M-Functions for Visualizing Robots

The following m-functions are provided for the course “Robot Kinematics and Dynamics” to visualize an arbitrary robot. The robot is drawn as a simplified line model. In addition, the base and tool coordinate frames are shown.

```
draw_robot_path
draw_kin
draw_frame
coortraf_craig
```

Intended Use:

`draw_robot_path (q,t_ipo,robot,ks_length,erase)`

is a Matlab Function to draw the robot moving along a given path. The path is specified by array q, which contains a series of column vectors. Each column vector represents the joint variables of one interpolated point on the trajectory. Array q must be calculated by applying the backward kinematics function M8 to each entry of the cell array ec from M11.

The function uses `coortraf_craig`, `draw_kin` and `draw_frame` to display the robot on the screen for each set of joint variables. The impression of a moving robot is generated by waiting before plotting the next robot position for a duration of t_ipo.
If erase = 1, the display shall be cleared after each interpolation.
If erase = 0, the screen shall not be cleared and all interpolations shall be plotted on top of each other.

`draw_kin(koor,ks_length)`

draws a simplified line model of a robot.
`length` specifies the length of the base and tool coordinate frames. Use 100 mm for the KR-15/2 or KR-16/2 robot.

Repeated use of `draw_kin` will plot each configuration into the same graphics window without erasing previous configurations. To erase the graphics window use `clf` or close the graphics window.

Before using the `draw_kin` function to draw the robot the graphics window must be initialized. Include the following code for displaying the Kuka KR-15/2 or KR-16/2 robot. For other robots, different values for the axes limits might be appropriate.

```
% initialize graph
axis([-2000 2000 -2000 2000 -0.2 2000]);
view([102,20]);
grid on; xlabel('X'); ylabel('Y'); zlabel('Z');
```

`draw_kin uses draw_frame.`

`koor = coortraf_craig(q,robot).`

Before displaying the robot, a cell array `koor` needs to be calculated. `koor` will contain the base frame, the frames of each axis and the tool frame of the robot corresponding to the axes variables specified by q. `coortraf_craig` will use the function `dh_trafo_craig` from M5.

Function Headers:

```
function draw_robot_path (q,t_ipo,robot,ks_length,erase)
      %
      % Input parameters:
      %   q ... cell array of column vectors of all interpolated joint
                variables for the whole trajectory
      %   t_ipo ... interpolation clock
      %   robot: robot parameters
      %   ks_length: length for drawing frame axes
      %   erase: flag to clear screen for each interpolation
```

```
function [coor_w] = coortraf_craig(q,robot)
%
% Calculates all frames of a robot in world coordinates
% into a {n+2}[4 4] Cellarray using CRAIG frame assignments
%
% Input Parameters:
% q:        column vector with joint values, [n 1] Array
%                                            n: number of axes
% robot:    structure with robot parameters
%           robot.dhp  DH parameters, [n 6] Array
%           colums:    type   sign  alpha  a    d    theta
%                      (1/2) (1/-1)
%                       1...rotational axis
%                       2...translational axis
%
%           robot.eff:  [4 4] Array, tool frame (in flange coordinates)
%           robot.bas:  [4 4] Array, base frame (in world coordinates)
%
%   ALL ANGLES in DEG!!
%
% Return Parameters:
% coor_w:    all coordinate frames in world coordinates
%            {n+2}[4 4] Cellarray;
```

```
function draw_kin(koor,ks_length)
%
% draws the base and tool frame of a robot
% and connects the origin of all frames with black lines
%
% Input parameters:
%   koor: cellarray containing all coordinate frames of the robot
%   ks_length: length for drawing frame axes
```