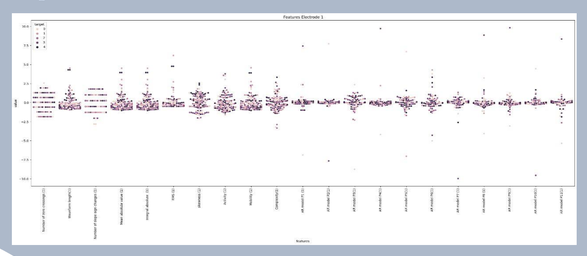
We employed the entire signal, a window of the signal, and an overlap signal.

in window of the signal, and an overlap signal, a 128msec analysis window size was used.

- number of zero crossings (1 feature)
- waveform length (1 feature)
- number of slope sign changes (1 feature)
- skewness (1 feature)
- root-mean-square (1 feature)
- mean absolute value (1 feature)
- integral absolute value (1 feature)
- parameters of an autoregressive (AR) model with an order of 11 providing significant enhancements upon smaller model orders (11 features)
- the Hjorth time-domain parameters (3 features)

In a problem of 8 channels, the total number of extracted features is 168 features (21 features/channel × 8 channels = 168 features).

Example of Features for electrode 1:



❑ Results

Processed data	Classifiers	Accuracy	Precision
All data (No feature selected)	kNN	0.958	0.96
	DT	0.708	0.718
	RF	0.83	0.88
	LR	0.37	0.37
	SVM	0.12	0.50
Whole signal (Selected Features1) SFFS by SVM	kNN	0.958	0.96
	DT	0.58	0.558
	RF	0.875	0.968
	LR	0.375	0.338
	SVM	0.58	0.66
Whole signal (Selected Features 2) SFFS by kNN	kNN	0.83	0.84
	DT	0.66	0.768
	RF	0.916	0.9375
	LR	0.625	0.726
	SVM	0.666	0.694
128msec window (selected Features 1) SFS by SVM	kNN	0.45	0.63
	DT	0.16	0.34
	RF	0.33	0.56
	LR	0.20	0.25
	SVM	0.33	0.30
128msec window (selected Features 2) SFS by kNN	kNN	0.75	0.63
	DT	0.25	0.34
	RF	0.20	0.56
	LR	0.08	0.25
	SVM	0.33	0.30
128msec overlapped window (selected Features 1) SFS by SVM	kNN	0.92	0.94
	DT	0.62	0.76
	RF	0.79	0.85
	LR	0.375	0.52
	SVM	0.75	0.89
128msec overlapped window (selected Features 2) SFS by kNN	kNN	0.87	0.935
	DT	0.62	0.76
	RF	0.75	0.85
	LR	0.29	0.52
	SVM	0.75	0.89

II. Selection

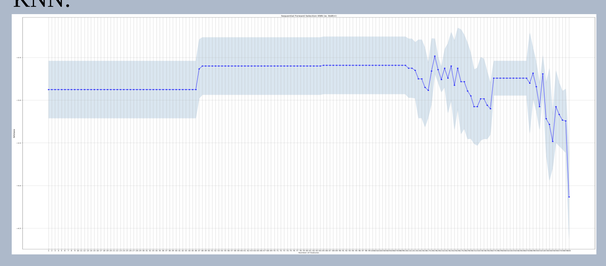
Different classifiers were used such as SVM and KNN .

SVM classifier parameters were optimized as cost parameter was c = 8 and kernel type was set to a radial basis function with $\gamma = 12$.

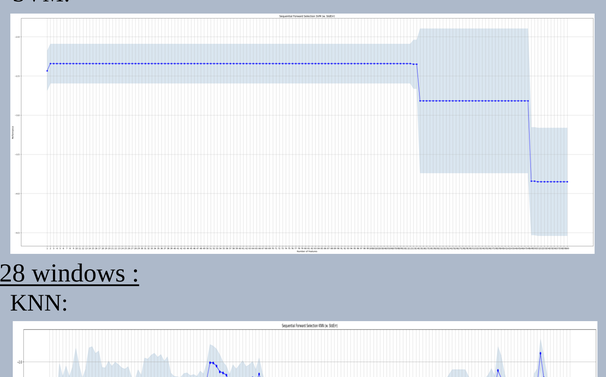
In KNN number of neighbors was set to 5.
Visualization of feature selection of:

128whole signal:

KNN:

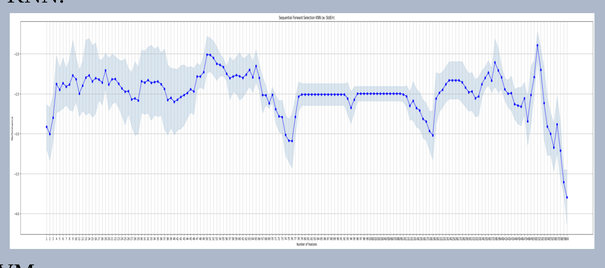


SVM:

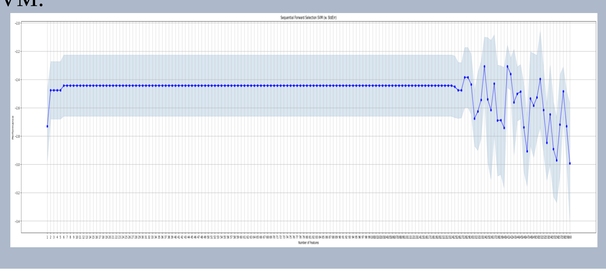


128 windows :

KNN:



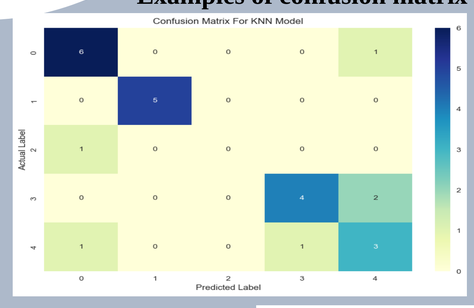
SVM:

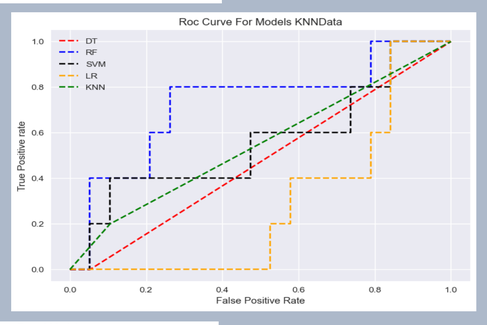


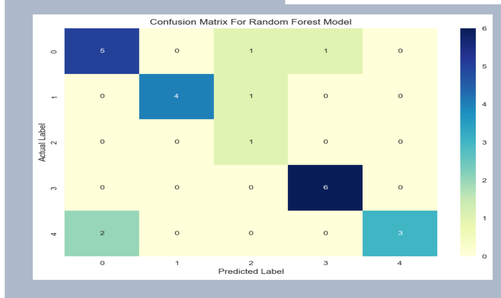
❑ Models

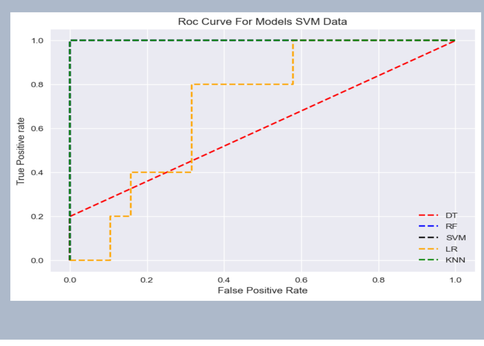
We used five different classifiers which are SVM, KNN, DT, LR, RF with 5 folds cross validation we also used grid search to improve our parameters, the data was spilt into 20% test and 80% train.

Examples of confusion matrix :





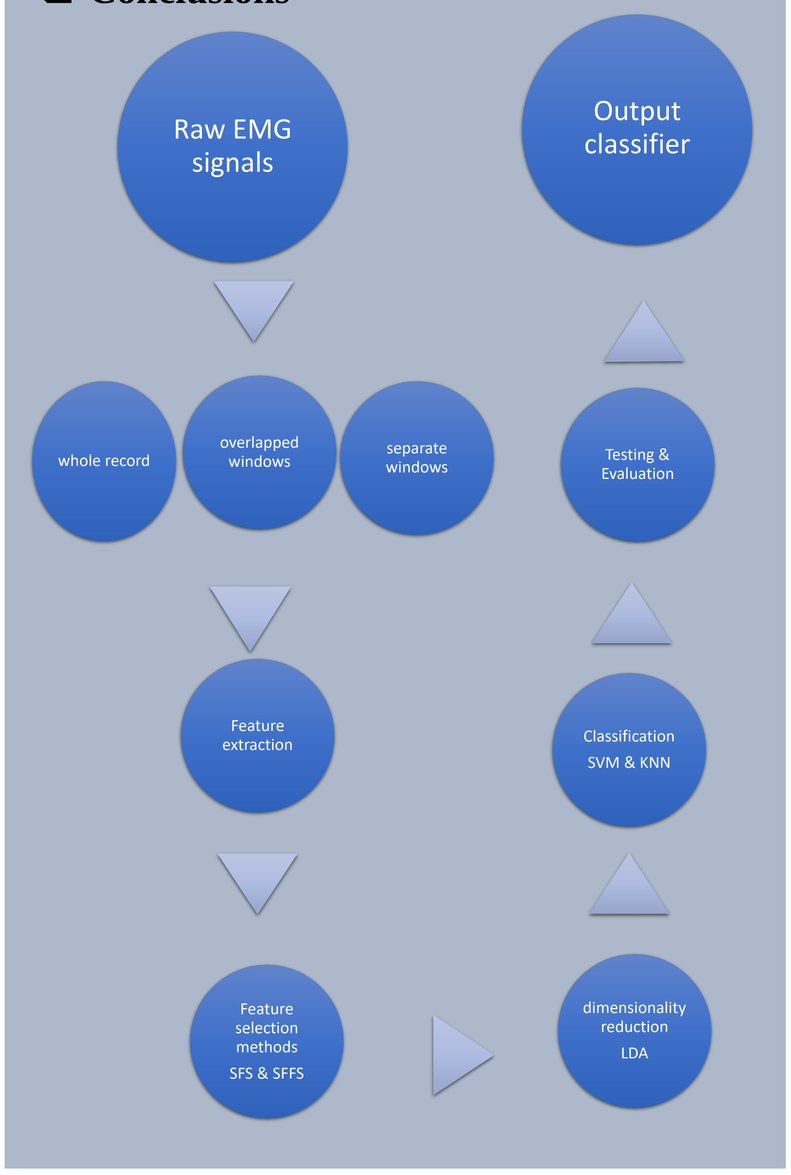




❑ Challenges

As stated in the paper different dimensionality reduction techniques were applied on the selected features we tried only one technique which is LDA and we got overfitted models and we were tight on time because some feature selection methods took a lot of run time from 30 min to 2 hours so we didn't get to try other techniques**.**

❑ Conclusions



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BLUE BRAIN