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

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signal.

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

A brief explanation of the parameters:

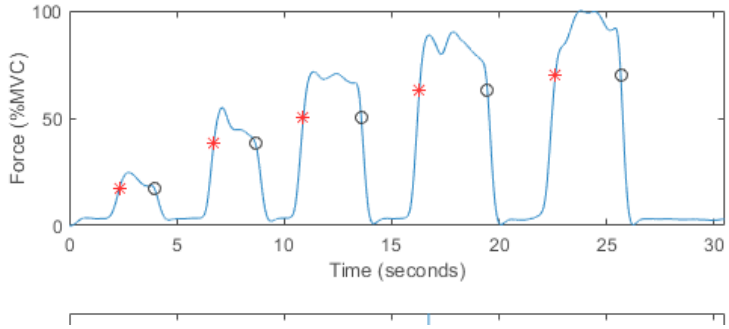
- The dynamic range (DR) of a signal is the difference between its maximum and minimum values ov
  swing or range.
- The average power of a signal is provided by the mean-squared (MS) value over a specified duratic
  squared (RMS) value. With the mean of the EMG signal being zero, the RMS value is equal to the s
- An approximate indicator of the level of activity in a signal is given by the number of times the signa
  should be subtracted from the signal). A zero crossing is said to occur when the sign of a sample of
  zero crossings over a certain time period is known as the zero-crossing rate (ZCR). It is expected th
  ZCR. 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
  selected to avoid counting insignificant fluctuations due to noise. TCR (Turns Count Rate) is the turn

Data

Muscle force and EMG data from the original experiment are shown in Figure 1. The sampling rate is 2000 H
segments have been prepared for the assignment and are available in `data.mat` file. The segments were cr
`struct` (for the 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 se



Script

Save Reset MATLAB Documentation (https://www.mathworks.com/help/)

Open Problem in MATLAB Online

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```

```
% Load the signals from data.mat into the struct 'data'
% << insert loading code here >>
load('data.mat');
% Number of segments
N = numel(data);

% Calculate average force of each segment (1xN vector)
AF = zeros(1, N);

% Calculate EMG dynamic range in each segment (1xN vector)
DR = zeros(1, N);

% Calculate EMG mean squared value in each segment (1xN vector)
MS = zeros(1, N);

% Calculate EMG zero crossing rate in each segment (1xN vector)
ZCR = zeros(1, N);

% Calculate EMG turns rate in each segment (1xN vector)
TCR = zeros(1, N);
for i = 1:N
    AF(i) = mean(data(i).force);
    DR(i) = max(data(i).EMG) - min(data(i).EMG);

    signal_length = length(data(i).EMG);
    MS(i) = sum((data(i).EMG).^2) / signal_length;

    %ZCR calculation
    time_duration = data(i).t(end) - data(i).t(1);
    zero_crossings = sum(abs(diff(sign(data(i).EMG)))) / 2;
    ZCR(i) = zero_crossings / time_duration;

    % Calculate Turns Count Rate (TCR)
    derivative = diff(data(i).EMG);
    signs = sign(derivative);
    turns = signs(1:end-1) .* signs(2:end);
    turn_indices = find(turns <= 0) + 1;
    extremes = data(i).EMG(turn_indices);
    extreme_diff = diff(extremes);
    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:

```
N = numel(data);  % number of segments

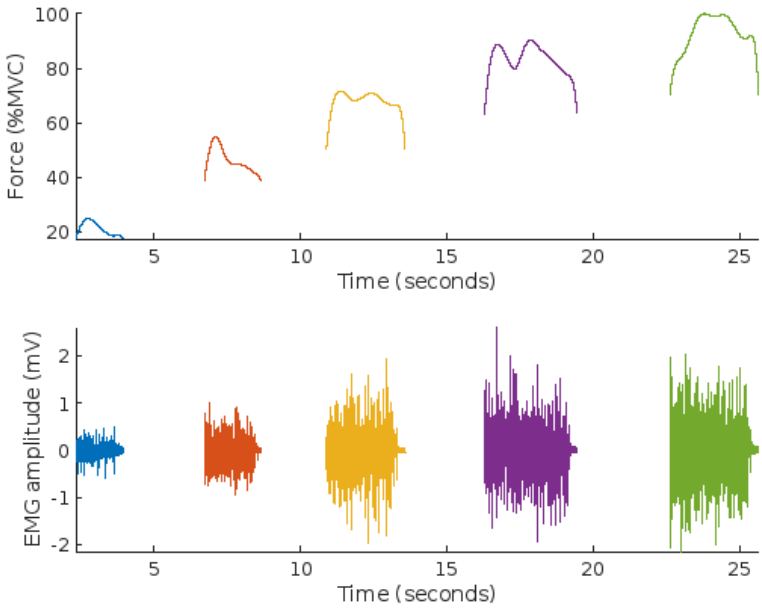
figure;

subplot(211);
hold on;
for i = 1:N
    plot(data(i).t, data(i).force);
end
axis tight;
xlabel('Time (seconds)');
ylabel('Force (%MVC)')

subplot(212);
hold on;
for i = 1:N
    plot(data(i).t, data(i).EMG);
end
axis tight;
xlabel('Time (seconds)');
ylabel('EMG amplitude (mV)');

```

Figures:



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

Test Code:

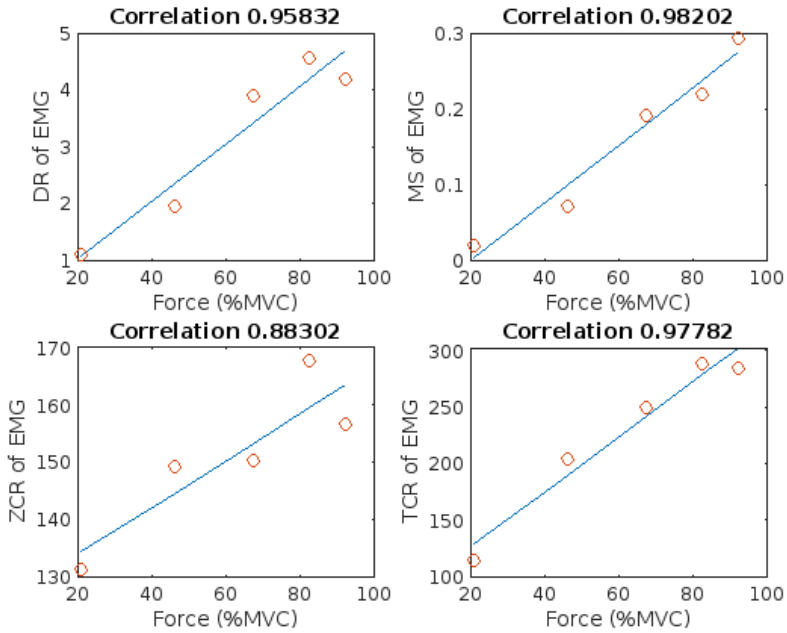
```

```

```
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;
```

Figures:



Output

```
Code ran without output.
```