DEMO_0011_nonUniform_Deformation_TPMS

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This is a demo for:

- Building geometry for an arbitrary non-uniform deformation matrix applied on gyroid structure.

This demo contains:

1. Case-1: Gyroid lattice under twist deformation.
2. Case-2: Gyroid lattice under rotation deformation.

Name

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```
Change log:
2023/11/15 MV Created
2024/02/2 MV  Edited
-------------------------------------------------------------------------
```

```
clear; close all; clc;
```

Plot settings

```
cMap=jet(250);
faceAlpha1=1;
faceAlpha2=0.65;
edgeColor1='none';
edgeColor2='none';
fontSize=20;
pColors=gjet(6);
```

Control parameters

```
n= 100; % resolution
boxDim = [1, 1, 2]; % dimenasion

rInner = 2;
```

```
bendAngle = pi/2;
barHeight = bendAngle*rInner;

l=0.9;% levleset
```

Create an origiional grid

```
DefType='Twist'; % Select between 'Twist' & 'Rotate'

switch DefType
    case 'Rotate'
        xRange = linspace(-pi,0,boxDim(1,1)*n)-rInner;
        yRange = linspace(0,2*pi,boxDim(1,2)*n);
        zRange = linspace(0,barHeight,boxDim(1,3)*n);

    case 'Twist'
        xRange = linspace(-pi,pi,boxDim(1,1)*n);
        yRange = linspace(-pi,pi,boxDim(1,1)*n);
        zRange = linspace(0,10,boxDim(1,1)*n);
end

[X,Y,Z]=meshgrid(xRange,yRange,zRange);
```

Applying deformation

```
%Deformation matrix
a=linspace(0,bendAngle,size(Z,3));
Xp=X; Yp=Y; Zp=Z;

switch DefType
    case 'Rotate'
        for q=1:1:size(Z,3)
            R = euler2DCM([0 a(q) 0]);
            x = X(:,:,q);
            y = Y(:,:,q);
            z = zeros(size(x));
            v = [x(:) y(:) z(:)];
            %     vp = v*R;
            vp = (R*v')';

            xp = reshape(vp(:,1),size(x));
            yp = reshape(vp(:,2),size(x));
            zp = reshape(vp(:,3),size(x));

            Xp(:,:,q)=xp;
            Yp(:,:,q)=yp;
            Zp(:,:,q)=zp;
        end

    case 'Twist'
        for q=1:1:size(Z,3)
            R = euler2DCM([0 0 a(q)]);
            x = X(:,:,q);
```

```
            y = Y(:,:,q);
            z = Z(:,:,q);
            v = [x(:) y(:) z(:)];
            %     vp = v*R;
            vp = (R*v')';

            xp = reshape(vp(:,1),size(x));
            yp = reshape(vp(:,2),size(x));
            zp = reshape(vp(:,3),size(x));

            Xp(:,:,q)=xp;
            Yp(:,:,q)=yp;
            Zp(:,:,q)=zp;
        end
end
```

Create deformed grid

```
Vo = [X(:) Y(:) Z(:)]; %Origional grids
Vp = [Xp(:) Yp(:) Zp(:)]; %Deformed grids
```

Evaluate triply periodic function

```
% calculate the grid value to create gyroid field
freq1=5; %period number
S=(sin(freq1.*X).*cos(freq1.*Y))+...
    (sin(freq1.*Y).*cos(freq1.*Z))+...
    (cos(freq1.*X).*sin(freq1.*Z));

% Construct deformed iso-surface
Sn=S;
[Fi,Vi] = isosurface(Xp,Yp,Zp,Sn,l);
[Fc,Vc] = isocaps(Xp,Yp,Zp,Sn,l);
[F,V] = joinElementSets({Fi,Fc},{Vi,Vc});
[F,V] = mergeVertices(F,V);
F=fliplr(F);

% Construct origional iso-surface
[Fi,Vi] = isosurface(X,Y,Z,Sn,l);
[Fc,Vc] = isocaps(X,Y,Z,Sn,l);
[Fj,Vj] = joinElementSets({Fi,Fc},{Vi,Vc});
[Fj,Vj] = mergeVertices(Fj,Vj);
Fj=fliplr(Fj);
```

Visualize deformed surface

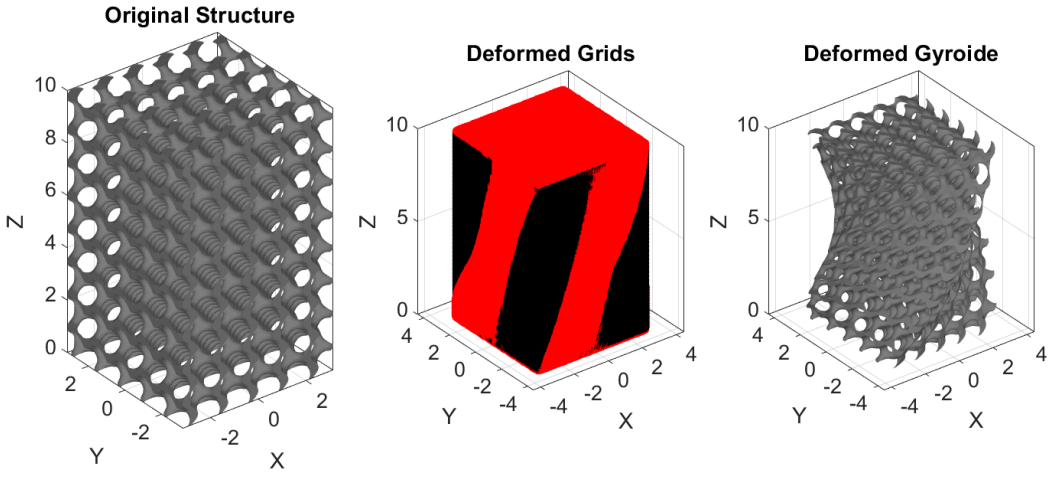
```
cFigure;

subplot(1,3,1);hold on;
title('Original Structure','FontSize',fontSize);
gpatch(Fj,Vj,'kw','none',1);
axisGeom(gca, fontSize);
```

```
camlight headlight;

hp1=subplot(1,3,2);hold on;
title('Deformed Grids','FontSize',fontSize);
plotV(Vo,'k.','MarkerSize',30);
plotV(Vp,'r.','MarkerSize',30);
axisGeom(gca, fontSize);
camlight headlight;

hp2=subplot(1,3,3);hold on;
title('Deformed Gyroide','FontSize',fontSize);
gpatch(F,V,'kw','none',1);
axisGeom(gca, fontSize);
camlight headlight;
drawnow;
```



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