Denavit_Hartenberg Matrix

```
function [ Dh ] = Denavit_Hartenberg( a,alpha,d,deta )

Dh=[cos(deta), -sin(deta)*cos(alpha), sin(deta)*sin(alpha), a*cos(deta);
    sin(deta) , cos(deta)*cos(alpha) ,-cos(deta)*sin(alpha), a*sin(deta);
       0    ,      sin(alpha)   ,    cos(alpha)    ,   d;
       0    ,        0          ,        0         ,   1];
End
```

Euler

```
function [ Psi,Theta,Phi ] = Eulerm( Orientation )

Theta=acos(Orientation(3,3));

Psi=atan2(Orientation(1,3),-Orientation(2,3));

Phi=atan2(Orientation(3,1),Orientation(3,2));

end
```

RPY

```
function [ Alpha, Beta,Gama ] = RPY( Orientation )

Alpha=atan2(Orientation(2,1),Orientation(1,1));

Beta=asin(-Orientation(3,1));

Gama=atan2(Orientation(3,2),Orientation(3,3));

end
```

DKM RPP

```matlab
function [Ex,Ey,Ez,Psi,Theta,Phi,Alpha,Beta,Gamma] = dkm_rpp(theta1,d2,d3)


DH_table=[0   0   100  theta1;
          0 -pi/2  d2    0  ;
          0   0    d3    0 ];
T01=Denavit_Hartenberg(DH_table(1,1),DH_table(1,2),DH_table(1,3),DH_table(1,4))
T12=Denavit_Hartenberg(DH_table(2,1),DH_table(2,2),DH_table(2,3),DH_table(2,4))
T23=Denavit_Hartenberg(DH_table(3,1),DH_table(3,2),DH_table(3,3),DH_table(3,4))
T02=(T01*T12)
T03=(T02*T23)


Ex=T03(1,4);
Ey=T03(2,4);
Ez=T03(3,4);


Psi=NaN; Theta=NaN; Phi=NaN; Alpha=NaN; Beta=NaN; Gamma=NaN;


if abs(T03(3,1))~=1
   [ Alpha,Beta,Gamma ] = RPY( T03(1:3,1:3) );
end
if abs(T03(3,3))~=1
   [ Psi,Theta,Phi ] = Eulerm( T03(1:3,1:3) );
end
```

DKM RR

```
function [ Ex,Ey,Ez,Psi,Theta,Phi,Alpha,Beta,Gamma ] = dkm_rr( theta1,theta2 )


dh_table=[50 0 0 theta1 ;
          30 0 0 theta2];


T01=Denavit_Hartenberg(dh_table(1,1),dh_table(1,2),dh_table(1,3),dh_table(1,4))


T12=Denavit_Hartenberg(dh_table(2,1),dh_table(2,2),dh_table(2,3),dh_table(2,4))
    T02=(T01*T12)
    Ex=T02(1,4);
    Ey=T02(2,4);
    Ez=T02(3,4);


Psi=NaN; Theta=NaN; Phi=NaN; Alpha=NaN; Beta=NaN; Gamma=NaN;


if abs(T02(3,1))~=1
    [ Alpha,Beta,Gamma ] = RPY( T02(1:3,1:3) );


end


if abs(T02(3,3))~=1
    [ Psi,Theta,Phi ] = Eulerm( T02(1:3,1:3) );
end
end
```

IKM RPP

```
function [ theta1,d2,d3] = IKM_RPP( Ex,Ey,Ez )
syms theta1 d2 d3
DH_t=[0  0    80  theta1;
      0 -pi/2  d2   0;
      0  0     d3   0];

T01=Denavit_Hartenberg(DH_t(1,1),DH_t(1,2),DH_t(1,3),DH_t(1,4))
T12=Denavit_Hartenberg(DH_t(2,1),DH_t(2,2),DH_t(2,3),DH_t(2,4))
T23=Denavit_Hartenberg(DH_t(3,1),DH_t(3,2),DH_t(3,3),DH_t(3,4))
T02=simplify(T01*T12);
T03=simplify(T02*T23)
% ----------solution--------
d2=Ez-100;
d3=sqrt(Ex^2+Ey^2);
theta1=atan2(-Ex,Ey);
end
```

IKM PPP (script)

```
clc
clear
syms d1 d2 d3
ex=550; ey=350; ez=950;
L0=500; L1=150; L2=150; L3=150;
T0E=[0 -1  0  L2+d2;
     -1  0  0  L1+d1;
      0  0 -1  L0+L3+d3;
      0  0  0  1]
 d2=ex-L2
 d1=ey-L1
 d3=ez-L0-L3
```

DVM SCARA

```matlab
function [ ve,we ] = dvm_scara( th1,th2,d3,th4,dth1,dth2,dd3,dth4 )
% ---------DKM--------
dh_table=[250  0  400  th1;
            150 pi  0   th2;
              0  0  d3   0 ;
              0  0  75  th4];
T01=Denavit_Hartenberg(dh_table(1,1),dh_table(1,2),dh_table(1,3),dh_table(1,4))

T12=Denavit_Hartenberg(dh_table(2,1),dh_table(2,2),dh_table(2,3),dh_table(2,4))

T23=Denavit_Hartenberg(dh_table(3,1),dh_table(3,2),dh_table(3,3),dh_table(3,4))

T34=Denavit_Hartenberg(dh_table(4,1),dh_table(4,2),dh_table(4,3),dh_table(4,4))

    T02=(T01*T12)
    T03=(T02*T23)
    T04=(T03*T34)
% ---------DVM----------
    Z0=[0;0;1]
    O0=[0;0;0]
    Z1=T01(1:3,3)
    O1=T01(1:3,4)
    Z2=T02(1:3,3)
    Z3=T03(1:3,3)
    O3=T03(1:3,4)
    O4=T04(1:3,4)
    J1=[cross(Z0,O4-O0);Z0]
    J2=[cross(Z1,O4-O1);Z1]
    J3=[Z2;0;0;0]
    J4=[cross(Z3,O4-O3);Z3]
    J=[J1 J2 J3 J4]
    dq=[dth1;dth2;dd3;dth4]
    Eps=J*dq
    ve=Eps(1:3);
    we =Eps(4:6);
end
```

DVM RPP

```matlab
function [ ve,we ] = dvm_rrp( th1,th2,d3,dth1,dth2,dd3 )
% ---------DKM--------
dh_table=[0 -pi/2  0.1 th1;
          0  pi/2 0.12 th2;
          0   0    d3  0];

T01=Denavit_Hartenberg(dh_table(1,1),dh_table(1,2),dh_table(1,3),dh_table(1,4));

T12=Denavit_Hartenberg(dh_table(2,1),dh_table(2,2),dh_table(2,3),dh_table(2,4));

T23=Denavit_Hartenberg(dh_table(3,1),dh_table(3,2),dh_table(3,3),dh_table(3,4));
   T02=(T01*T12);
   T03=(T02*T23);

% ---------DVM----------

   Z0=[0;0;1];
   O0=[0;0;0];
   Z1=T01(1:3,3);
   Z2=T02(1:3,3);
   O3=T03(1:3,4);
   J1=[cross(Z0,O3-O0);Z0];
   J2=[Z1;0;0;0];
   J3=[Z2;0;0;0];
   J=[J1 J2 J3];
   dq=[dth1;dth2;dd3];
   Eps=J*dq;
   ve=Eps(1:3);
   we =Eps(4:6);
end
```