Table of Contents

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```
Teixeira MS Thesis Intrusion Detection Model
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clear,
clc
```

Simulation parameters

```
TSIM = 20;

% u1Val = 34.632;
% u2Val = 1641.6;
% u3Val = 29980;
%
% X0 = [0.3412;525.7;525.7;496.2];
%
% z110 = 518.6174;
% z410 = -51365.5370;
% z320 = 472.2;
% z420 = -18391.8;
%
% fa1 = 0;
% fa2 = 0;
% fa3 = 1;
%
% f = [fa1;fa2;fa3]
```

Dynamic system

```
L = [
    3   -1  -1  -1  0   0   0;
    -1  4   -1  -1  -1  0   0;
    -1  -1  3   0   0   -1  0;
    -1  -1  0   3   0   0  -1;
    0   -1  0   0   2   0  -1;
    0   0   -1  0   0   2  -1;
```

```
    0   0   0  -1  -1  -1   3
    ]

A = -L

B = eye(7)
Bf=B;
Bf(2,2)=0

C = [
    0 0 0 0 0 0 0;
    0 1 0 0 0 0 0;
    0 0 1 0 0 0 0;
    0 0 0 1 0 0 0;
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0
    ]

E = [1.0;20.758;0.0;0.0]

x0 = [0 1 1 0 0 0 0]
```

L =

3	-1	-1	-1	0	0	0
-1	4	-1	-1	-1	0	0
-1	-1	3	0	0	-1	0
-1	-1	0	3	0	0	-1
0	-1	0	0	2	0	-1
0	0	-1	0	0	2	-1
0	0	0	-1	-1	-1	3

A =

-3	1	1	1	0	0	0
1	-4	1	1	1	0	0
1	1	-3	0	0	1	0
1	1	0	-3	0	0	1
0	1	0	0	-2	0	1
0	0	1	0	0	-2	1
0	0	0	1	1	1	-3

B =

1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	1	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	1	0

```
     0     0     0     0     0     0     1
```

```
Bf =

     1     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     1     0     0     0     0
     0     0     0     1     0     0     0
     0     0     0     0     1     0     0
     0     0     0     0     0     1     0
     0     0     0     0     0     0     1
```

```
C =

     0     0     0     0     0     0     0
     0     1     0     0     0     0     0
     0     0     1     0     0     0     0
     0     0     0     1     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
```

```
E =

    1.0000
   20.7580
         0
         0
```

```
x0 =

     0     1     1     0     0     0     0
```

Construct Fault Vectors

```
f1 = [1 0 0 0 0 0 0]'  % Vertex one is the intruder
f2 = [0 1 0 0 0 0 0]'  % Vertex two is the intruder
f3 = [0 0 1 0 0 0 0]'  % Vertex three is the intruder
f4 = [0 0 0 1 0 0 0]'  % Vertex four is the intruder
f5 = [0 0 0 0 1 0 0]'  % Vertex five is the intruder
f6 = [0 0 0 0 0 1 0]'  % Vertex six is the intruder
f7 = [0 0 0 0 0 0 1]'  % Vertex seven is the intruder

%E = [f1 f2 f3 f4 f5 f6 f7]
%E = [f2 f3 f4 f5 f6 f7]
E = [f1 f3 f5]

% Choose the agent to be attacked
```

```
flt1  = 0
flt2  = 0
flt3  = 0
flt4  = 1
flt5  = 0
flt6  = 0
flt7  = 0

% Choose a magnitude for the attack
f1Val = 10
f2Val = 10
f3Val = 10
f4Val = 10
f5Val = 10
f6Val = 10
f7Val = 10

% Chose the attack time
tf1   = 2
tf2   = 2
tf3   = 2
tf4   = 2
tf5   = 2
tf6   = 5
tf7   = 7


f1 =

     1
     0
     0
     0
     0
     0
     0


f2 =

     0
     1
     0
     0
     0
     0
     0


f3 =

     0
     0
     1
```

```
     0
     0
     0
     0

f4 =

     0
     0
     0
     1
     0
     0
     0

f5 =

     0
     0
     0
     0
     1
     0
     0

f6 =

     0
     0
     0
     0
     0
     1
     0

f7 =

     0
     0
     0
     0
     0
     0
     1

E =

     1     0     0
     0     0     0
```

```
     0     1     0
     0     0     0
     0     0     1
     0     0     0
     0     0     0


flt1 =

     0


flt2 =

     0


flt3 =

     0


flt4 =

     1


flt5 =

     0


flt6 =

     0


flt7 =

     0


f1Val =

    10


f2Val =

    10


f3Val =
```

```
    10

f4Val =

    10

f5Val =

    10

f6Val =

    10

f7Val =

    10

tf1 =

     2

tf2 =

     2

tf3 =

     2

tf4 =

     2

tf5 =

     2

tf6 =

     5

tf7 =
```

```
     7
```

UIO 1

This UIO is insensitive to faults in agent 2, but can detect faults in agents 3 and 4:

```
bf1 = [0 1 0 0 0 0 0]'

% Rank conditions
rank(C*bf1)
rank(bf1)

% Observer matrices
CE = C*bf1
CEin = inv(CE'*CE)
H1=bf1*CEin*CE'
T1 = eye(7)-H1*C
A11 = T1*A
rank(obsv(A11,C))
k11 = place(A11,C,[-1,-2,-3,-4,-5,-6,-7])
%F = A1-k1*C
F1 = A+H1*C*L-k11*C
k1 = k11 + F1*H1


bf1 =

     0
     1
     0
     0
     0
     0
     0


ans =

     1


ans =

     1


CE =

     0
     1
     0
     0
```

```
     0
     0
     0


CEin =

     1


H1 =

     0     0     0     0     0     0     0
     0     1     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0


T1 =

     1     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     1     0     0     0     0
     0     0     0     1     0     0     0
     0     0     0     0     1     0     0
     0     0     0     0     0     1     0
     0     0     0     0     0     0     1


A11 =

    -3     1     1     1     0     0     0
     0     0     0     0     0     0     0
     1     1    -3     0     0     1     0
     1     1     0    -3     0     0     1
     0     1     0     0    -2     0     1
     0     0     1     0     0    -2     1
     0     0     0     1     1     1    -3


ans =

     7


k11 =

         0         0         0         0         0         0         0
    0.4469    7.0316   -0.0797    0.4125    0.3204    0.0027    0.1221
    0.8230    0.5890    2.4289   -0.7112   -0.0196    0.8962   -0.1124
    0.9040    1.1596   -0.6336    2.5395    0.1004   -0.0957    0.9599
```

```
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
```

```
F1 =

   -3.0000    1.0000    1.0000    1.0000         0         0         0
         0   -7.0316    0.0797   -0.4125         0         0         0
    1.0000    0.4110   -5.4289    0.7112         0    1.0000         0
    1.0000   -0.1596    0.6336   -5.5395         0         0    1.0000
         0    1.0000         0         0   -2.0000         0    1.0000
         0         0    1.0000         0         0   -2.0000    1.0000
         0         0         0    1.0000    1.0000    1.0000   -3.0000
```

```
k1 =

         0    1.0000         0         0         0         0         0
    0.4469         0   -0.0797    0.4125    0.3204    0.0027    0.1221
    0.8230    1.0000    2.4289   -0.7112   -0.0196    0.8962   -0.1124
    0.9040    1.0000   -0.6336    2.5395    0.1004   -0.0957    0.9599
         0    1.0000         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
```

UIO 2

This UIO is insensitive to faults in agent 3, but can detect faults in agents 2 and 4:

```
bf2 = [0 0 1 0 0 0 0]'

% Rank conditions
rank(C*bf2)
rank(bf2)

% Observer matrices
CE = C*bf2
CEin = inv(CE'*CE)
H2=bf2*CEin*CE'
T2 = eye(7)-H2*C
A12 = T2*A
rank(obsv(A12,C))
k12 = place(A12,C,[-1,-2,-3,-4,-5,-6,-7])
%F = A1-k1*C
F2 = A+H2*C*L-k12*C
k2 = k12 + F2*H2
```

```
bf2 =

     0
     0
```

```
     1
     0
     0
     0
     0

ans =

     1

ans =

     1

CE =

     0
     0
     1
     0
     0
     0
     0

CEin =

     1

H2 =

     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     1     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0

T2 =

     1     0     0     0     0     0     0
     0     1     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     1     0     0     0
     0     0     0     0     1     0     0
     0     0     0     0     0     1     0
     0     0     0     0     0     0     1
```

```
A12 =

    -3     1     1     1     0     0     0
     1    -4     1     1     1     0     0
     0     0     0     0     0     0     0
     1     1     0    -3     0     0     1
     0     1     0     0    -2     0     1
     0     0     1     0     0    -2     1
     0     0     0     1     1     1    -3


ans =

     7


k12 =

         0         0         0         0         0         0         0
    1.4469    3.0316    0.9203    1.4125    1.3204    0.0027    0.1221
   -0.1770   -0.4110    5.4289   -0.7112   -0.0196   -0.1038   -0.1124
    0.9040    1.1596   -0.6336    2.5395    0.1004   -0.0957    0.9599
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0


F2 =

   -3.0000    1.0000    1.0000    1.0000         0         0         0
    1.0000   -7.0316    0.0797   -0.4125    1.0000         0         0
         0    0.4110   -5.4289    0.7112         0         0         0
    1.0000   -0.1596    0.6336   -5.5395         0         0    1.0000
         0    1.0000         0         0   -2.0000         0    1.0000
         0         0    1.0000         0         0   -2.0000    1.0000
         0         0         0    1.0000    1.0000    1.0000   -3.0000


k2 =

         0         0    1.0000         0         0         0         0
    1.4469    3.0316    1.0000    1.4125    1.3204    0.0027    0.1221
   -0.1770   -0.4110         0   -0.7112   -0.0196   -0.1038   -0.1124
    0.9040    1.1596         0    2.5395    0.1004   -0.0957    0.9599
         0         0         0         0         0         0         0
         0         0    1.0000         0         0         0         0
         0         0         0         0         0         0         0
```

Sim & Plot

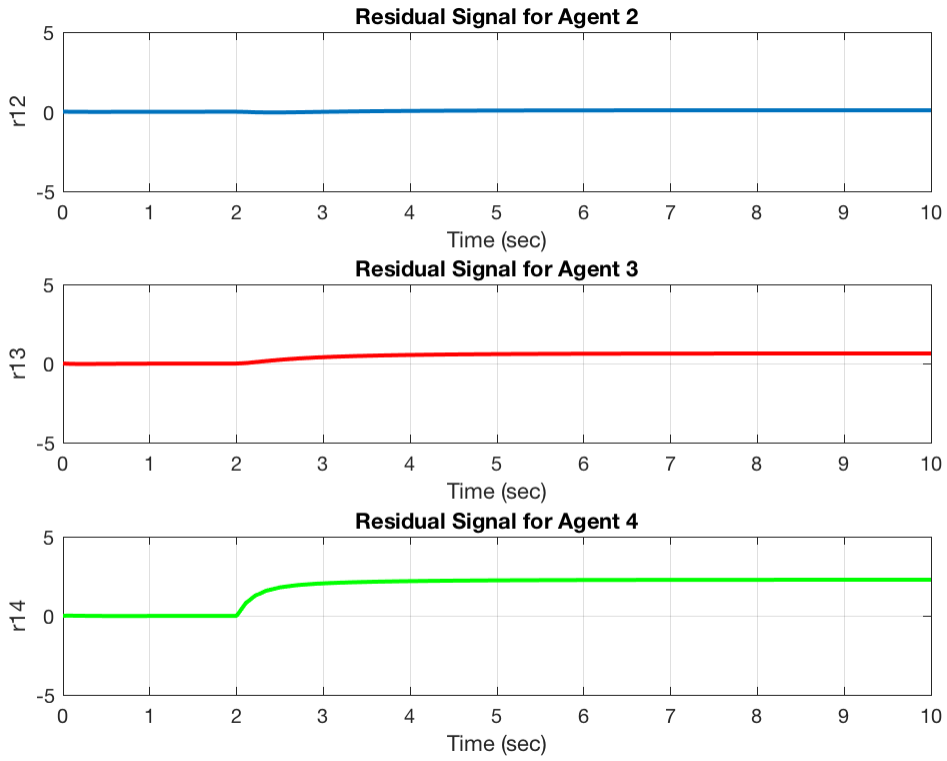
```
sim('TeixeiraModel')
```

```
figure,
subplot(311),
plot(fn2,'LineWidth',2),ylabel('r12'),xlabel('Time
 (sec)'),title('Residual Signal for Agent 2'), grid on, ylim([-5,5])
subplot(312),
plot(fn3,'r','LineWidth',2),ylabel('r13'),xlabel('Time
 (sec)'),title('Residual Signal for Agent 3'), grid on, ylim([-5,5])
subplot(313),
plot(fn4,'g','LineWidth',2),ylabel('r14'),xlabel('Time
 (sec)'),title('Residual Signal for Agent 4'), grid on, ylim([-5,5])
%
% figure,
% subplot(311),
% plot(tout,y1R,'k'),ylabel('y1_R'),xlabel('Time
 (sec)'),title('Outputs: y1_R, y2_R, y3_R')
% subplot(312),
% plot(tout,y2R,'b'),ylabel('y2_R'),xlabel('Time (sec)')
% subplot(313),
% plot(tout,y3R,'r'),ylabel('y3_R'),xlabel('Time (sec)')
%
% figure,
% plot(tout,r11,'k'),ylabel('r_1^1'),xlabel('Time (sec)')
% title('Residual from UIO 1')
%
% figure,
% plot(tout,r12,'k'),ylabel('r_1^2'),xlabel('Time (sec)')
% title('Residual from UIO 2')
%
% figure
% ax1=subplot(411),plot(tout,y1R*T1(1,1),'k'),ylabel('y1R x T_1(1,1)')
% grid on
% ax2=subplot(412),plot(tout,y2R,'r'),ylabel('y2R')
% grid on
% ax3=subplot(413),plot(tout,z11,'b'),ylabel('z_1^1'),
% grid on
% ax4=subplot(414),plot(tout,r11,'g'),ylabel('r_1^1'),
% grid on
% linkaxes([ax1,ax2,ax3,ax4],'x')
%
% figure,
% ax1=subplot(211),plot(tout,r11,'k'),ylabel('r_1^1'),
% title('Residual from UIO 1 and UIO 2'),xlabel('Time (hr)')
% grid on
% ax2=subplot(212),plot(tout,r12,'b'),ylabel('r_1^2')
% xlabel('Time (hr)'),grid on
% linkaxes([ax1,ax2],'x')
% figure
% ax1=subplot(411),plot(tout,y1R*T1(1,1),'k'),ylabel('y1R x T_1(1,1)')
% grid on
% ax2=subplot(412),plot(tout,y2R,'r'),ylabel('y2R')
% grid on
% ax3=subplot(413),plot(tout,z11,'b'),ylabel('z_1^1'),
% grid on
```

```
% ax4=subplot(414),plot(tout,r11,'g'),ylabel('r_1^1'),
% grid on
% linkaxes([ax1,ax2,ax3,ax4],'x')

%
% figure,
% plot(tout,r2)
```

```
Warning: Model 'TeixeiraModel' is using a default value of 0.2 for
 maximum step
size. You can disable this diagnostic by setting Automatic solver
 parameter
selection to 'none'
```



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