

521273S - Biosignal Processing I - Online Labs - Autumn 2024 (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024)

- Assignment 1 - Respiration analysis (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449045-assignment-1-respiration-analysis)
- Assignment 2 - ECG Filtering to Remove Noise (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449050-assignment-2-ecg-filtering-to-remove-noise)
- Assignment 3 - Adaptive filtering (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449055-assignment-3-adaptive-filtering)
- Assignment 4 - Pan-Tompkins Algorithm for QRS Detection (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449060-assignment-4-pan-tompkins-algorithm-for-qrs-detection)
- ✓ Assignment 5 - EMG and Muscular Force Analysis (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449065-assignment-5-emg-and-muscular-force-analysis)
- ✓ Linear modeling (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449065-assignment-5-emg-and-muscular-force-analysis/problems/1664235-linear-modeling)
- Assignment 6 - Frequency-Domain Analysis of Heart Sounds (/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/assignments/449070-assignment-6-frequency-domain-analysis-of-heart-sounds)

521273S - Biosignal Processing I - Online Labs - Autumn 2024 (/courses/157000-521273s-biosignal-2024) ➤ Assignment 5 - EMG and Muscular Force Analysis (/courses/157000-521273s-biosignal-pr2024/assignments/449065-assignment-5-emg-and-muscular-force-analysis) ➤



Linear modeling (/courses/157000-521273s-biosignal-processing-i-onautumn-2024/assignments/449065-assignment-5-emg-and-muscular-analysis/problems/1664235-linear-modeling)

8 solutions submitted (max: Unlimited) |
[View my solutions \(/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/problmodeling/solutions/people/35170603-abu-taher\)](/courses/157000-521273s-biosignal-processing-i-online-labs-autumn-2024/problems/1664235-linear-modeling/solutions/people/35170603-abu-taher)

Open

signal.

In order to investigate the relationship between an independent variable and a dependent variable, it is common to fit a model to the data and then to examine the accuracy of the underlying model (goodness of fit). In the present lab assignment, you will represent the variation of each of the parameters DR, MS, ZCR and TCR as a function of independent variable.

A brief explanation of the parameters:

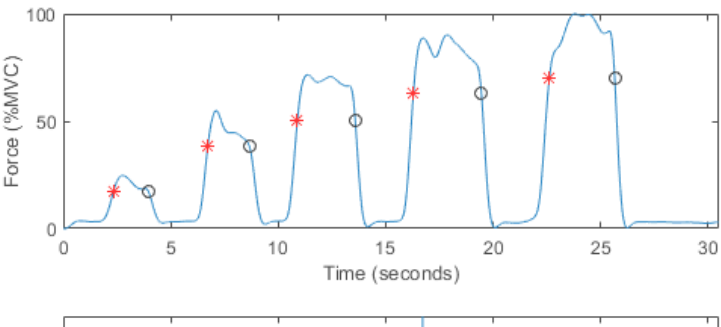
- The dynamic range (DR) of a signal is the difference between its maximum and minimum values over a specified time interval or range.
- The average power of a signal is provided by the mean-squared (MS) value over a specified duration. The root-mean-squared (RMS) value. With the mean of the EMG signal being zero, the RMS value is equal to the standard deviation of the signal.
- An approximate indicator of the level of activity in a signal is given by the number of times the signal crosses the zero line (zero crossings). A zero crossing is said to occur when the sign of a sample of the signal changes from positive to negative or vice versa. The zero-crossing rate (ZCR) is the number of zero crossings over a certain time period is known as the zero-crossing rate (ZCR). It is expected that the ZCR will increase with the level of activity. See Section 5.6 on statistical analysis of EMG signals.
- Turns count (TC) is the number of times the signal amplitude changes direction. In Willison method, a threshold is selected to avoid counting insignificant fluctuations due to noise. TCR (Turns Count Rate) is the turn count rate.

Data

Muscle force and EMG data from the original experiment are shown in Figure 1. The sampling rate is 2000 Hz. Five 5-second segments have been prepared for the assignment and are available in data.mat file. The segments were constructed by dividing the data into 5 segments, and has the following fields:

- t: the time points for the segment
- force: muscle force data readily prepared in percent of maximal voluntary contraction
- EMG: the EMG data for the segment with its mean (DC) subtracted
- length: the number of samples in the segment

You can reach the data with the following syntax: for example data(2).force is the force signal from the second segment.



Script ?

Save Reset MATLAB Documentation (<https://www.mathworks.com/help/>)
[Open Problem in MATLAB Online](#)

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```
22 % Load the signals from data.mat into the struct 'data'
23 % << insert loading code here >>
24 load('data.mat');
25 % Number of segments
26 N = numel(data);
27
28 % Calculate average force of each segment (1xN vector)
29 AF = zeros(1, N);
30
31 % Calculate EMG dynamic range in each segment (1xN vector)
32 DR = zeros(1, N);
33
34 % Calculate EMG mean squared value in each segment (1xN vector)
35 MS = zeros(1, N);
36
37 % Calculate EMG zero crossing rate in each segment (1xN vector)
38 ZCR = zeros(1, N);
39
40 % Calculate EMG turns rate in each segment (1xN vector)
41 TCR = zeros(1, N);
42 for i = 1:N
43     AF(i) = mean(data(i).force);
44     DR(i) = max(data(i).EMG) - min(data(i).EMG);
45
46     signal_length = length(data(i).EMG);
47     MS(i) = sum((data(i).EMG).^2) / signal_length;
48
49     %ZCR calculation
50     time_duration = data(i).t(end) - data(i).t(1);
51     zero_crossings = sum(abs(diff(sign(data(i).EMG)))) / 2;
52     ZCR(i) = zero_crossings / time_duration;
53
54     % Calculate Turns Count Rate (TCR)
55     derivative = diff(data(i).EMG);
56     signs = sign(derivative);
57     turns = signs(1:end-1) .* signs(2:end);
58     turn_indices = find(turns <= 0) + 1;
59     extremes = data(i).EMG(turn_indices);
60     extreme_diff = diff(extremes);
61     valid_turns = find(abs(extreme_diff) > 0.1);
```

Previous Assessment: All Tests Passed

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✓ Correct average forces

✓ Correct dynamic ranges

✓ Correct mean squared values

✓ Correct zero crossing rates

✓ Correct turn count rates

✓ Correct AF-DR correlation

✓ Correct AF-MS correlation

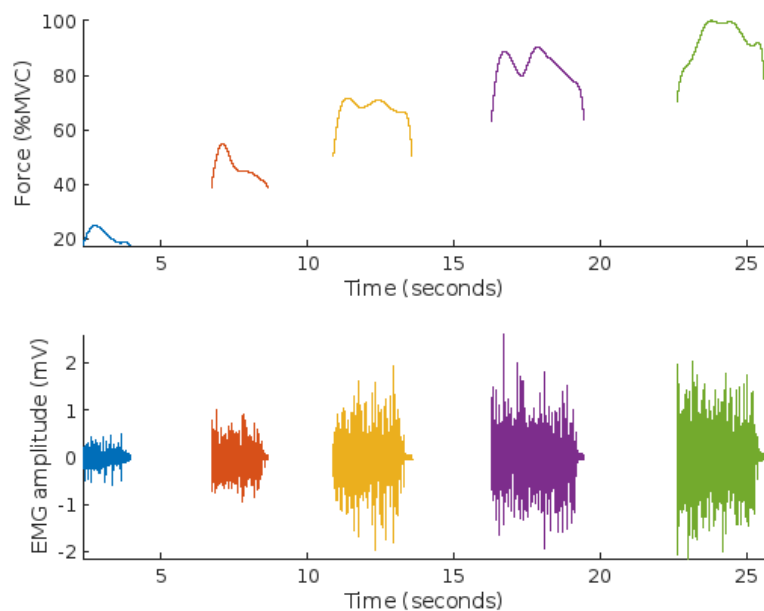
✔ Correct AF-TCR correlation

✔ Plotting 1 - not a real test (Open to view) (Pretest)

Test Code:

```
1 N = numel(data); % number of segments
2
3 figure;
4
5 subplot(211);
6 hold on;
7 for i = 1:N
8     plot(data(i).t, data(i).force);
9 end
10 axis tight;
11 xlabel('Time (seconds)');
12 ylabel('Force (%MVC)')
13
14 subplot(212);
15 hold on;
16 for i = 1:N
17     plot(data(i).t, data(i).EMG);
18 end
19 axis tight;
20 xlabel('Time (seconds)');
21 ylabel('EMG amplitude (mV)');
22
```

Figures:



✔ Plotting 2 - not a real test (Open to view) (Pretest)

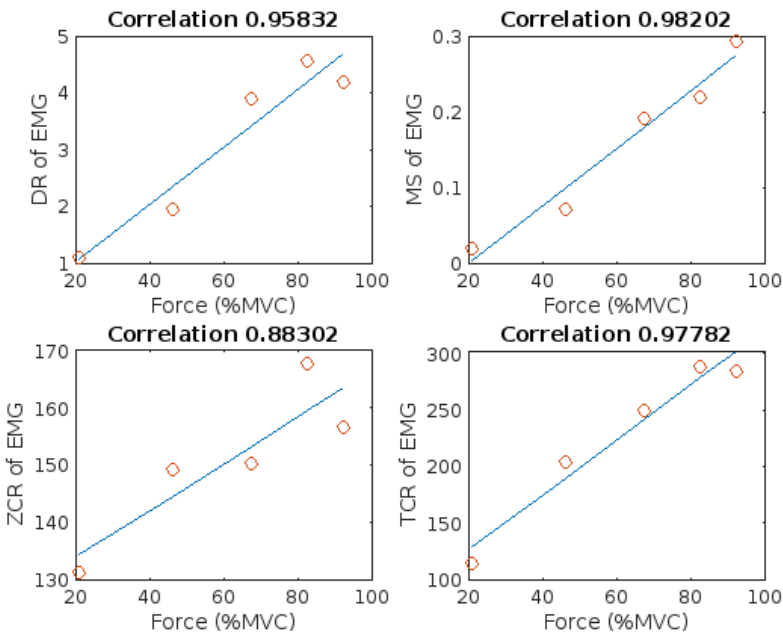
Test Code:

```
1
2
3
4
5
```

```
MODELS = [P_DR, P_MS, P_ZCR, P_TCR];
LABELS = {'DR', 'MS', 'ZCR', 'TCR'};
CORRS = [c_DR, c_MS, c_ZCR, c_TCR];

% Plotting linear models and raw data
figure;
for i = 1:4
    subplot(2,2,i);
    line = polyval(MODELS{i}, AF); % line estimate
    plot(AF, line);
    hold on;
    plot(AF, Y(i,:), 'o');
```

Figures:



Output

Code ran without output.

