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Development of Sine Wave Curve Fitting Algorithm

In this section we start the program and read from the Excel file

```
clear; clc; close all

ExpData = xlsread('SineWaveData.xlsx');

CumErrorTrace = [];
```

1-Parameter ID using nested for loops

```
tic
x1 = [5:(10-5)/99:10];
x2 = [0:pi/2/99:pi/2];

CumErrorMin = inf;
for i = 1:length(x1)
    for j = 1:length(x2)
        CumError(i,j) = CalcCumError([x1(i) x2(j)]);
        if CumError(i,j) < CumErrorMin
            CumErrorMin = CumError(i,j);
            x1_opt = x1(i);
            x2_opt = x2(j);
        end
    end
end
toc

disp(['Estimated amplitude is: ' num2str(x1_opt) '[V]'])
disp(['Estimated phase is: ' num2str(x2_opt) '[rad]'])
disp(['Minimum cumulative error is: ' num2str(CumErrorMin)])

figure(1); surf(x1,x2,CumError)
xlabel('Amplitide [V]')
ylabel('Phase [rad]')
zlabel('Cumulative error')
title('Cumulative Error vs Amplitude and Phase')
```
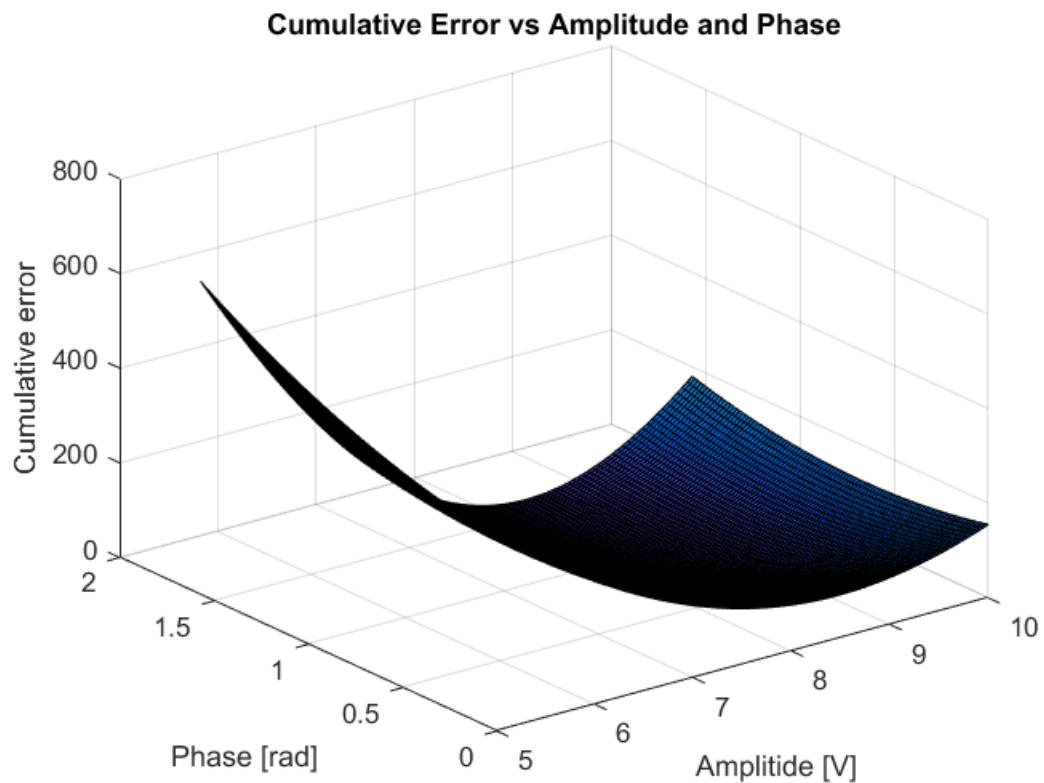
```
t1 = [0:0.001:(ExpData(end,1))];
y1 = x1_opt*sin(2*pi*10*t1 + x2_opt);

figure(2); plot(t1,y1,ExpData(:,1),ExpData(:,2),'or','linewidth',2);
xlabel('Time [s]')
ylabel('Signal [V]')
title('Simulated Signal vs Measured Data using Nested "for" Loops')
legend('Simulated','Measured');

figure(3); plot(CumErrorTrace,'linewidth',2)
xlabel('Number of Function Evaluations')
ylabel('Objective Function Value')
title('Curve Fitting based on Nested "for" Loops')

Elapsed time is 0.575259 seconds.
Estimated amplitude is: 8.7879[V]
Estimated phase is: 1.0472[rad]
Minimum cumulative error is: 6.2391
```
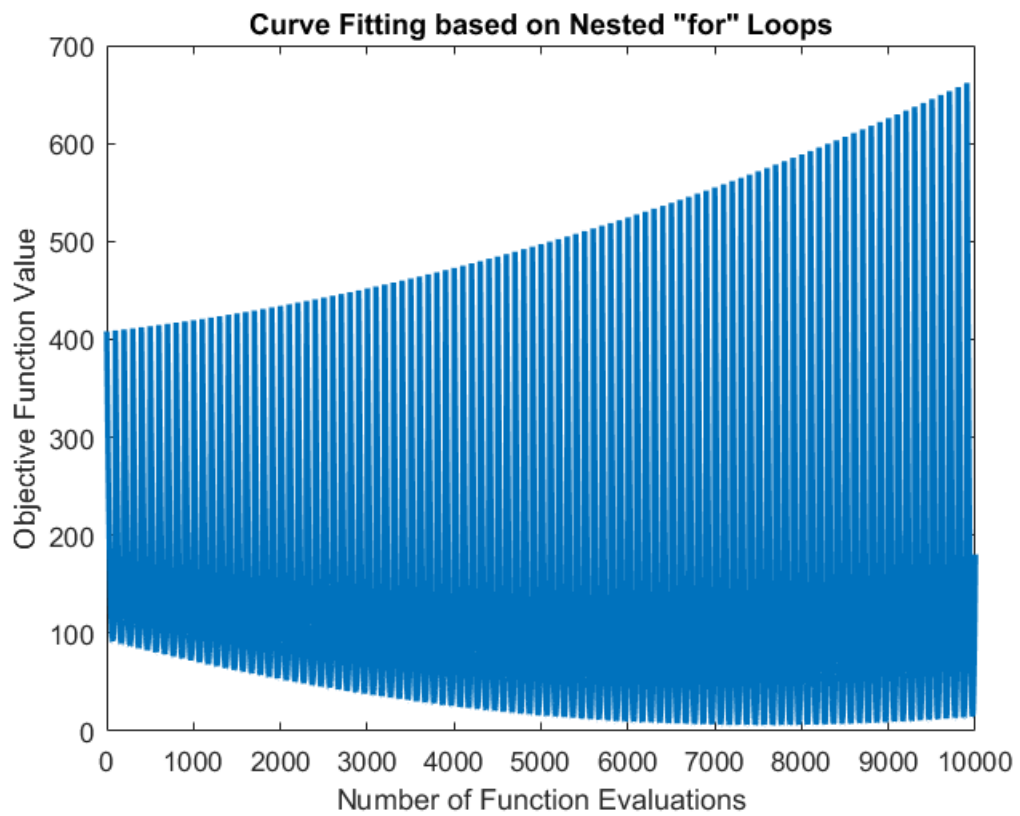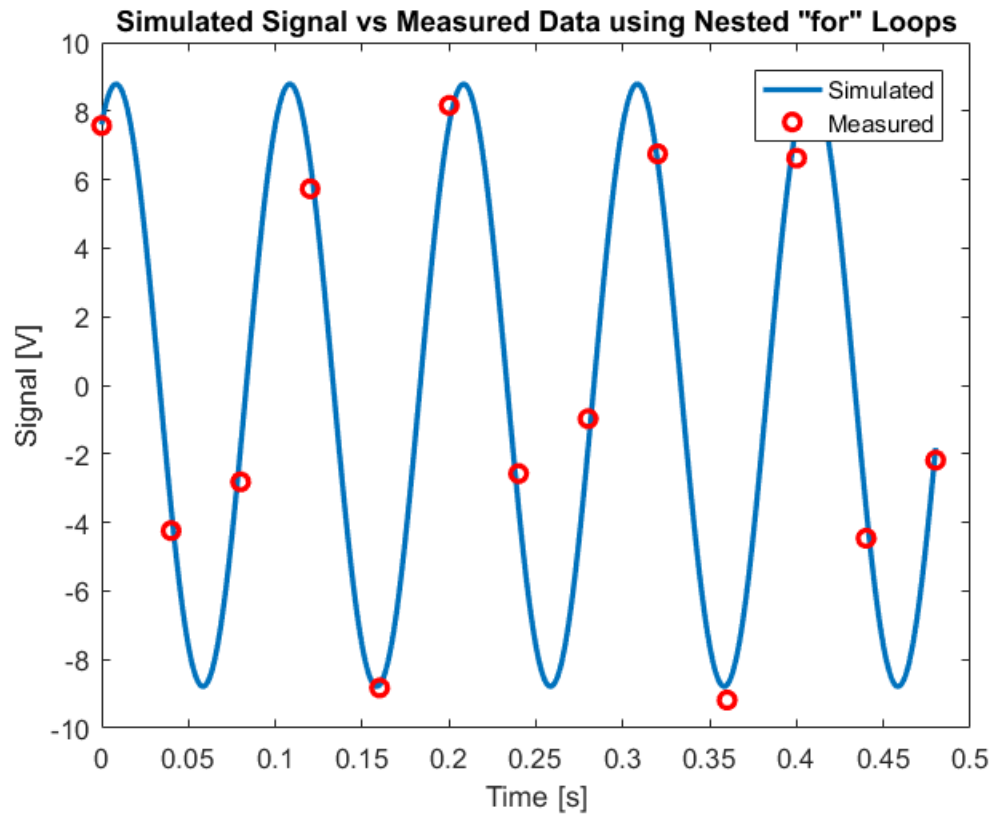

Cumulative Error vs Amplitude and Phase

Simulated Signal vs Measured Data using Nested "for" Loops

Curve Fitting based on Nested "for" Loops

2-Parameter ID using NesIder-Mead optimization algorithm

```
tic
CumErrorTrace = [];
[x_opt f_opt] = fminsearch('CalcCumError',[7.5 pi/4]);
toc

disp(['Estimated amplitude is: ' num2str(x_opt(1)) '[V]'])
disp(['Estimated phase is: ' num2str(x_opt(2)) '[rad]'])
disp(['Minimum cumulative error is: ' num2str(f_opt)])

t2 = [0:0.001:(ExpData(end,1))];
y2 = x_opt(1)*sin(2*pi*10*t1 + x_opt(2));

figure(4); plot(t2,y2,ExpData(:,1),ExpData(:,2),'or','linewidth',2);
xlabel('Time [s]')
ylabel('Signal [V]')
title('Simulated Signal vs Measured Data Using Nelder-Mead Method')
legend('Simulated','Measured');

figure(5); plot(CumErrorTrace,'linewidth',2)
xlabel('Number of Function Evaluations')
ylabel('Objective Function Value')
title('Nelder-Mean based curve fitting')

Elapsed time is 0.082009 seconds.
Estimated amplitude is: 8.7913[V]
Estimated phase is: 1.0492[rad]
Minimum cumulative error is: 6.2368
```
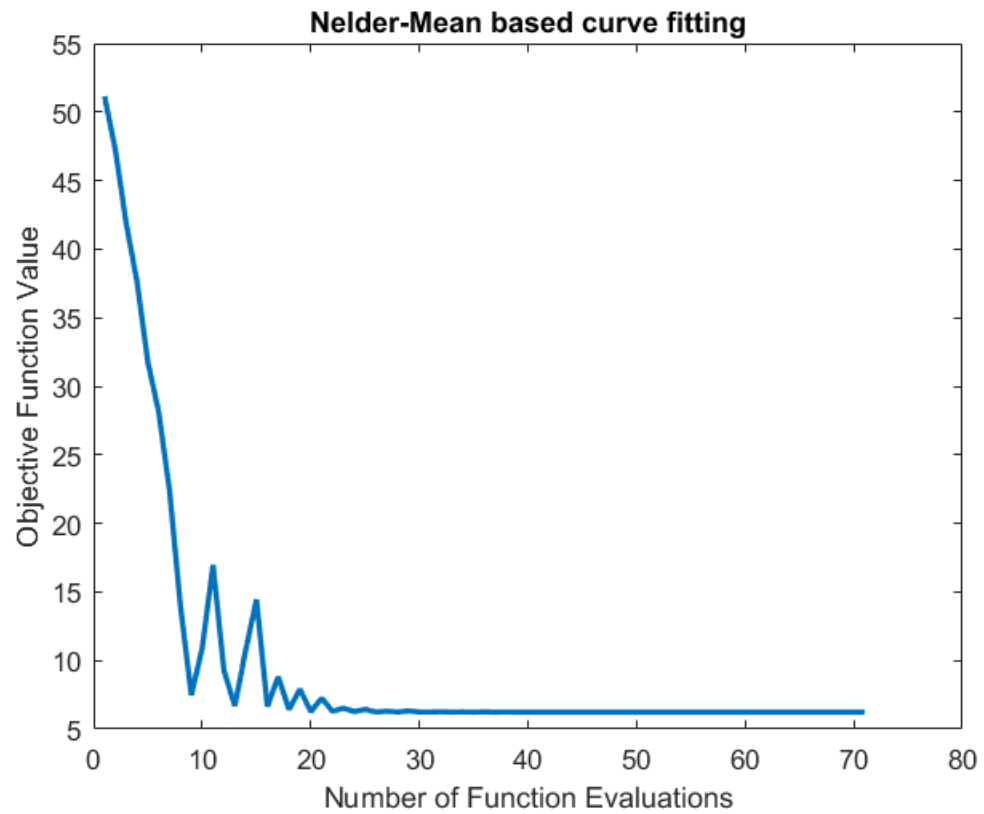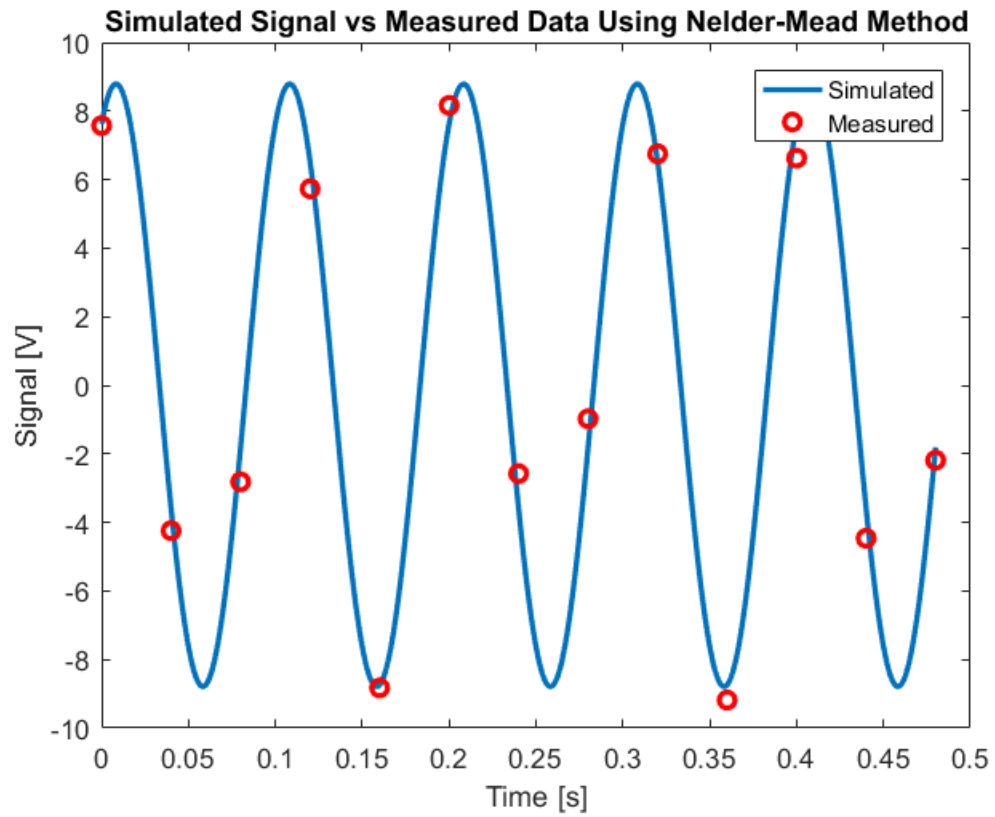
Simulated Signal vs Measured Data Using Nelder-Mead Method

Nelder-Mean based curve fitting

Error Calculation Function

```
function CumError = CalcCumError(x)

ExpData = evalin('base','ExpData');

tm = ExpData(:,1);

ym = ExpData(:,2);

y = x(1)*sin(2*pi*10*tm + x(2));

CumError = sum((ym-y).^2);

CumErrorTrace = evalin('base','CumErrorTrace');

CumErrorTrace = [CumErrorTrace CumError];

assignin('base','CumErrorTrace',CumErrorTrace);
```

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