```
% ************************************ EMPIRE OF THE SUN ********************************
%%File: CV-CODE-Project-R2PT-ANIMATION-2link-Quadruped-EXP-3.mlx    :      Robot Arm (2-link) T
% Trajectory Generation of the Equivalent End Effector _EE for a 2-link robot arm
% Source location: QRIS> C:\Users\USER-PC\QRIS\MATLAB Code
% ------------------------------------------------------------------------------
% Notes:
% 1. Animation of 2-link leg quadruped
% ------------------------------------------------------------------------------
% ------------------------------------------------------------------------------------------------
clc;clf ; clear all;
clear global
% ------------------------------------------------------------------------------
% CODE execution START:
% ------------------------------------------------------------------------------
global numConfigs Ts
numConfigs = 300;
Ts = 1/300; % sample time rate [s]
% ------------------------------------------------------------------------------
% C:\Users\USER-PC\QRIS\MATLAB Code\DATA   <---- DATA Folder to access
theta=[];
%MatrixDATA = dlmread('C:\Users\USER-PC\QRIS\MATLAB Code\DATA\LSQ_thetaDATA_2link.txt '); % the
MatrixDATA = dlmread('C:\Users\USER-PC\QRIS\MATLAB Code\DATA\LSQ_thetaDATA_2link_FL.txt '); % t
theta = MatrixDATA';% LSQ-optimised data [radians] <---> [300x2] <-- 2-link FL equivalent for C
[rws,cms] = size(MatrixDATA) ;
% ------------------------------------
% NOTE: angle order is [th1  th2 ]
% angle number         [ 1    2  ]
rws
```

```
rws = 2
```

```
cms
```

```
cms = 300
```

```
th1 = theta(:,1);   % theta 1 LSQ data of 2-link front leg [300x1]
th2 = theta(:,2);   % theta 2 LSQ data of 2-link front leg [300x1]
% ------------------------------------------------------------------------------------------------
% ------------------------------------
% color CODE vectors ---->
cW = [1 1 1]; % white
cA = [1 0 0]; % red
cB = [0 0 1]; % blue
cC = [0 1 1]; % cyan
cD = [1 0 1]; % magenta
cE = [1 1 0]; % yellow
cJ = [0 1 0]; % green
cK = [0 0 0]; % black
% --- hybrids ----------
cF = [0.75 0 0.99]; % purple
cG = [0 0.4 0.3]; % dark green
cH = [0.6 0.98 0]; % light green
```

```
cI = [0.99 0.5 0]; % orange
% ------------------------------------
% ------------------------------------------------
%xo = 0; yo = 0; % fixed reference joint coordinates
%xo = 0.729; yo = 0; % fixed reference joint coordinates
xo = 2*0.729; yo = 0; % fixed reference joint coordinates
%r1 = 0.59; r2 = 0.711; % link lengths of 2-link <---- original dimensions
r1 = 0.6375; r2 = 0.85; % link lengths of 2-link
%r1 = 0.6375/2; r2 = 0.85/2; % link lengths of 2-link

sum_r1r2 = r1+r2;
r1
```

```
r1 = 0.6375
```

```
r2
```

```
r2 = 0.8500
```

```
sum_r1r2
```

```
sum_r1r2 = 1.4875
```

```
% ------------------------------------------------------------
% EE coordinates 2D ------------------------->
% ------------------------------------------------------------
xEEplane = xo + r1*cos(th1) + r2*cos(th1 + th2); % [300x1]
yEEplane = yo + r1*sin(th1) + r2*sin(th1 + th2); % [300x1]
% ------------------------------------------------------------
% EE coordinates 2D ------------------------->
% ------------------------------------------------------------
% ------------------------------------------------------------
p1x = xo*ones(300,1); p1y = yo*ones(300,1);
p2x =  xo + r1*cos(th1); p2y =  yo + r1*sin(th1);
p3x =  xo + r1*cos(th1) + r2*cos(th1 + th2); p3y =  yo + r1*sin(th1) + r2*sin(th1 + th2);
xPTS_FL = [p1x,p2x,p3x]; % [300x3] <--- configuration coordinates : X
yPTS_FL = [p1y,p2y,p3y]; % [300x3] <--- configuration coordinates : Y
% ------------------------------------------------------------
xEE_FLspace = xEEplane;
yEE_FLspace = -yEEplane;
% ------------------------------------------------------------
% ------------------------------------------------------------
%                       BACK LEG
% ------------------------------------------------------------
% ------------------------------------------------------------
global numConfigs Ts
numConfigs = 300;
Ts = 1/300; % sample time rate [s]
% ------------------------------------------------------------------------
% C:\Users\USER-PC\QRIS\MATLAB Code\DATA   <---- DATA Folder to access
theta=[];
MatrixDATA = dlmread('C:\Users\USER-PC\QRIS\MATLAB Code\DATA\LSQ_thetaDATA_2link_BL.txt '); % t
theta = MatrixDATA';% LSQ-optimised data [radians] <---> [300x2] <-- 2-link FL equivalent for C
```

```
[rws,cms] = size(MatrixDATA) ;
% ------------------------------------
% NOTE: angle order is [th1  th2 ]
% angle number         [ 1    2  ]
rws
```

```
rws = 2
```

```
cms
```

```
cms = 300
```

```
th1 = theta(:,1);   % theta 1 LSQ data of 2-link front leg [300x1]
th2 = theta(:,2);   % theta 2 LSQ data of 2-link front leg [300x1]
% ------------------------------------------------------------------------------------------------
% ------------------------------------------------
xo = 0; yo = 0; % fixed reference joint coordinates
%xo = 0.729; yo = 0; % fixed reference joint coordinates
r1 = 0.59; r2 = 0.711; % link lengths of 2-link <------------ good results
sum_r1r2 = r1+r2;
r1
```

```
r1 = 0.5900
```

```
r2
```

```
r2 = 0.7110
```

```
sum_r1r2
```

```
sum_r1r2 = 1.3010
```

```
% ----------------------------------------------------------
% EE coordinates 2D ------------------------->
% ----------------------------------------------------------
xEEplane = xo + r1*cos(th1) + r2*cos(th1 + th2); % [300x1]
yEEplane = yo + r1*sin(th1) + r2*sin(th1 + th2); % [300x1]
% ----------------------------------------------------------
% EE coordinates 2D ------------------------->
% ----------------------------------------------------------
% ----------------------------------------------------------
p1x = xo*ones(300,1); p1y = yo*ones(300,1);
p2x =  xo + r1*cos(th1); p2y =  yo + r1*sin(th1);
p3x =  xo + r1*cos(th1) + r2*cos(th1 + th2); p3y =  yo + r1*sin(th1) + r2*sin(th1 + th2);
xPTS_BL = [p1x,p2x,p3x]; % [300x3] <--- configuration coordinates : X
%yPTS = [p1y,p2y,p3y]; % [300x3] <--- configuration coordinates : Y
yPTS_BL = -1.*[p1y,p2y,p3y]; % [300x3] <--- configuration coordinates : Y
% ----------------------------------------------------------
xEE_BLspace = xEEplane;
yEE_BLspace = -yEEplane;
% ------------------------------------------------------------------
% ------------------------------------------------------------------
% ------------------------------------------------------------------
```

```
%                     ANIMATION OF FULL QUADRUPED
% ------------------------------------------------------------------------
% Motion analysis:
% ----------------
% Ground contact BL:
GNDcontactBL = min(yEE_BLspace(113:201));
GNDcontactBL
```

```
GNDcontactBL = -1.1705
```

```
INDX_gnd = find(GNDcontactBL==yEE_BLspace); % <--- ground contact BL index for gait 2
INDX_gnd
```

```
INDX_gnd = 142
```

```
GNDcntctBL_pnt = [xEE_BLspace(INDX_gnd); yEE_BLspace(INDX_gnd)]; % ground contact point [x;y] c
GNDcntctBL_pnt
```

```
GNDcntctBL_pnt = 2×1
   -0.1911
   -1.1705
```

```
GNDLL = [[-1.5,-1,-0.5,0,0.5,1,1.5,2,2.5];GNDcntctBL_pnt(2,1)*ones(1,9)];
GNDLL
```

```
GNDLL = 2×9
   -1.5000   -1.0000   -0.5000         0    0.5000    1.0000    1.5000    2.0000
   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705
```

```
% Ground contact FL:
GNDcontactFL = min(-yEE_FLspace(113:201));
GNDcontactFL
```

```
GNDcontactFL = -1.1705
```

```
INDX_gnd_FL = find(GNDcontactFL==-yEE_FLspace); % <--- ground contact FL index for gait 2
INDX_gnd_FL
```

```
INDX_gnd_FL = 197
```

```
GNDcntctFL_pnt = [xEE_FLspace(INDX_gnd_FL); -yEE_FLspace(INDX_gnd_FL)]; % ground contact point
GNDcntctFL_pnt
```

```
GNDcntctFL_pnt = 2×1
    1.8148
   -1.1705
```

```
GNDLL2 = [[-1.5,-1,-0.5,0,0.5,1,1.5,2,2.5];GNDcntctFL_pnt(2,1)*ones(1,9)];
GNDLL2
```

```
GNDLL2 = 2×9
   -1.5000   -1.0000   -0.5000         0    0.5000    1.0000    1.5000    2.0000
   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705
```

```
Ydlta = abs(GNDcntctBL_pnt(2) - GNDcntctFL_pnt(2));
Ydlta
```

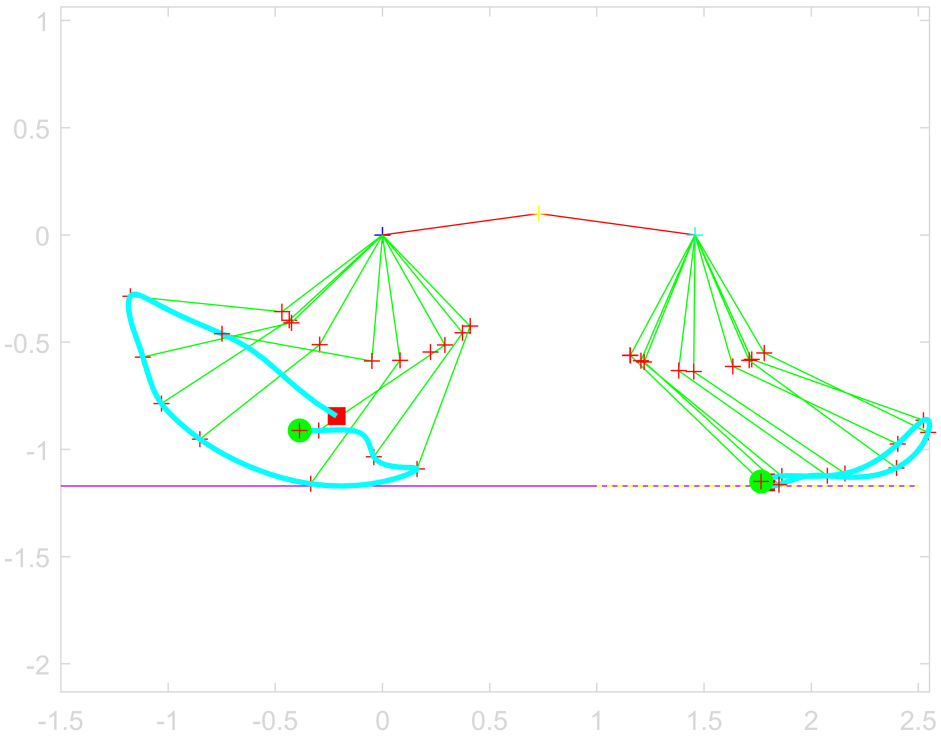
```
Ydlta = 3.0659e-05
```

```
GNDLL2_adjstd = [[-1.5,-1,-0.5,0,0.5,1,1.5,2,2.5];(GNDcntctFL_pnt(2,1) + (-1*Ydlta))*ones(1,9)]
GNDLL2_adjstd
```

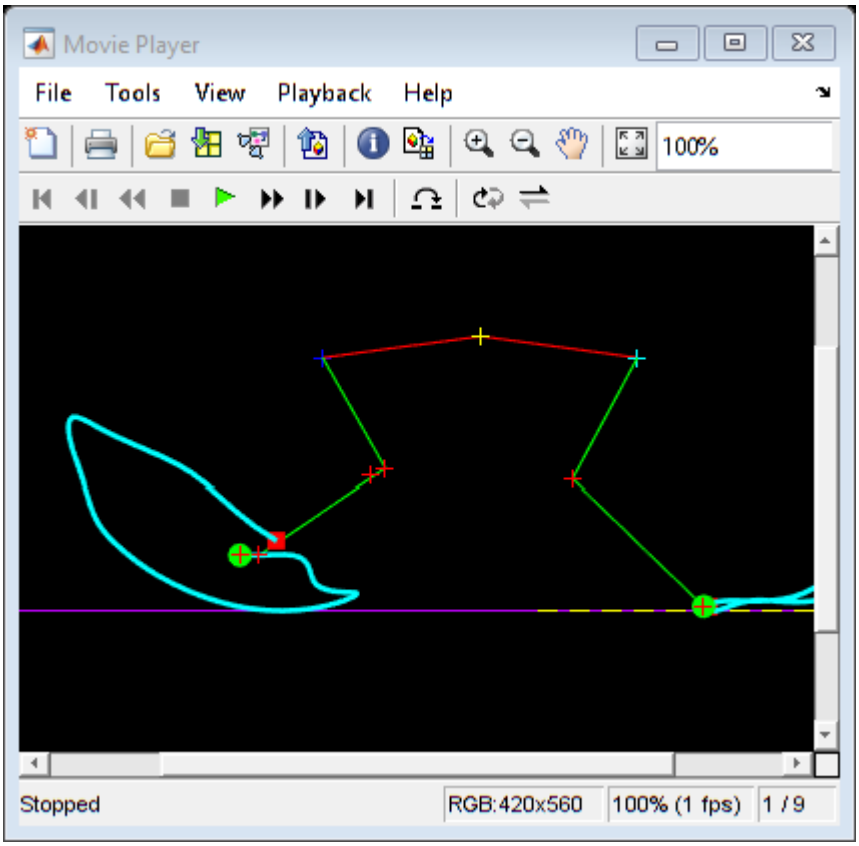
```
GNDLL2_adjstd = 2×9
   -1.5000   -1.0000   -0.5000         0    0.5000    1.0000    1.5000    2.0000
   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705   -1.1705
```

```
% ----------------------------
loops = 1;
movColr(1:loops) = struct('cdata', [],'colormap',[]);
k=1;


i=1;
figure
% ----------------------------
% set background colour
fig = gcf;
fig.Color = [0 0 0]; % black = [0 0 0]
colordef black

J_o = [0,0,0]; % MAIN static reference joint [x,y,z] coordinates
J_midS = [0.729,0.1,0]; % mid spine joint
%J_1 = [0.729,0,0]; % static reference  [x,y,z] coordinates
J_1 = [2*0.729,0,0]; % static reference  [x,y,z] coordinates
%PLtfrm = [J_o;J_1];
PLtfrm = [J_o;J_midS;J_1]; % includes mid spine joint
plot(J_o(1,1),J_o(1,2),'b','Marker','+') % reference marker = CoM LSQ

hold on
plot(GNDLL(1,:),GNDLL(2,:), 'Color',cF,'LineStyle','-'); % GROUND level for BL
plot(GNDLL2(1,6:9),GNDLL2(2,6:9), 'Color',cF,'LineStyle','--'); % GROUND level for FL
plot(GNDLL2_adjstd(1,6:9),GNDLL2_adjstd(2,6:9), 'Color',cE,'LineStyle','--'); % adjusted -->GR

while k < 90
% ----------------------[FL]------------------------------------------------------>
line(PLtfrm(:,1),PLtfrm(:,2), 'Color',cA,'LineStyle','-') ;% <-- static platform link
plot(J_1(1,1),J_o(1,2),'c','Marker','+') % reference marker = CoM LSQ
plot(J_midS(1,1),J_midS(1,2),'y','Marker','+') % mid SPINE joint

line(xPTS_FL(113+k,1:3),yPTS_FL(113+k,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dynamic link

plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFace
plot(xEE_FLspace(201),-yEE_FLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFace

% EE trajectory of FL ---->
```

```
plot(xEE_FLspace(113:201),-yEE_FLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_FL(113+k,2),yPTS_FL(113+k,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_FL(113+k,3),yPTS_FL(113+k,3),'r','Marker','+') % <---- all joint 3 markers = EE
plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceC
plot(xPTS_FL(113,2),yPTS_FL(113,2),'r','Marker','+')
plot(xPTS_FL(113,3),yPTS_FL(113,3),'r','Marker','+')
% ------------------------------------------------------------------------------>
% ----------------------[BL]------------------------------------------------------>
line(xPTS_BL(113+k,1:3),yPTS_BL(113+k,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dynamic links

plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceCo
plot(xEE_BLspace(201),yEE_BLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFaceCo

% EE trajectory of BL ---->
plot(xEE_BLspace(113:201),yEE_BLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_BL(113+k,2),yPTS_BL(113+k,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_BL(113+k,3),yPTS_BL(113+k,3),'r','Marker','+') % <---- all joint 3 markers = EE
%line(xPTS(185,:),yPTS(185,:), 'Color',cJ,'LineStyle','-')
%line(xPTS(201,:),yPTS(201,:), 'Color',cJ,'LineStyle','-')
plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceCo
%plot(xPTS(113,1),yPTS(113,1),'r','Marker','+')
plot(xPTS_BL(113,2),yPTS_BL(113,2),'r','Marker','+')
plot(xPTS_BL(113,3),yPTS_BL(113,3),'r','Marker','+')
% ------------------------------------------------------------------------------>

%hold off
axis equal  % <---------------- SET axes equal for plot
%line(xPTS(1,:),yPTS(1,:), 'Color',[crG(k) crR(k) 0],'LineStyle','-')
%i = i + 30;
k=k+10;
movColr(i) = getframe(gcf); % <--- store the current frame
i = i + 1;
end
hold off
```



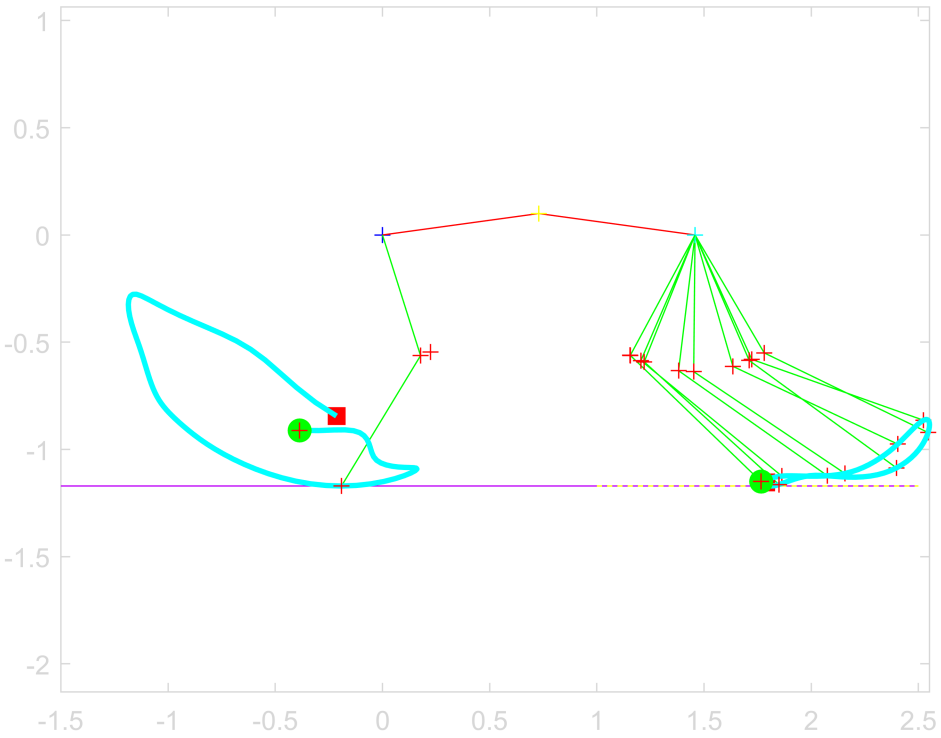

```
%mplay(movColr);  % default : 100% <---> 20 frames/second = 20fps
%fps = 1/3; % <--- shows a frame every 1/3 = 0.333 [s]
fps = 1; % <--- shows a frame every 1 [s]
implay(movColr,fps); % specify the frames per second to show in the animation
```



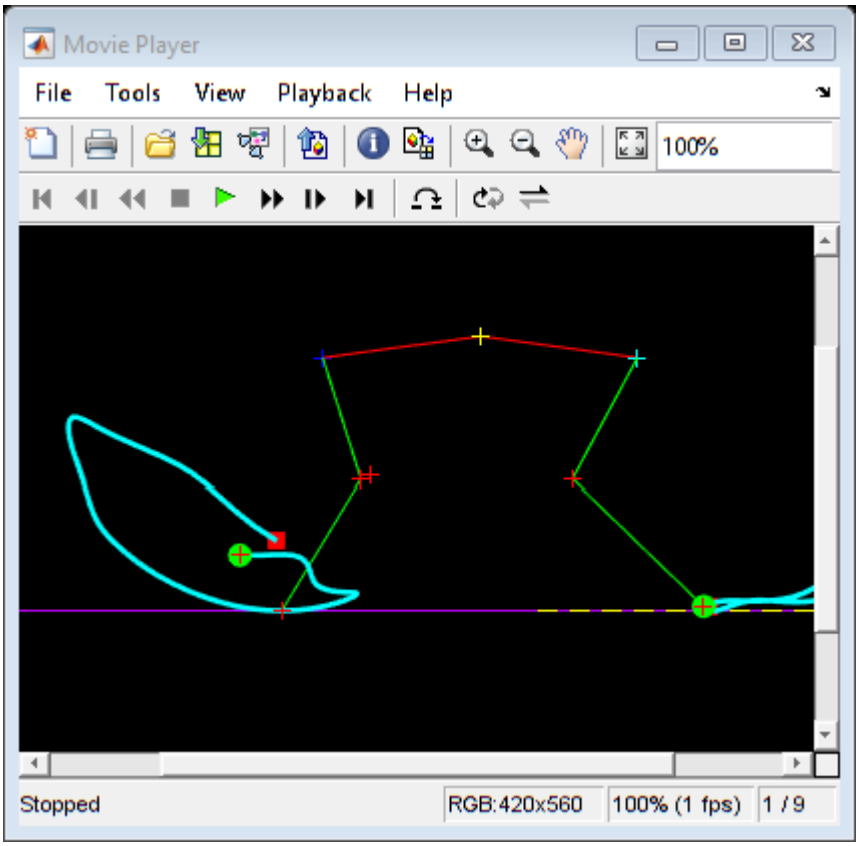

```
clear movColr
% ------------------------------------------------------------------------------------------
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
%                     ANIMATION OF FULL QUADRUPED
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
%                     SYNCHRONISED MOTION OF LEGS
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
% NOTE: Back leg is in GROUND CONTACT and EE_FL trajectory is executed
% ------------------------------------------------------------------------
movColr(1:loops) = struct('cdata', [],'colormap',[]);
k=1;


i=1;
figure
% ----------------------------
% set background colour
fig = gcf;
fig.Color = [0 0 0]; % black = [0 0 0]
colordef black

J_o = [0,0,0]; % MAIN static reference joint [x,y,z] coordinates
J_midS = [0.729,0.1,0]; % mid spine joint
%J_1 = [0.729,0,0]; % static reference  [x,y,z] coordinates
```

```
J_1 = [2*0.729,0,0]; % static reference  [x,y,z] coordinates
%PLtfrm = [J_o;J_1];
PLtfrm = [J_o;J_midS;J_1]; % includes mid spine joint
plot(J_o(1,1),J_o(1,2),'b','Marker','+') % reference marker = CoM LSQ

hold on
plot(GNDLL(1,:),GNDLL(2,:), 'Color',cF,'LineStyle','-'); % GROUND level for BL
plot(GNDLL2(1,6:9),GNDLL2(2,6:9), 'Color',cF,'LineStyle','--'); % GROUND level for FL
plot(GNDLL2_adjstd(1,6:9),GNDLL2_adjstd(2,6:9), 'Color',cE,'LineStyle','--'); % adjusted -->GR

while k < 90
% ----------------------[FL]------------------------------------------------------>
line(PLtfrm(:,1),PLtfrm(:,2), 'Color',cA,'LineStyle','-') ;% <-- static platform link
plot(J_1(1,1),J_o(1,2),'c','Marker','+') % reference marker = CoM LSQ
plot(J_midS(1,1),J_midS(1,2),'y','Marker','+') % mid SPINE joint

line(xPTS_FL(113+k,1:3),yPTS_FL(113+k,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dynamic link

plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFace
plot(xEE_FLspace(201),-yEE_FLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFace

% EE trajectory of FL ---->
plot(xEE_FLspace(113:201),-yEE_FLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_FL(113+k,2),yPTS_FL(113+k,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_FL(113+k,3),yPTS_FL(113+k,3),'r','Marker','+') % <---- all joint 3 markers = EE
plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFace
plot(xPTS_FL(113,2),yPTS_FL(113,2),'r','Marker','+')
plot(xPTS_FL(113,3),yPTS_FL(113,3),'r','Marker','+')
% ------------------------------------------------------------------------------>
% ----------------------[BL]------------------------------------------------------>
% k static variable ----->
%k_sttc = 25;  % <--- estimated configuration number when BL is in ground contact i.e on level
%k_sttc = 28;  % <--- estimated configuration number when BL is in ground contact i.e on level
k_sttc = 29;  % <--- estimated configuration number when BL is in ground contact i.e on level

line(xPTS_BL(113+k_sttc,1:3),yPTS_BL(113+k_sttc,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dy

plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceC
plot(xEE_BLspace(201),yEE_BLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFaceC

% EE trajectory of BL ---->
plot(xEE_BLspace(113:201),yEE_BLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_BL(113+k_sttc,2),yPTS_BL(113+k_sttc,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_BL(113+k_sttc,3),yPTS_BL(113+k_sttc,3),'r','Marker','+') % <---- all joint 3 markers
%line(xPTS(185,:),yPTS(185,:), 'Color',cJ,'LineStyle','-')
%line(xPTS(201,:),yPTS(201,:), 'Color',cJ,'LineStyle','-')
plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceC
%plot(xPTS(113,1),yPTS(113,1),'r','Marker','+')
plot(xPTS_BL(113,2),yPTS_BL(113,2),'r','Marker','+')
```

```
plot(xPTS_BL(113,3),yPTS_BL(113,3),'r','Marker','+')

% ------------------------------------------------------------------------------>

%hold off
axis equal  % <---------------- SET axes equal for plot
%line(xPTS(1,:),yPTS(1,:), 'Color',[crG(k) crR(k) 0],'LineStyle','-')
%i = i + 30;
k=k+10;
movColr(i) = getframe(gcf); % <--- store the current frame
i = i + 1;
end
hold off
```



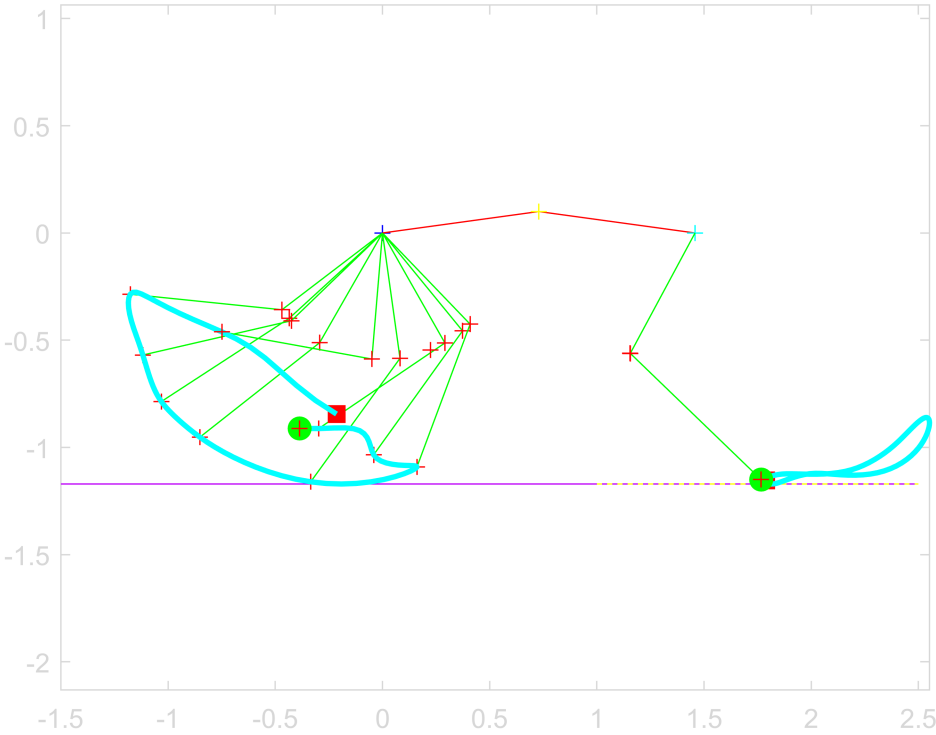

```
%mplay(movColr);  % default : 100% <---> 20 frames/second = 20fps
%fps = 1/3; % <--- shows a frame every 1/3 = 0.333 [s]
fps = 1; % <--- shows a frame every 1 [s]
implay(movColr,fps); % specify the frames per second to show in the animation
```



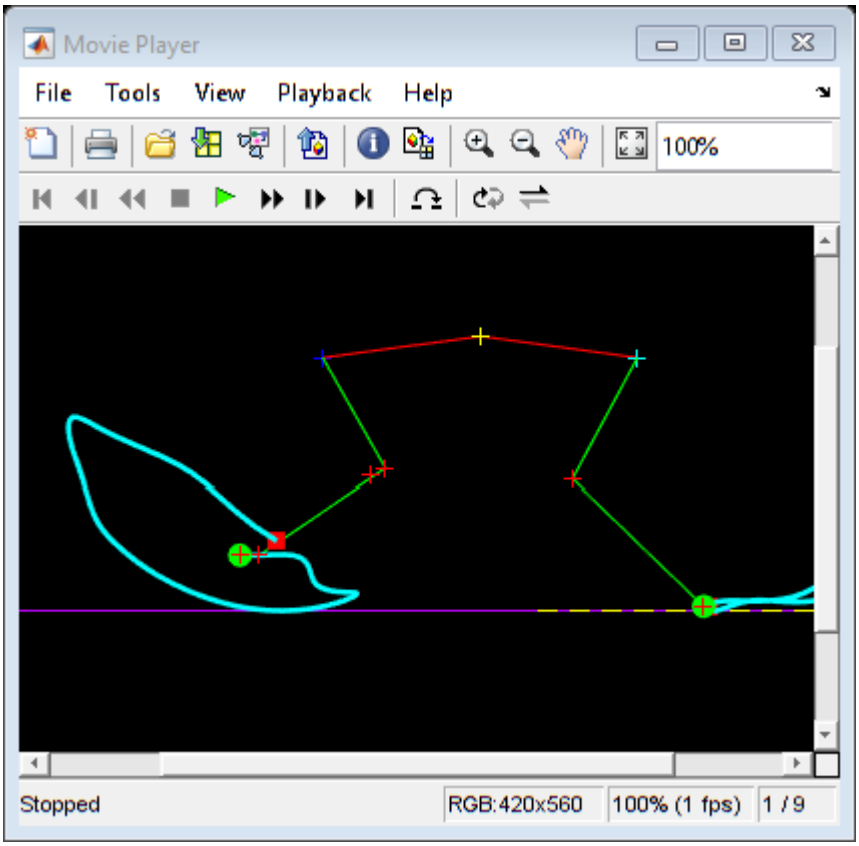

```
clear movColr
% ------------------------------------------------------------------------------------------------
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
%                     ANIMATION OF FULL QUADRUPED
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
%                     SYNCHRONISED MOTION OF LEGS
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
% NOTE: Front leg is in GROUND CONTACT and EE_BL trajectory is executed
% ------------------------------------------------------------------------
movColr(1:loops) = struct('cdata', [],'colormap',[]);
k=1;


i=1;
figure
% ----------------------------
% set background colour
fig = gcf;
fig.Color = [0 0 0]; % black = [0 0 0]
colordef black

J_o = [0,0,0]; % MAIN static reference joint [x,y,z] coordinates
J_midS = [0.729,0.1,0]; % mid spine joint
%J_1 = [0.729,0,0]; % static reference  [x,y,z] coordinates
```

```
J_1 = [2*0.729,0,0]; % static reference  [x,y,z] coordinates
%PLtfrm = [J_o;J_1];
PLtfrm = [J_o;J_midS;J_1]; % includes mid spine joint
plot(J_o(1,1),J_o(1,2),'b','Marker','+') % reference marker = CoM LSQ

hold on
plot(GNDLL(1,:),GNDLL(2,:), 'Color',cF,'LineStyle','-'); % GROUND level for BL
plot(GNDLL2(1,6:9),GNDLL2(2,6:9), 'Color',cF,'LineStyle','--'); % GROUND level for FL
plot(GNDLL2_adjstd(1,6:9),GNDLL2_adjstd(2,6:9), 'Color',cE,'LineStyle','--'); % adjusted -->GR

while k < 90
% ----------------------[FL]------------------------------------------------------>
line(PLtfrm(:,1),PLtfrm(:,2), 'Color',cA,'LineStyle','-') ;% <-- static platform link
plot(J_1(1,1),J_o(1,2),'c','Marker','+') % reference marker = CoM LSQ
plot(J_midS(1,1),J_midS(1,2),'y','Marker','+') % mid SPINE joint

% k static variable ----->
k_sttc = 1;  % <--- estimated configuration number when FL is in ground contact i.e on level >
%k_sttc = 88;  % <--- estimated configuration number when FL is in ground contact i.e on level

line(xPTS_FL(113+k_sttc,1:3),yPTS_FL(113+k_sttc,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dy

plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFace
plot(xEE_FLspace(201),-yEE_FLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFace

% EE trajectory of FL ---->
plot(xEE_FLspace(113:201),-yEE_FLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_FL(113+k_sttc,2),yPTS_FL(113+k_sttc,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_FL(113+k_sttc,3),yPTS_FL(113+k_sttc,3),'r','Marker','+') % <---- all joint 3 markers
plot(xEE_FLspace(113),-yEE_FLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFace
plot(xPTS_FL(113,2),yPTS_FL(113,2),'r','Marker','+')
plot(xPTS_FL(113,3),yPTS_FL(113,3),'r','Marker','+')
% ------------------------------------------------------------------------------>
% ----------------------[BL]------------------------------------------------------>
line(xPTS_BL(113+k,1:3),yPTS_BL(113+k,1:3), 'Color',cJ,'LineStyle','-') ; % <---- dynamic link

plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceC
plot(xEE_BLspace(201),yEE_BLspace(201),'s', 'LineWidth',3, 'MarkerEdgeColor','r', 'MarkerFaceC

% EE trajectory of BL ---->
plot(xEE_BLspace(113:201),yEE_BLspace(113:201),'Color',['cyan' ...
    ],'LineStyle','-','LineWidth',2)% -,--,:,-.

plot(xPTS_BL(113+k,2),yPTS_BL(113+k,2),'r','Marker','+') % <---- all joint 2 markers
plot(xPTS_BL(113+k,3),yPTS_BL(113+k,3),'r','Marker','+') % <---- all joint 3 markers = EE
%line(xPTS(185,:),yPTS(185,:), 'Color',cJ,'LineStyle','-')
%line(xPTS(201,:),yPTS(201,:), 'Color',cJ,'LineStyle','-')
plot(xEE_BLspace(113),yEE_BLspace(113),'o', 'LineWidth',3, 'MarkerEdgeColor','g', 'MarkerFaceC
%plot(xPTS(113,1),yPTS(113,1),'r','Marker','+')
plot(xPTS_BL(113,2),yPTS_BL(113,2),'r','Marker','+')
plot(xPTS_BL(113,3),yPTS_BL(113,3),'r','Marker','+')
```

```
% ------------------------------------------------------------------------------>

%hold off
axis equal  % <---------------- SET axes equal for plot
%line(xPTS(1,:),yPTS(1,:), 'Color',[crG(k) crR(k) 0],'LineStyle','-')
%i = i + 30;
k=k+10;
movColr(i) = getframe(gcf); % <--- store the current frame
i = i + 1;
end
hold off
```




```
%mplay(movColr);  % default : 100% <---> 20 frames/second = 20fps
%fps = 1/3; % <--- shows a frame every 1/3 = 0.333 [s]
fps = 1; % <--- shows a frame every 1 [s]
implay(movColr,fps); % specify the frames per second to show in the animation
```




```
clear movColr
```