Måling, behandling og præsentation af biologiske signaler

mm2
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Matrixlaboratory

Indhold
Introduktion til matricer og numeriske beregninger
Grafik i 2- og 3-D
Programmering i MATLAB, m-filer
Signal behandling 1
Signal behandling 2

Matlab graphics

Indhold
- Plotting line and data in 2D and 3D
- Plotting functions in 2D and 3D
- Handle graphics objects
2D Graphics

- 2-D graphics with
  - plot
  - loglog
  - semilogx
  - semilogy

2D Plot (data)

```matlab
x=[1:10];
y=[2 8 5 6 8 3 8 9 5 -1];
plot(x,y,options);
axis([x_min x_max y_min y_max]);
hold on;
title('Experiment 1');
plot(x,y,'y',x,z,'m');
legend
```

2D Plot graph (data)

![2D Plot graph](image)

Plot (options)

<table>
<thead>
<tr>
<th>Color</th>
<th>Point type</th>
<th>Line Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>yellow</td>
<td>solid</td>
</tr>
<tr>
<td>m</td>
<td>magenta</td>
<td>dotted</td>
</tr>
<tr>
<td>c</td>
<td>cyan</td>
<td>dashdot</td>
</tr>
<tr>
<td>r</td>
<td>red</td>
<td>-</td>
</tr>
<tr>
<td>g</td>
<td>green</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>blue</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>black</td>
<td></td>
</tr>
</tbody>
</table>

Bar graph

bar created a bar graph

```
bar(emg,'stack')
```

Several 2D Plot in one graph

```matlab
subplot(m,n,i) created m*n plots, arranged in a array with m rows and n columns
```

```
subplot(2,3,6)
plot(x_6,y_6)
```
• 90° bilateral continuous arm flexion and abduction at approximately 20%MVC (N=11)

Polar plot (data)

\[ t = 0:0.01:2\pi \]

polar(t,abs(cos(2*t).*sin(t)),'*g')

For more advanced 2D graph:
try graf 2D
and/or help graphics
and/or Help Desk

2D Plot (transfer function)

\[ TF = \frac{n}{d} = \frac{8s + 9}{s^2 + 3s} \]

Hints for good graph

Scaling of the plot
Log scale

plot(log10(x),log10(y),'x')
loglog(x,y,'x')

3D Graphics

• 3-D graphics with
  – plot3
  – surf
  – surfc
  – surf1
  – mesh
  – shading
  – view

  – rotate3d
  – meshgrid
  – meshc
  – meshz
  – contour
  – contour3
  – colormap
  – ...

Two-Dimensional Graphics

Elementary X-Y Graphs
plot Line plot.

loglog Log-log scale plot.

polar Polar coordinate plot.

semilogx Semi-log scale plot, x-axis logarithmic.

semilogy Semi-log scale plot, y-axis logarithmic.

Specific X-Y Graphs
bar Bar graph.

hist histogram plot.

stem Stem plot.

Specific X-Y Graphs (cont.)
compass Compass plot.

pie Pie chart.

rose Angle histogram plot.

contour Contour plot.

contourf Contourf plot.

square Square plot.

stem3 Stem plot for 3D data.

Specific X-Y Graphs (cont.)

Graph Annotation

grid Grid lines.

title Graph title.

xlabel X-axis label.

ylabel Y-axis label.

text Text annotation.

Coordinate System Conversion
cart2pol Cartesian to polar coordinates.
pol2cart Polar to Cartesian coordinates.

Miscellaneous
zoom Zoom in and out of a 2-D plot.
3D Plot graph (data)

\[ x = -2:0.1:2; \]
\[ y = -1:0.1:2; \]
\[ [x\_coord, y\_coord] = \text{meshgrid}(x, y); \]
\[ f = 1 / (1 + x\_coord.^2 + y\_coord.^2); \]
\[ \text{mesh}(x\_coord, y\_coord, f); \]
\[ \text{surf}(x\_coord, y\_coord, f); \]

\[ \text{surf}(x\_coord, y\_coord, f); \]

\[ \text{meshc}(x\_coord, y\_coord, f); \]
\[ \text{contour}(x\_coord, y\_coord, f); \]

For more advanced 3D graph, try graf 3D and/or help graphics and/or Help Desk

3-D Graphics

- Different colorscale with: ‘colormap’
- Different angle of vision with: ‘view’
- Different surface properties with: ‘shading’
- Color reference scale with: ‘colorbar’

3-D Graphics

- Visualisation of functions of 2 variables
  - meshgrid
- Visualisation of 3D data
  - griddata
• Surface EMG signals from the upper trapezius muscle with a 5x13 electrode grid

2D Function Plot

ezplot function:

\[ \text{ezplot('function', \([x_{\text{min}}, x_{\text{max}}, y_{\text{min}}, y_{\text{max}}]\))} \]

\[ \text{ezplot('sin(x)/(1+x^2)')} \]

\[ \text{ezpolar('function', \([x_{\text{min}}, x_{\text{max}}, y_{\text{min}}, y_{\text{max}}]\))} \]

\[ \text{ezpolar('sin(x)/x', \([-6*\pi, 6*\pi]\))} \]

fplot: More plot on one figure and is quickly

3D Function Plot

ezsurf3 function:

\[ \text{ezsurf3('function1', 'function2', 'function3')} \]

\[ \text{ezsurf3('cos(2*\pi*t)', 'sin(2*\pi*t)', 't', [0,4])} \]

ezsurf: surface plot

\[ \text{ezsurf('x*y*exp(-(x^2+y^2)))} \]

shading interp
colorbar
ezsurf
ezmesh
ezcontour
ezcontourf
**Print graph**

print -f1 -device -options filename

print -f1 -tiff -depsc2 graph

copy and paste commands (Edit menu)

For more advanced 2D graph

try graf 2D or graf 3D and/or help graphics and/or Help Desk

**Objects in MATLAB graphics**

An axis will always have a figure as a parent and may have image, line, patch, surface, text, light

**Handle graphics objects**

- Useful in GUI and m-files generation
- All object are stored in a hierarchical arrangement that can be inspected using the properties ’parent’ and ’children’

**Handle Graphics objects in MATLAB**

- uicontrol
- axes
- uimenu
- uicontextmenu
- image
- line
- patch
- surface
- text
- light

**Graphics objects**

- Root object
- Figure object
- UIMenu objects
- Surface object
- Line objects
- Text objects

**How to create an object and get its handle?**

- Each graphical object has a unique handle used to identify the object
  - f=figure;
- Value of a selected property
  - gcf, gca, …
- Find an arbitrary object
  - findobj(’property’,’value’)
    - returns all the objects with the specified property values (use property “UserData”)

**Change properties**

- Graphics properties can be changed via property editor (propedit)
- From the command line, use set and get
  - set(object, ’property’, ’value’)
  - get(object, ’property’)

set(object) shows all the object possible properties
exp. set(0)
get(object) shows the actual object common properties
exp. get(0)
**CameraPosition**
- CameraPositionMode: [ {auto} | manual ]

**CameraTarget**
- CameraTargetMode: [ {auto} | manual ]

**CameraUpVector**
- CameraUpVectorMode: [ {auto} | manual ]

**CameraViewAngle**
- CameraViewAngleMode: [ {auto} | manual ]

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**Set and Get Example**

- `set(0, 'DefaultFigurePaperType','A4letter')`
  - changes paper size to A4 for all the created figures
- `set(gcf, 'color','b')`
  - gives blue figure background
- `h=plot(1:20); set(h, 'linewidth',2, 'color',[1 0 0])`
  - gives en thick red line

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**Graphical User Interface (GUI)**

- **GUI**
  - Simplicity
  - Consistency
  - Familiarity
  - Dynamic interface
  - Keep it simple

- **GUI - Example**

  Select **File**: **New**: **GUI**

  Make a GUI with the following features:
  - one graphical window
  - four buttons
    - one to plot 10 seconds of ECG
    - one to toggle grid on/off
    - one scale axis
    - one to close figure
GUI

- Modifying properties with the property Inspector
  - Property editor
  - Guide control panel
  - Callback editor
  - Alignment tool
  - Menu editor

**GUI - example**

Saving and running a GUI

GUI callback functions

```matlab
% --------------------------------------------------------------------
function popupmenu1_CreateFcn(hObject, eventdata, handles)
switch get(hObject,'Value')
  case 1
    axis equal
  case 2
    axis normal
  case 3
    axis square
end

% --------------------------------------------------------------------
function togglebutton1_Callback(hObject, eventdata, handles)
close

% --------------------------------------------------------------------
function togglebutton2_Callback(hObject, eventdata, handles)
load ekg.txt
t=0.01:0.01:(59.99-0.01);
plot(t(1:1000),ekg(1:1000))
```

**GUI callback functions (example)**

**GUI**

**Matlab graphics**

**Sammenfatning**

- 2D and 3D plot
- function plot
- Handle graphics objects
- Graphical user interface