Finite element solution for a single element

Contributed by OuYang,Xiong

Contents

definte parameters

material parameters young modulus

```
E    = 10;
% poisson's ratio
nu   = 0.33;
% model parameters
% dimensionality
D    = 3;
% number of nodes
nnde = 4;
% order of numerical integration
nint = 3;
% all degrees of freedom
nf   = D* nnde;
```

define element info

coordinates

```
x = [-0.1968   -0.1969         0
     -0.5000         0         0
     -0.5000   -0.5000         0
     -0.5000   -0.1934    0.3260]*100;
% node number
ix = [1 2 3 4];
```

define numerical integration parameters

get parameters

```
SF = GenerateShapeFunction(D,nnde,nint);
% calculate elast tensor
CC = ElastTensor(E,nu);
```

take a numerical integration

```
[K, M]=IntKMLoc(SF, CC, x(ix, :));
```

Show K matrix and its eigenvalues

```
disp('K = : ');
disp(K);
disp('eig = : ')
disp(eig(K));
```

```
K = :
  列 1 至 7

  132.7552   -0.0000   -0.0000  -80.4762   39.6506  -37.2910  -52.2790
   -0.0000   33.6841    0.0000   20.4261  -20.4193   -0.0000  -20.4261
   -0.0000    0.0000   33.6841  -19.2105   -0.0000  -20.4193  -12.1178
  -80.4762   20.4261  -19.2105   72.1270  -36.4185   34.2512   26.2161
   39.6506  -20.4193   -0.0000  -36.4185   72.1511  -34.2625   -3.2321
  -37.2910   -0.0000  -20.4193   34.2512  -34.2625   67.9442   22.0310
  -52.2790  -20.4261  -12.1178   26.2161   -3.2321   22.0310   37.3332
  -39.6506  -13.2648    0.0000   15.9924  -33.8648   15.2650   23.6582
  -23.5228    0.0000  -13.2648   21.8246   -2.6149   22.8920   14.0353
   -0.0000    0.0000   31.3283  -17.8670   -0.0000  -18.9912  -11.2703
   -0.0000   -0.0000   -0.0000   -0.0000  -17.8670   18.9975    0.0000
   60.8138   -0.0000   -0.0000  -36.8653   36.8775  -70.4169  -23.9485

  列 8 至 12

  -39.6506  -23.5228   -0.0000   -0.0000   60.8138
  -13.2648    0.0000    0.0000   -0.0000   -0.0000
    0.0000  -13.2648   31.3283   -0.0000   -0.0000
   15.9924   21.8246  -17.8670   -0.0000  -36.8653
  -33.8648   -2.6149   -0.0000  -17.8670   36.8775
   15.2650   22.8920  -18.9912   18.9975  -70.4169
   23.6582   14.0353  -11.2703    0.0000  -23.9485
   58.3999   21.6124    0.0000  -11.2703  -36.8775
   21.6124   34.7910  -12.3371  -18.9975  -44.4182
    0.0000  -12.3371   29.1373    0.0000   -0.0000
  -11.2703  -18.9975    0.0000   29.1373   -0.0000
  -36.8775  -44.4182   -0.0000   -0.0000  114.8351

eig = :
   1.0e+02 *

   3.3650 + 0.0000i
   0.9669 + 0.0000i
   0.8936 + 0.0000i
   0.8568 + 0.0000i
   0.5278 + 0.0000i
   0.5497 + 0.0000i
   0.0000 + 0.0000i
   0.0000 - 0.0000i
   0.0000 + 0.0000i
  -0.0000 + 0.0000i
  -0.0000 - 0.0000i
  -0.0000 + 0.0000i
```

initialization displacement and force vector

```
u    = zeros(D*nnde,1);
fext = zeros(D*nnde,1);
```

define constraint point and others

```
pu2 = [1 2 3 4 8 12];
pu1 = setxor((1:nf), pu2);
```

impose constraints

```
u(pu2)  = 0;
fext(:) = 0;
% extrude the 4th node a distance
u(12)   = 0.1;
```

define Known displacement and force

```
u2 = u(pu2);
f1 = fext(pu1);
```

calculate Unknown displacement and force

```
u(pu1)    = K(pu1, pu1) \ (f1 - K(pu1, pu2) * u2);
fext(pu2) = K(pu2, :) * u;
```

```
警告: 矩阵接近奇异值，或者缩放错误。结果可能不准确。RCOND =  8.950083e-19。
```

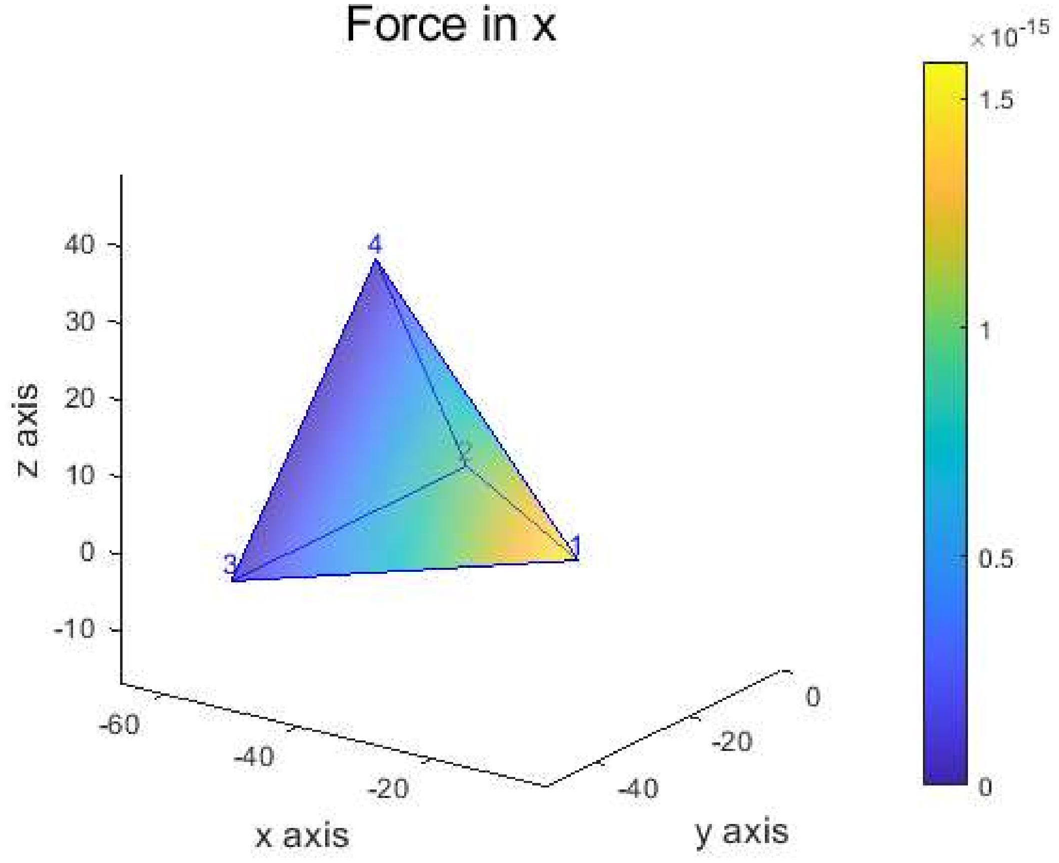
Draw displacement distribution and force distribution

reshape force and displacement matrix

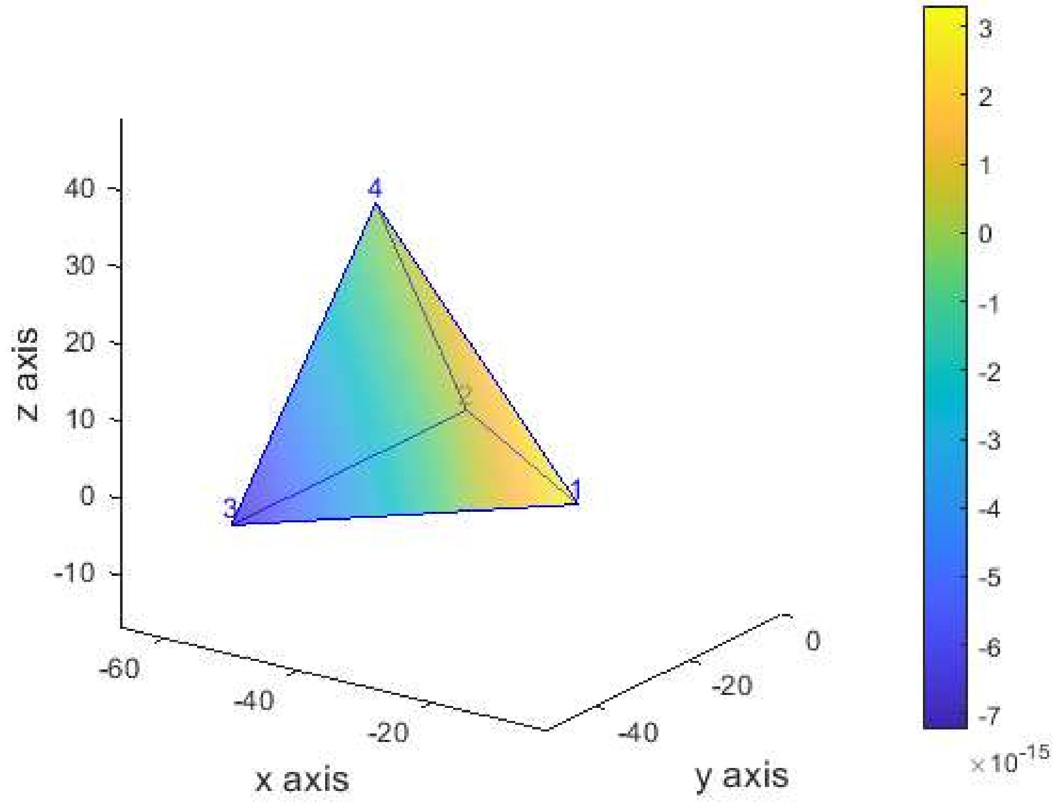
```
fext0 = reshape(fext,[3,4])';
```

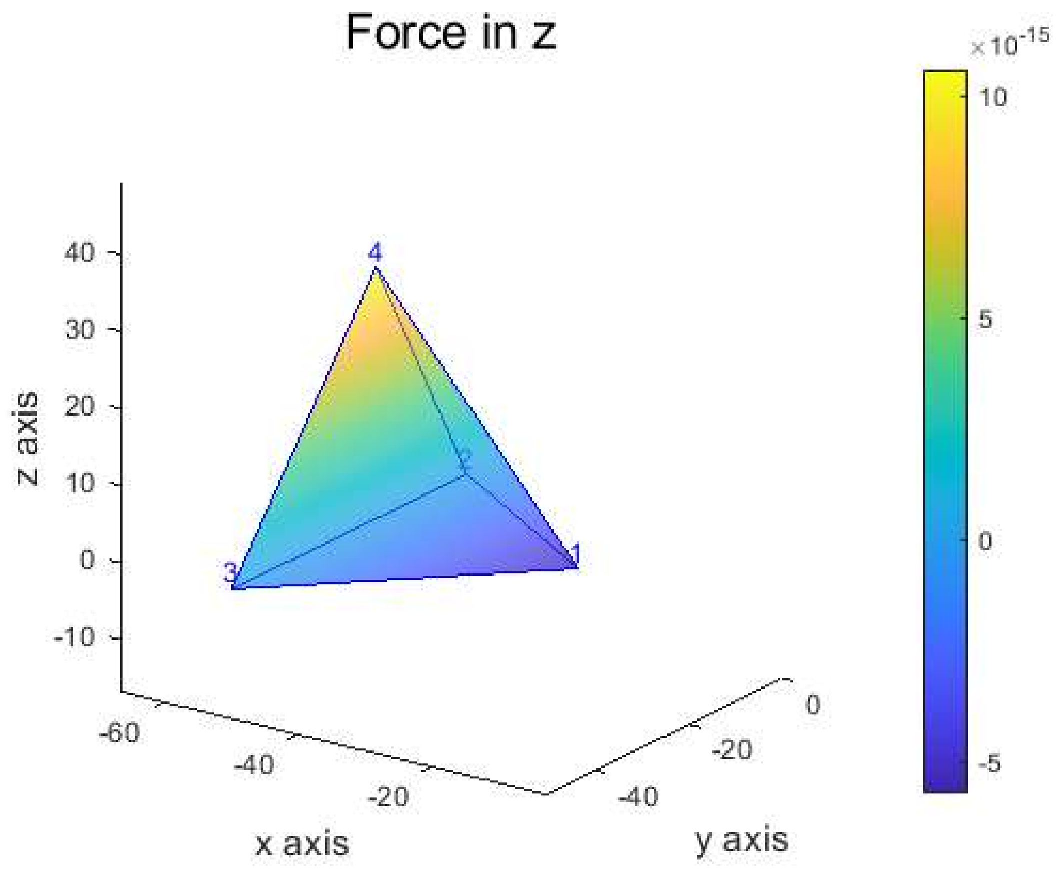
```
u0    = reshape(u,[3,4])';
% get the current location of node
xu    = x+u0;
% convert vertex matrix to face matrix
fx    = VerToFace(x,ix);

% difine title
ftl ={'Force in x', 'Force in y', 'Force in z'};
% draw all force distribution
for i =1:3
figure
% draw the frame
patch('vertices', x, 'faces', fx, 'facecolor', 'none', 'edgecolor', 'b');
hold on
% draw force distribution
mypatch(x, fx, 'interp', 'none', fext0(:,i), 0.5, 0,ftl{i},'x axis','y axis','z axis');
view(35,20)
colorbar
% mark node number
gui_label(3, x, fx, 4, 1, ix);
end

%define title
dtl ={'Displacement in x', 'Displacement in y', 'Displacement in z'};
% draw all displacement distribution
for i =1:3
figure
% draw frame
patch('vertices', x, 'faces', fx, 'facecolor', 'none', 'edgecolor', 'b');
hold on
% draw displacement distribution
mypatch(xu, fx, 'interp', 'none', u0(:,i), 0.5, 1,dtl{i},'x axis','y axis','z axis');
view(35,20)
colorbar
% mark node number
gui_label(3, x, fx, 4, 1, ix);
end
```

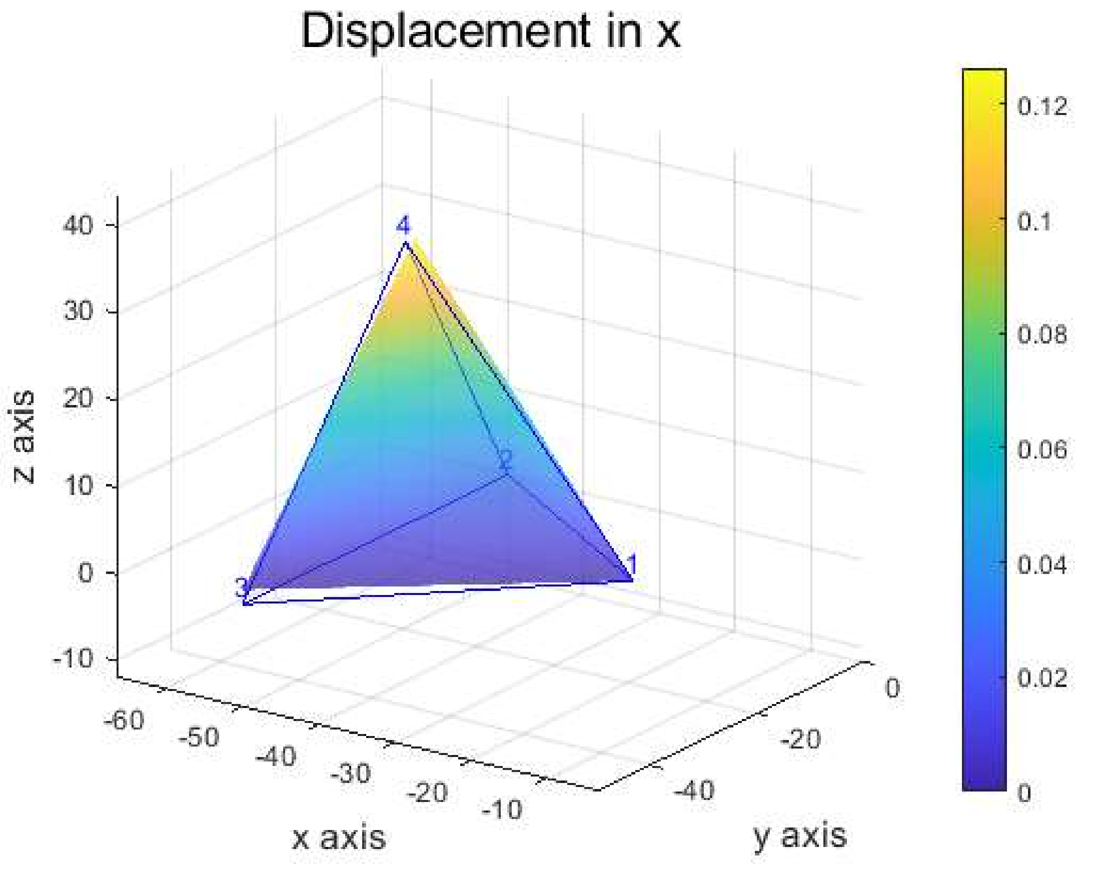
Force in x

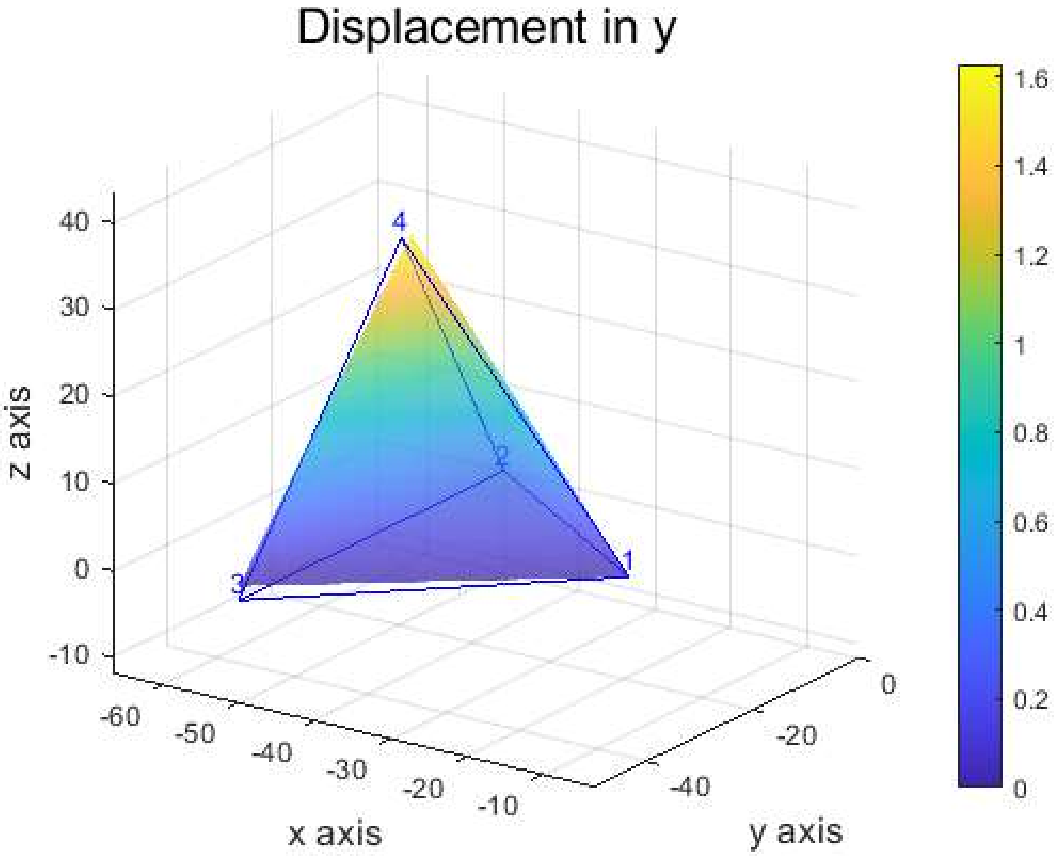


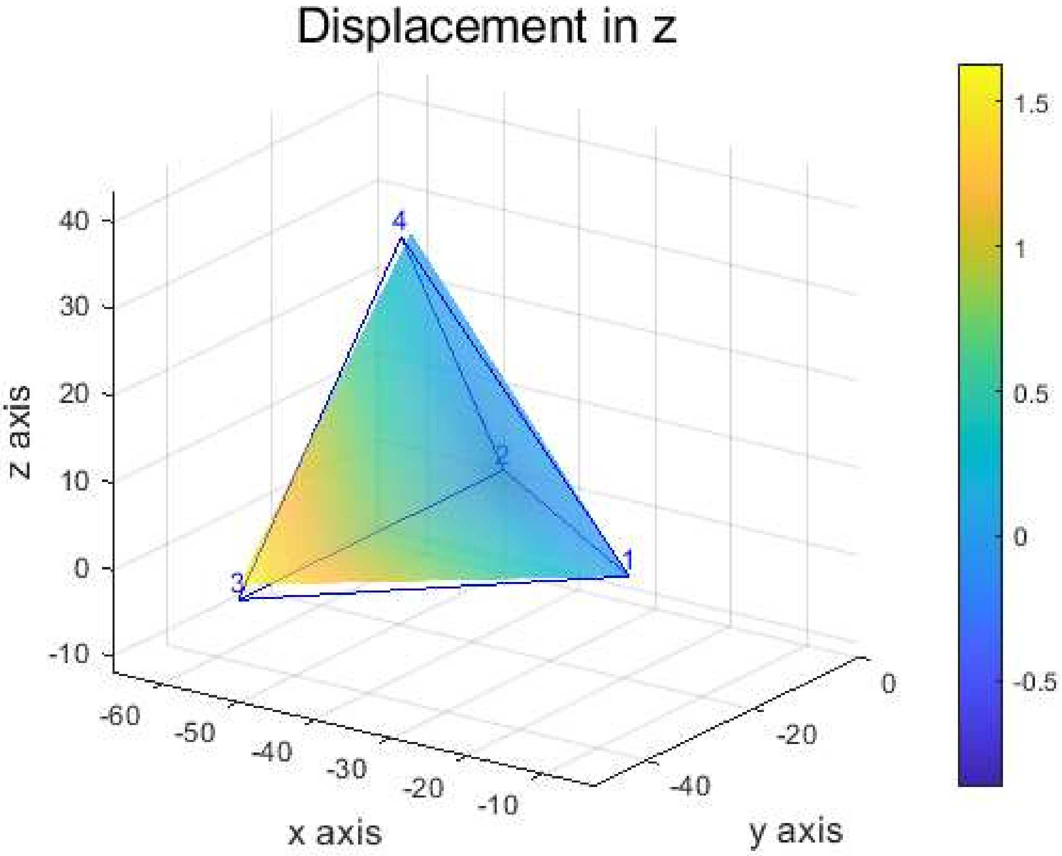
Force in y




Force in z


Displacement in x


Displacement in y


Displacement in z

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