Practical Course

EMG-based Robotic Control

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Project Plan Presentation

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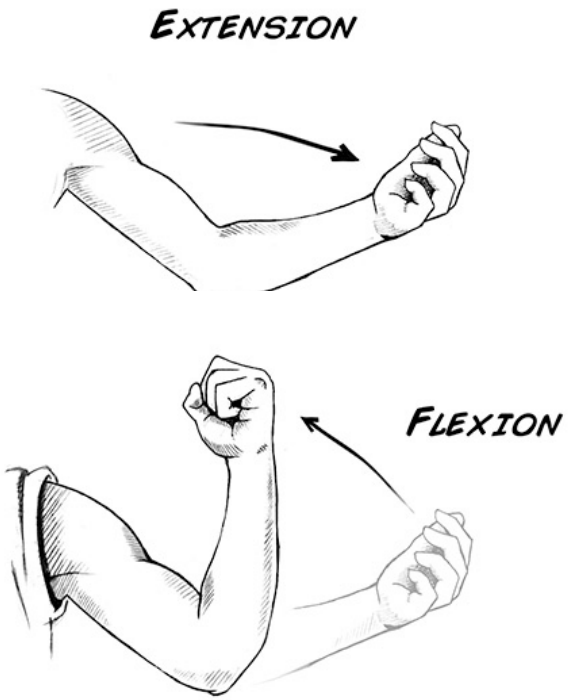
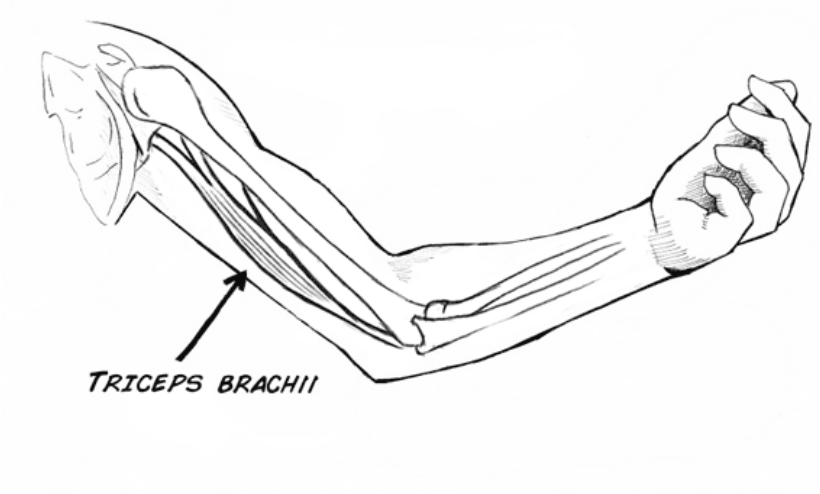
Contents

- Skin Preparation
- Data Acquisition
- EMG Processing & Features Extraction
- Dimensionality Reduction
- Motion Decoding
- Controller Design
- Performance Analysis
- Timeline

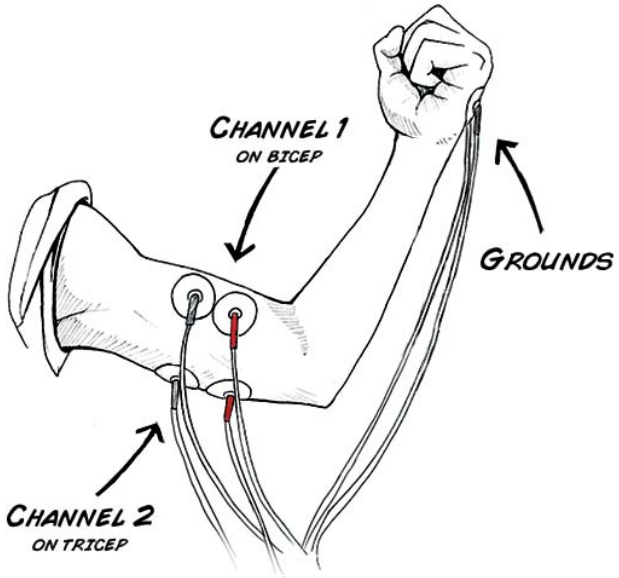
Skin Preparation



Select gestures



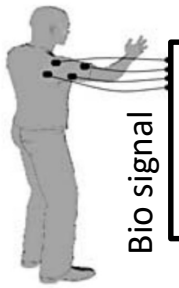
Define the target muscle fibres



Define positions of the sticker electrode patches

Source [http://backyardbrains.de/experiments/muscleSpikerBoxPro]

Data Acquisition



Sensor → Signal Conditioning → Acquisition Hardware → Software (Recorder)

User interface

Define type of EMG sensors

- non invasive and differential electrodes
- energy range
- rejection ratio
- noise RMS
- input impedance

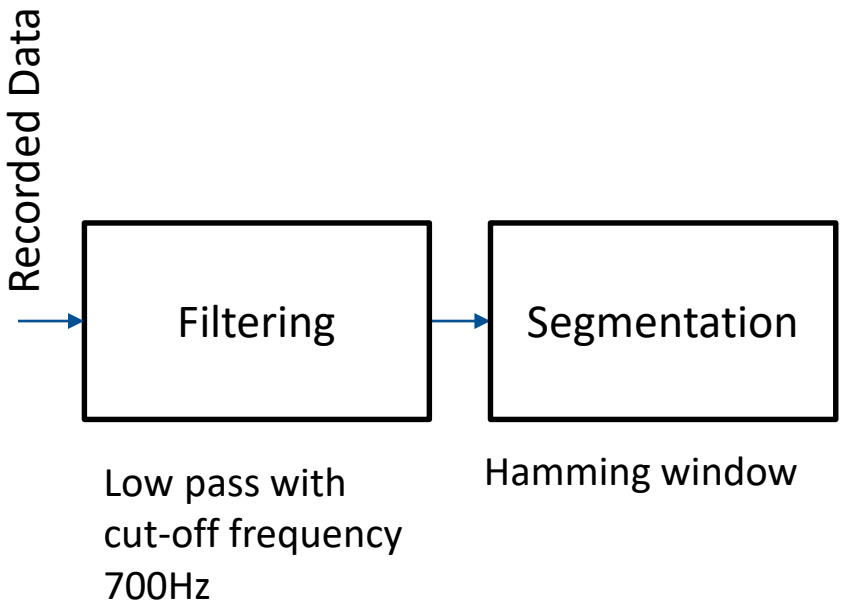
Analog signal conditioning circuitry (Amplifiers)

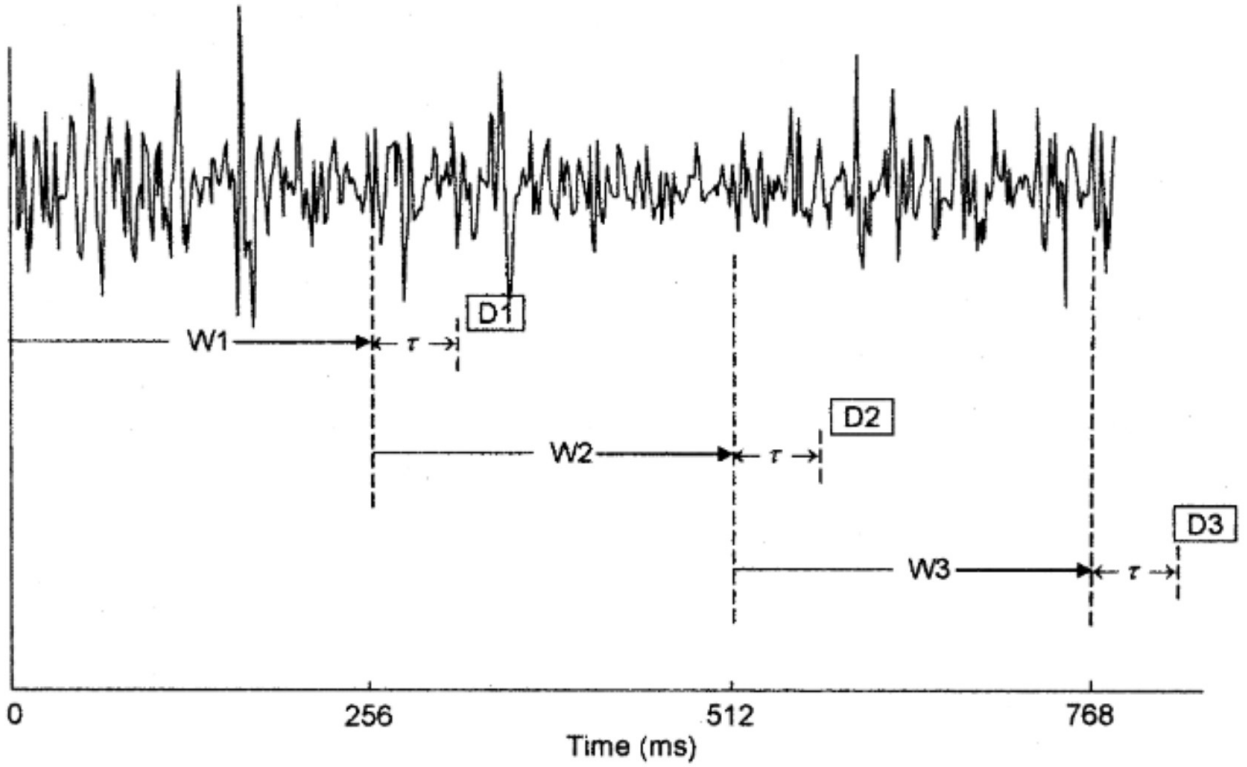
Sample-and-hold circuitry (A/D converter)

Data storage

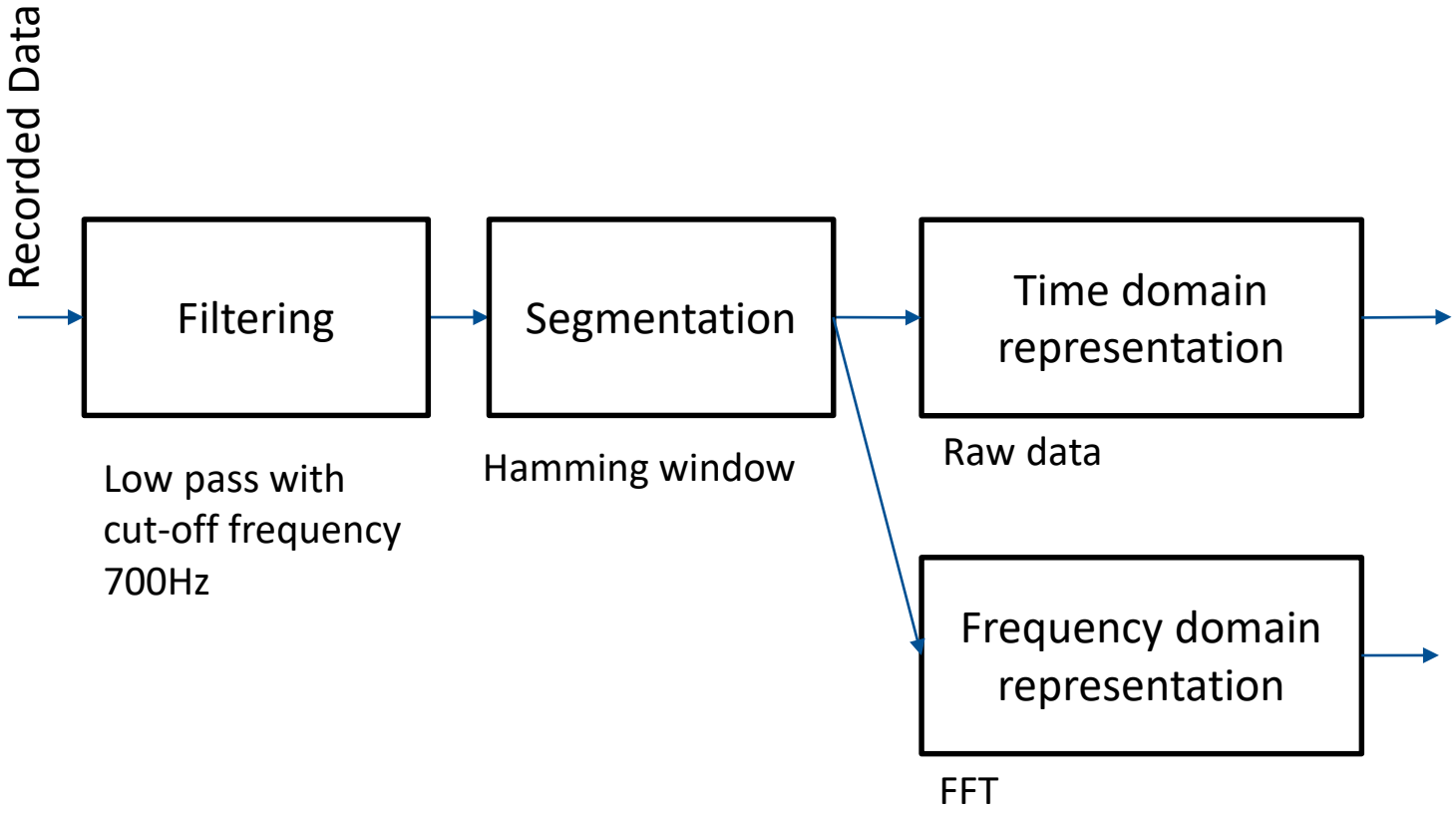
2 second/trial

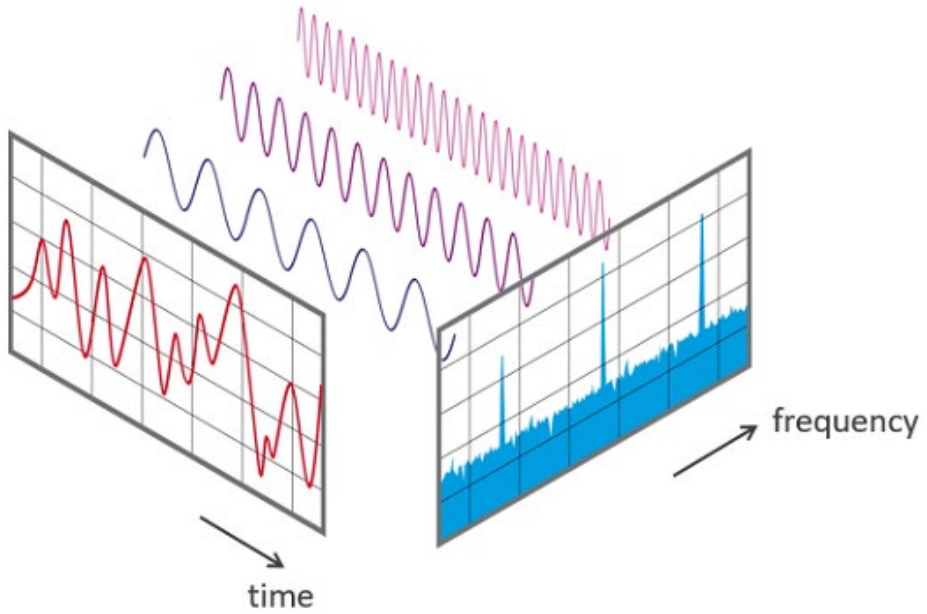
EMG Processing & Features Extraction



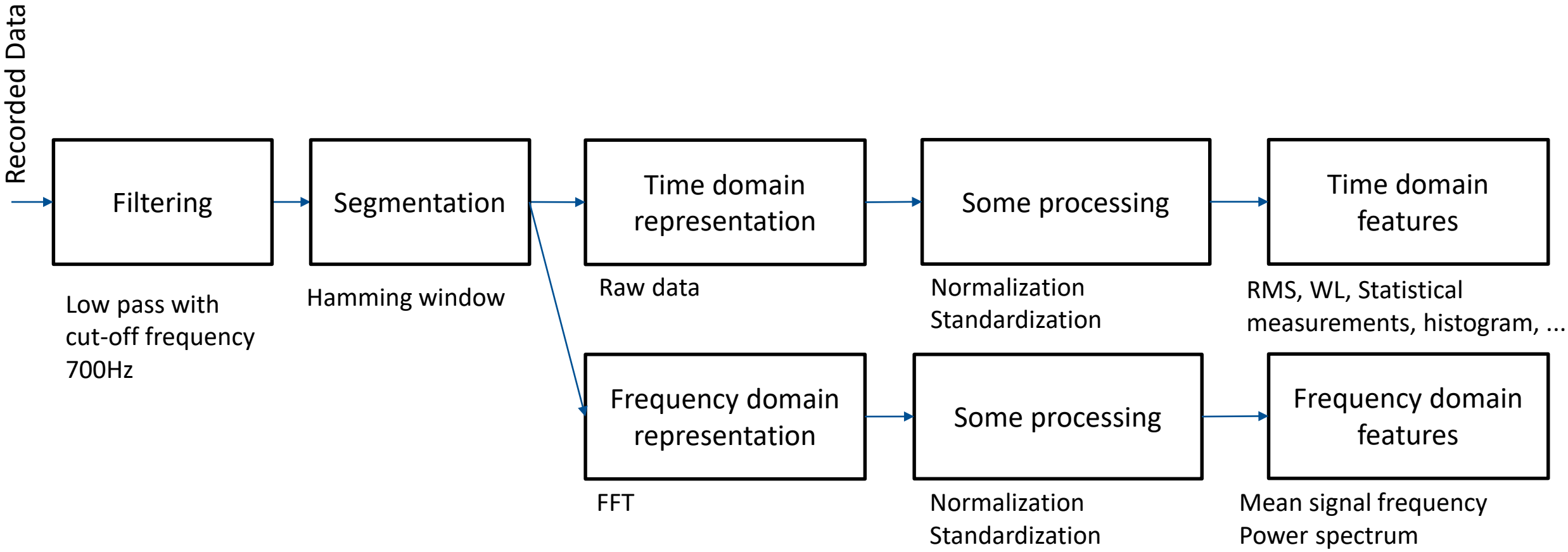


EMG Processing & Features Extraction





EMG Processing & Features Extraction



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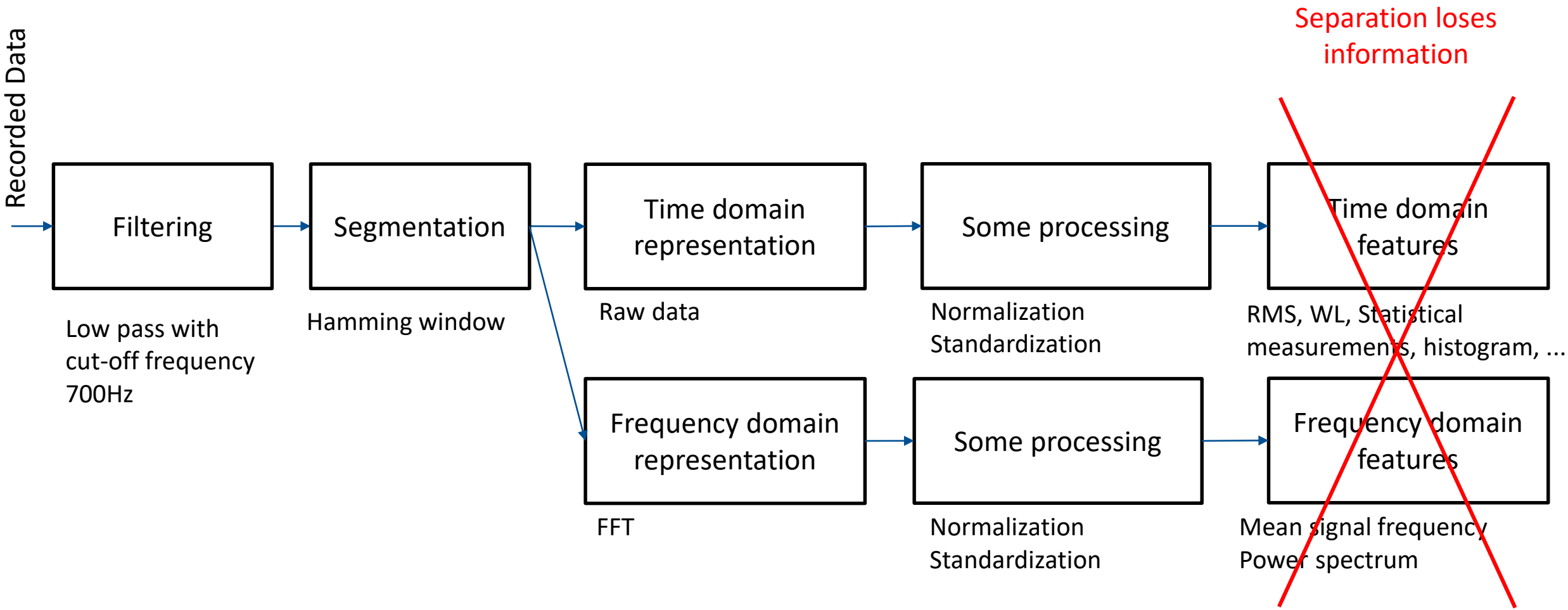

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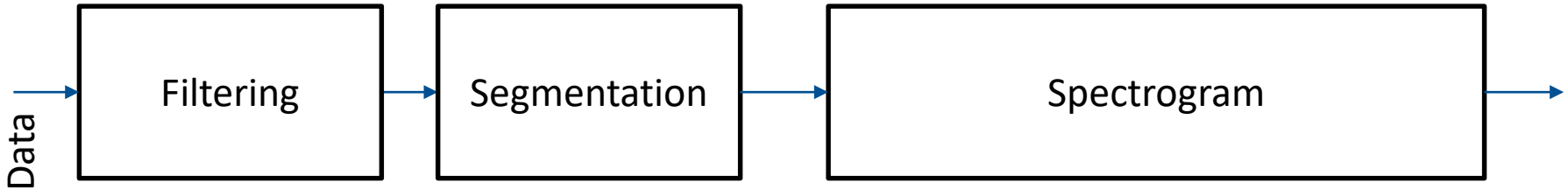


6th order Butterworth low-pass filter with cut-off frequency 120Hz.

200ms segments

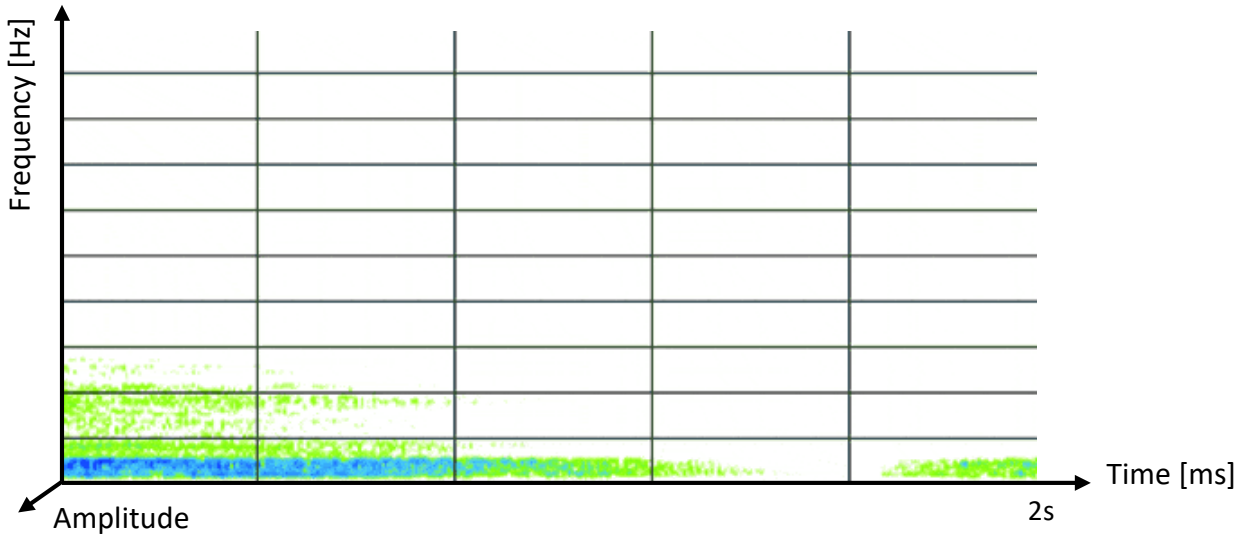
100ms increments (overlap)

[Englehart and Hudgins, 2003]

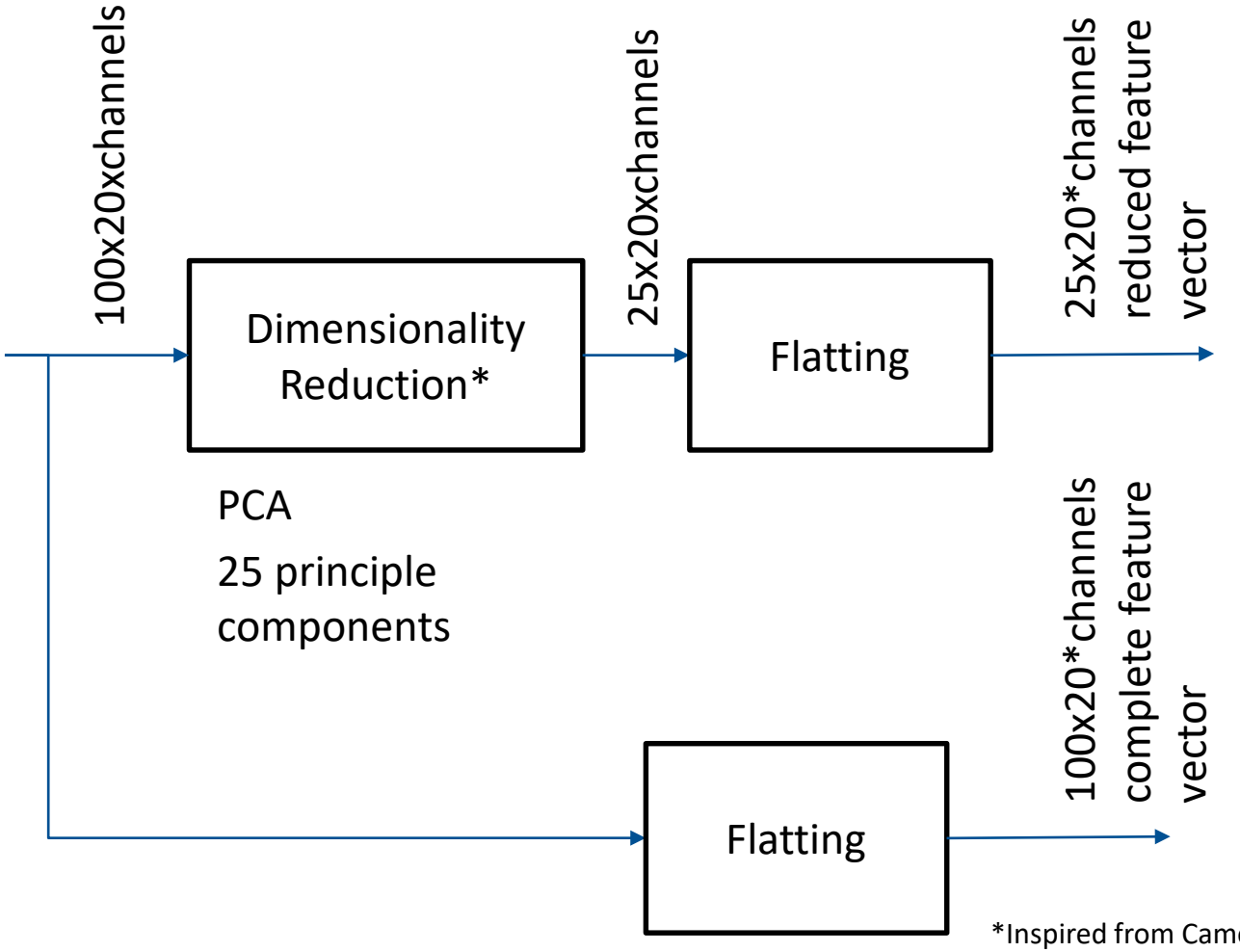
- 256 point FFT with 184-point overlap

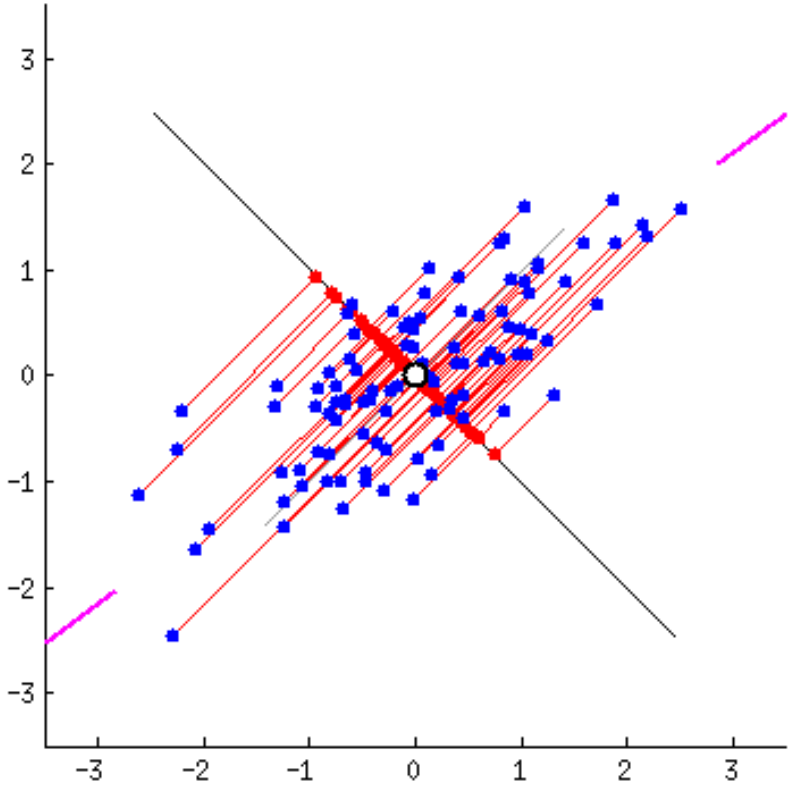
➔100 frequency points qt different frequencies (0 to ~700Hz).

- 2000ms/100ms = 20 time bins



Dimensionality Reduction

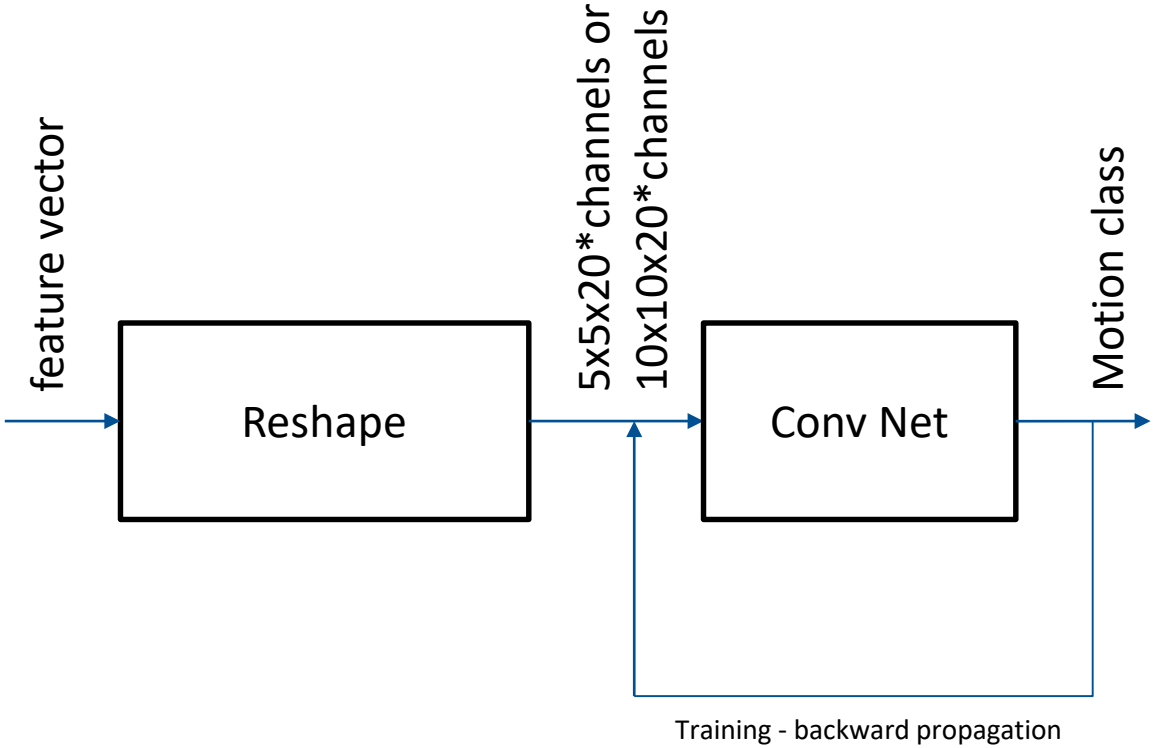


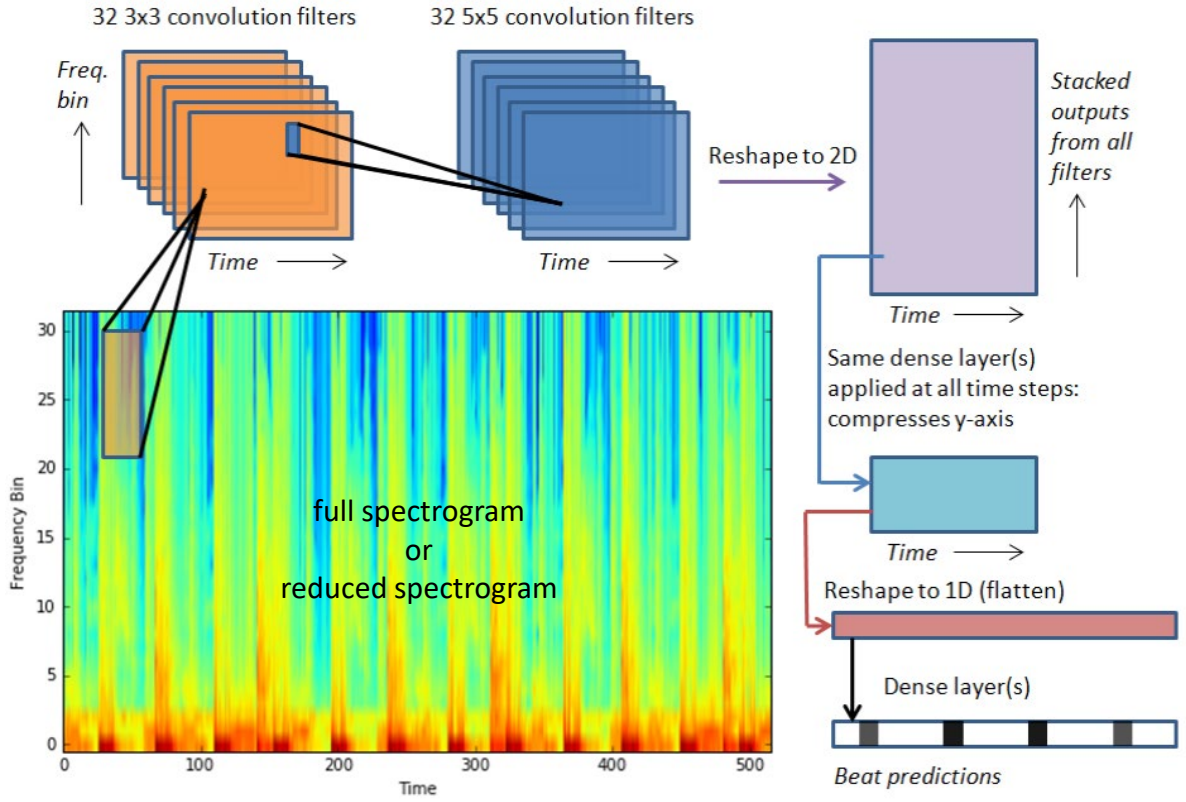


PCA 2D to 1D
[https://giphy.com/gifs/pca-KRpGtfuxQgCEo]

*Inspired from Camera Control with EMG Signals using Principal Component Analysis and Support Vector Machines

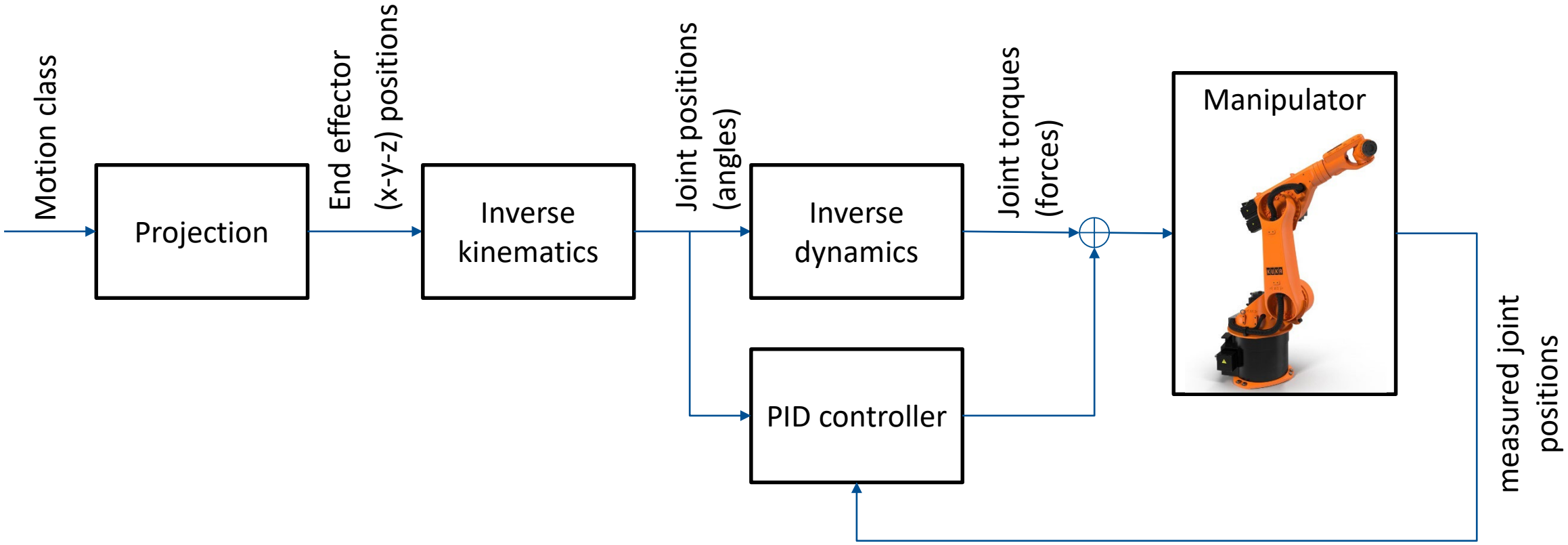
Motion Decoding





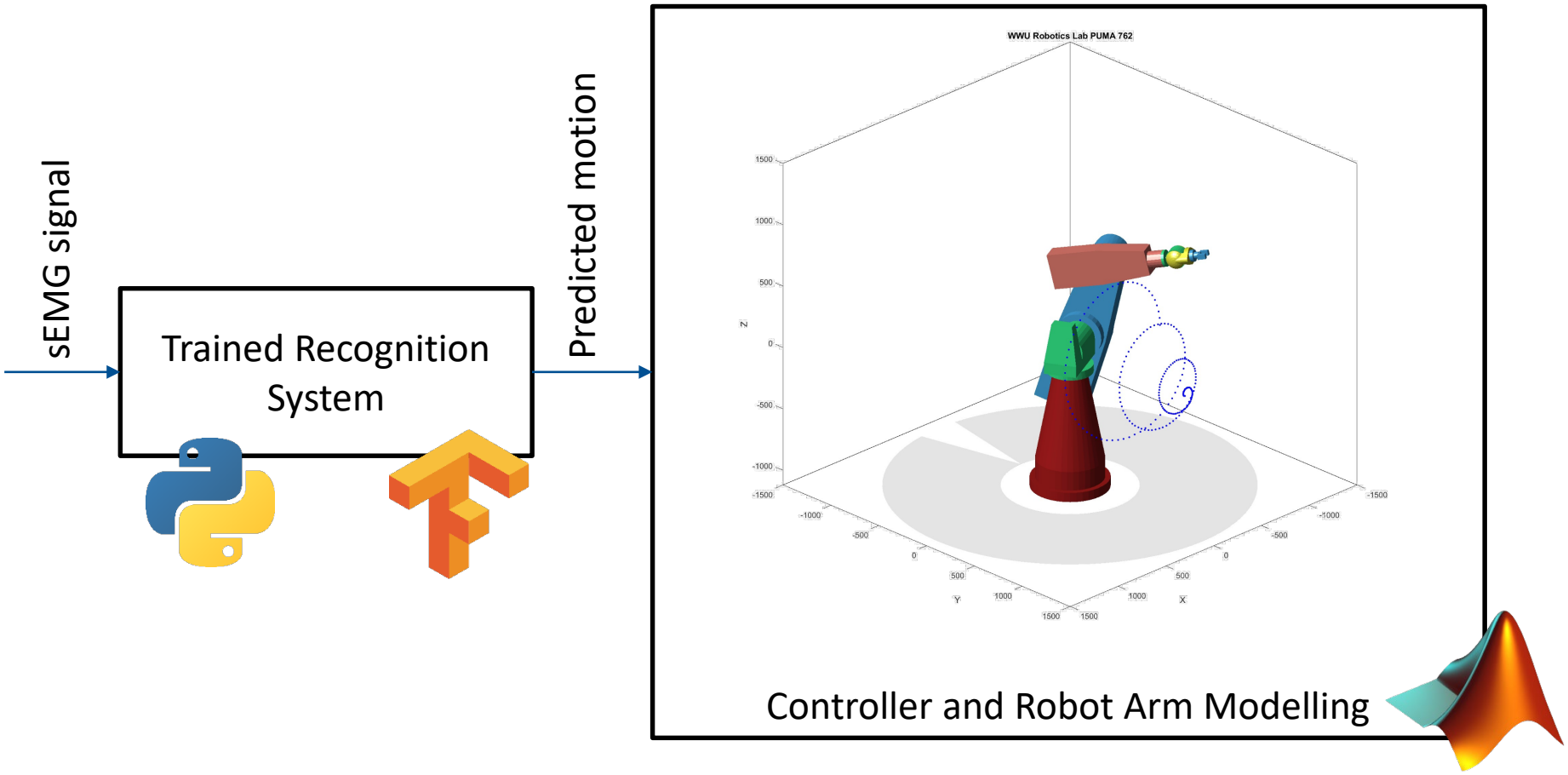
Convolutional Network [nlml.github.io/neural-networks/detecting-bpm-neural-networks/]

Controller Design



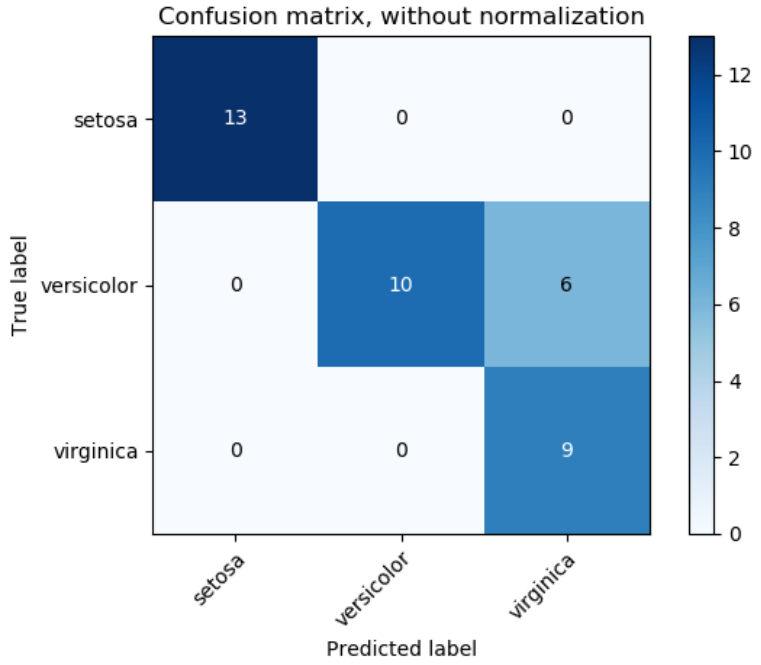
Controller Design

- WWVU Robotics Lab PUMA 762 simulator



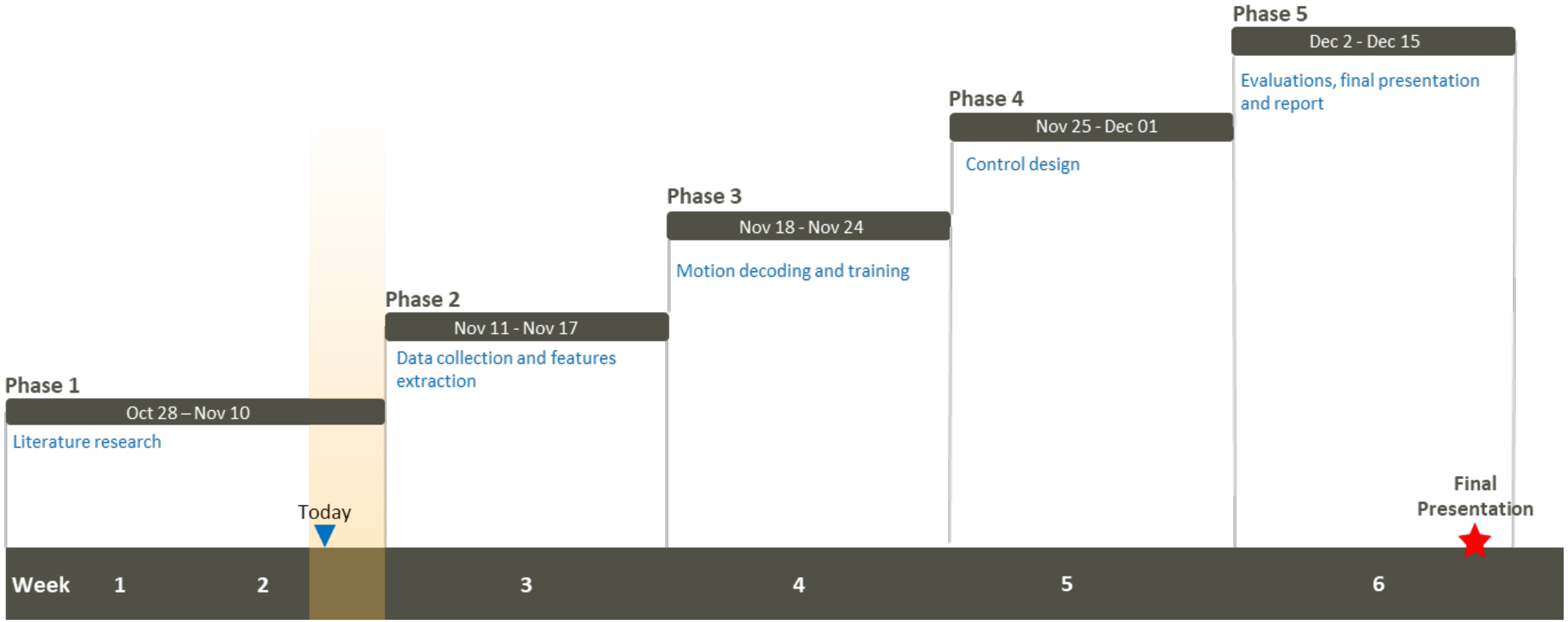
Performance Analysis

- Common metrics for evaluating classifers:
  - Accuracy
  - Loss
  - Confusion matrix



Confusion matrix [scikit-learn]

Timeline


Phase 5
Dec 2 - Dec 15
Evaluations, final presentation and report
Phase 4
Nov 25 - Dec 01
Control design
Phase 3
Nov 18 - Nov 24
Motion decoding and training
Phase 2
Nov 11 - Nov 17
Data collection and features extraction
Phase 1
Oct 28 – Nov 10
Literature research
Today
Final Presentation
Week 1 2 3 4 5 6

References

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