FitHelicalMotion

Fits a parametric vector path to helical motion described by the time-dependent vector

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Define Constants

```
clear;
R = 1; % m
omega = .33 * pi; % Hz
vz = 1; % m/s
```

Set up time

```
ntimes=10;
t=[0:.1:ntimes]';% times col vector
ndata=length(t);
```

Set initial values

```
R0=[R,R]; % initial position row vector
omega_0=[omega,omega]; % initial velocity row vector
vz0=[vz]; % initial acceleration row vector
beta0=[R0'; omega_0'; vz0'];% parameter initial values
```

Create helical motion equations in each axis

```
x = R*cos(omega*t)+rand(ndata,1)/5;
y = R*sin(omega*t)+rand(ndata,1)/5;
z = vz * t+rand(ndata,1)/5;
```

Generate combined vectors

```
xt=[x;y;z]; % path reshaped into one long column vector
tt=[t;t;t];% corresponding long column vector of times
ct1=[ones(ndata,1);zeros(ndata,1);zeros(ndata,1)];% coordinate logical
ct2=[zeros(ndata,1);ones(ndata,1);zeros(ndata,1)];% coordinate logical
ct3=[zeros(ndata,1);zeros(ndata,1);ones(ndata,1)];% coordinate logical
tbl=table(ct1,ct2,ct3,tt,xt);% columns are coordinate logicals, predictor time, and value
```

Create a model function for our motion

```
modelfun = @(b,a)( ...
a(:,1).*(b(1)*cos(b(2) * a(:,4)))+...
a(:,2).*(b(3)*sin(b(4) * a(:,4)))+...
a(:,3).*(b(5) * a(:,4))...
);
```

Create a fit and grab the equations in each axis

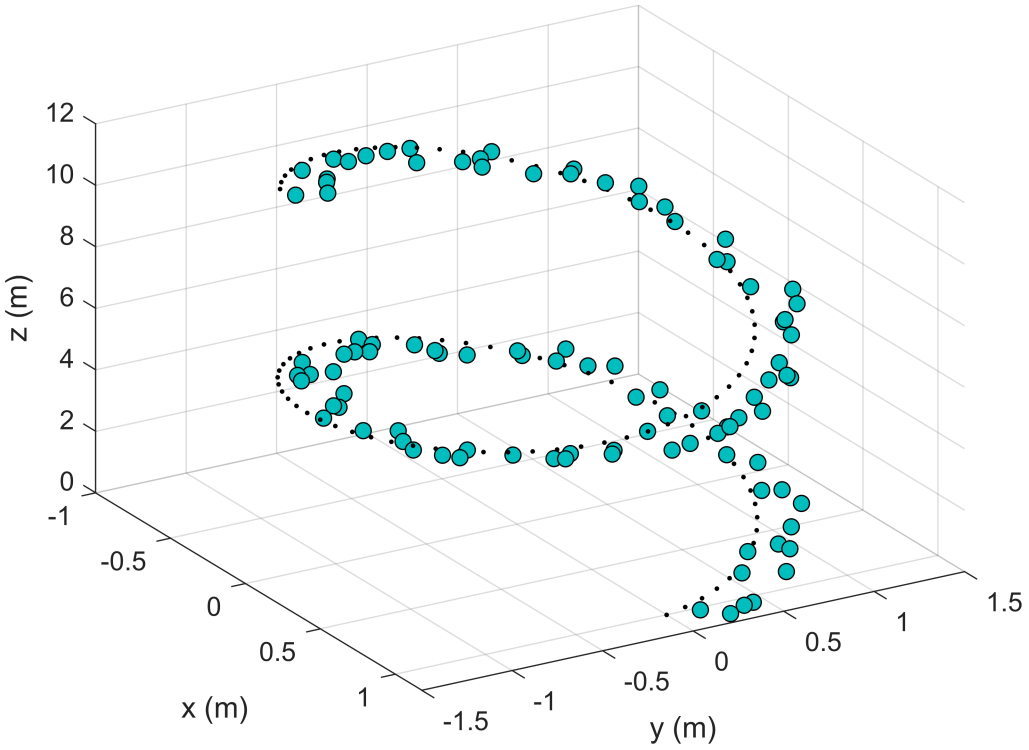
```
model = fitnlm(tbl, modelfun, beta0)
```

```
model =
Nonlinear regression model:
    xt ~ (ct1*(b1*cos(b2*tt)) + ct2*(b3*sin(b4*tt)) + ct3*(b5*tt))

Estimated Coefficients:
          Estimate       SE        tStat       pValue
          ________    _________    ______    ___________

    b1     1.0003      0.014965    66.846    1.9368e-181
    b2     1.0345     0.0028373     364.6              0
    b3     1.0422      0.015733    66.242     2.441e-180
    b4     1.0311     0.0023867    432.01              0
    b5      1.015     0.0018718    542.26              0


Number of observations: 303, Error degrees of freedom: 298
Root Mean Squared Error: 0.109
R-Squared: 0.999,  Adjusted R-Squared 0.999
F-statistic vs. zero model: 6.06e+04, p-value = 0
```

```
bfit  = model.Coefficients.Estimate;
xfit = [  bfit(1)*cos(bfit(2) * t) ];
yfit = [  bfit(3)*sin(bfit(4) * t) ];
zfit = [  bfit(5)*t ];
xdat = x; ydat = y; zdat = z;
```

Plot the observations and fit in 3D

```
scatter3(xdat,ydat,zdat,'MarkerEdgeColor','k','MarkerFaceColor',[0 .75 .75])
hold on;
scatter3(xfit,yfit,zfit,'.','MarkerEdgeColor','k','MarkerFaceColor',[0 .75 .75])
xlabel('x (m)');ylabel('y (m)');zlabel('z (m)');
view(-30,10)
view([59 32])
```


12
10
8
6
4
2
0
z (m)
-1
-0.5
0
0.5
1
x (m)
-1.5
-1
-0.5
0
0.5
1
1.5
y (m)