Instituto Tecnológico y de Estudios Superiores de Monterrey

TE3002B.502

Implementación de robótica inteligente (Gpo 101)

Semestre: febrero - junio 2023

Actividad 5 (Landmarks)

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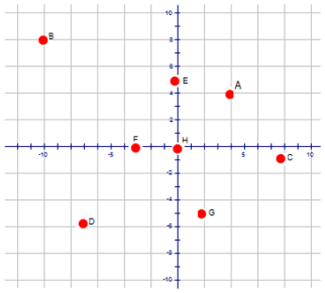
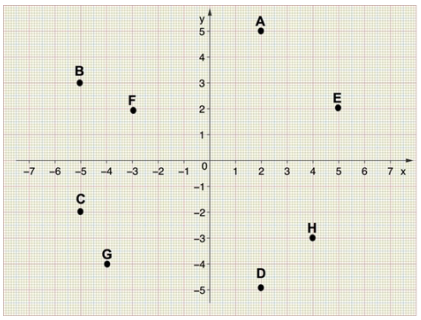
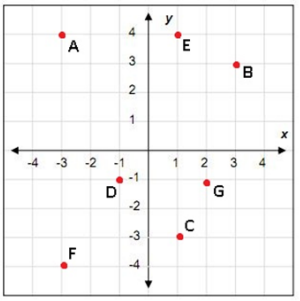
En esta actividad primero se implementa el código requerido para generar el seguimiento de los siguientes waypoints (puntos de referencia).







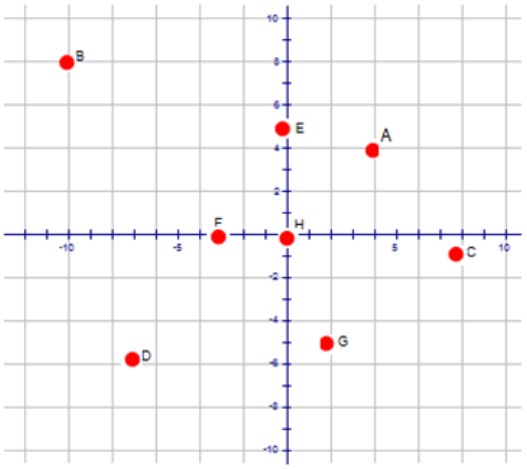
Para lograr el seguimiento de trayectoria se ajustará el tiempo de muestreo: "sampleTime", vector de tiempo: "tVec", pose inicial: "initPose", y los waypoints: "waypoints"

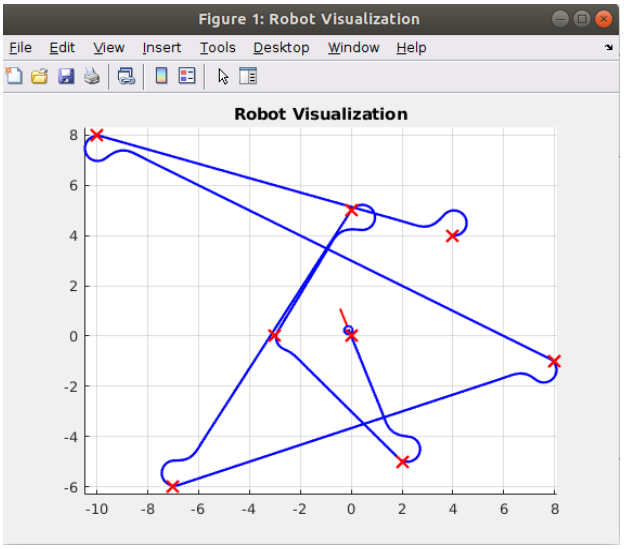
Primera trayectoria

```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:120;         % Time array
initPose = [4;4;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;
% Define waypoints

waypoints = [4,4; -10,8; 8,-1; -7,-6; 0,5; -3,0; 2,-5; 0,0];
% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 0.75;
controller.MaxAngularVelocity = 1.5;

%% Simulation loop
close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);
```

```
    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints)
    waitfor(r);
    grid on;
    hold on;
end
```

Resultado:



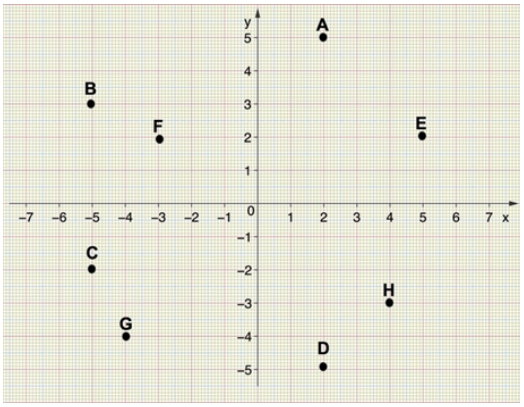


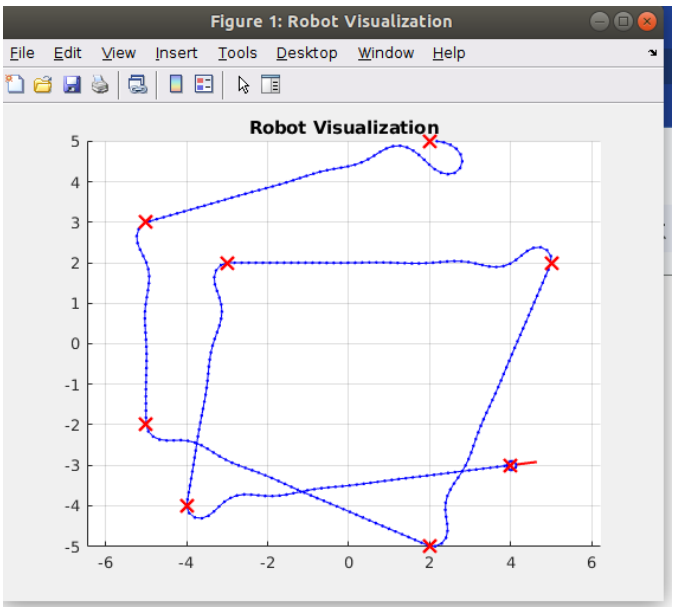
Segunda trayectoria

```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:30.5;         % Time array
initPose = [2;5;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [2,5; -5,3; -5,-2; 2,-5; 5,2; -3,2; -4,-4; 4,-3];
% Create visualizer
viz = Visualizer2D;
```

```
viz.hasWaypoints = true;
%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 1.75;
controller.MaxAngularVelocity = 5.5;
%% Simulation loop

close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);

    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints)
    waitfor(r);
    grid on;
    hold on;
end
```

Resultado:

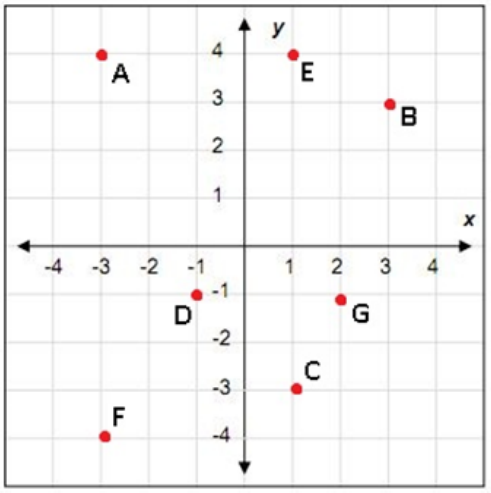


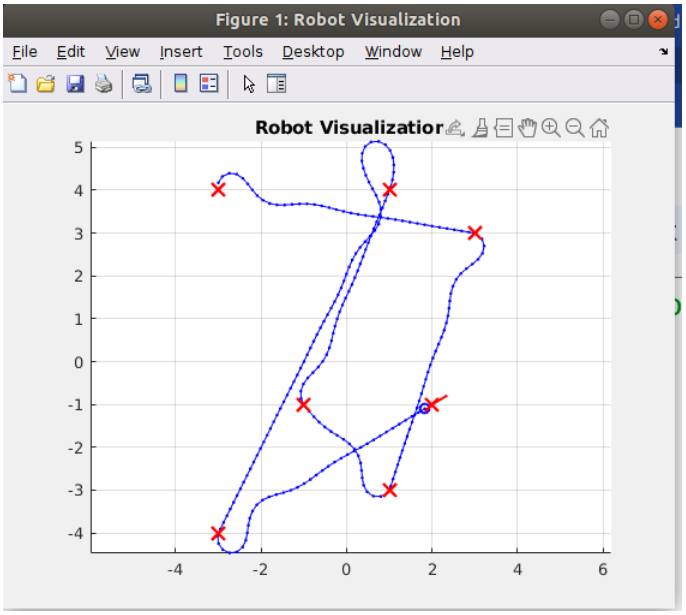


Tercera trayectoria

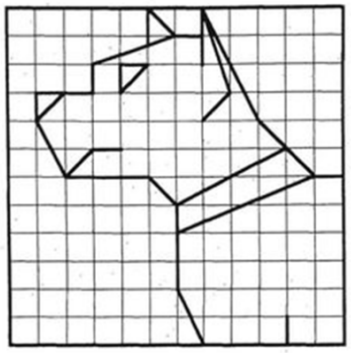
```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:23;         % Time array
initPose = [-3;4;pi/2];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [-3,4; 3,3; 1,-3; -1,-1; 1,4; -3,-4; 2,-1];
% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;
%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 1.75;
controller.MaxAngularVelocity = 6.5;
%% Simulation loop

close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
   % Run the Pure Pursuit controller and convert output to wheel speeds
   [vRef,wRef] = controller(pose(:,idx-1));
   [wL,wR] = inverseKinematics(dd,vRef,wRef);

   % Compute the velocities
   [v,w] = forwardKinematics(dd,wL,wR);
   velB = [v;0;w]; % Body velocities [vx;vy;w]
   vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

   % Perform forward discrete integration step
   pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

   % Update visualization
   viz(pose(:,idx),waypoints)
   waitfor(r);
   grid on;
   hold on;
end
```

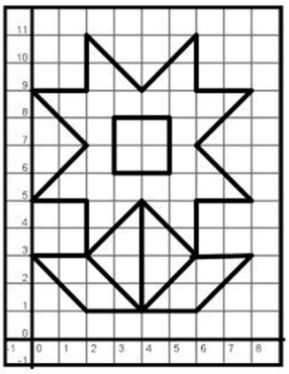
Resultado:

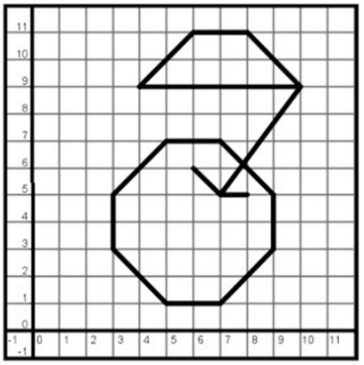




Ahora se generan los waypoints (puntos de referencia) necesarios para obtener las siguientes trayectorias.







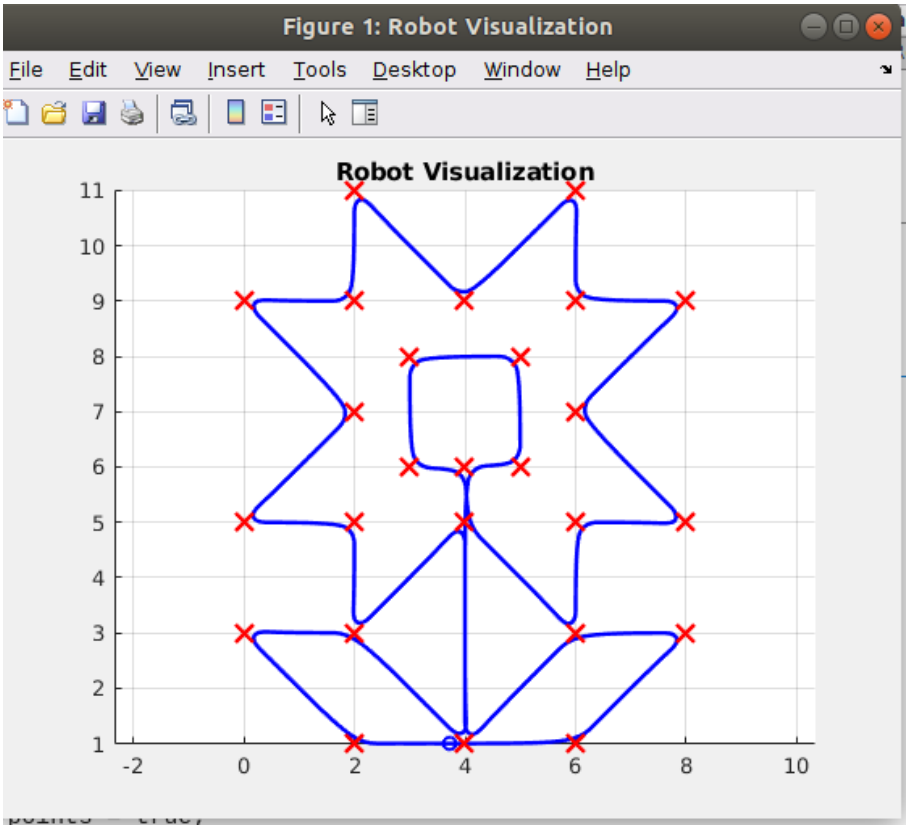
Nuevamente se ajustarán el tiempo de muestreo: “sampleTime”, vector de tiempo: “tVec”, pose inicial: “initPose”, y los waypoints: “waypoints”

Código de la trayectoria de la flor:

```
%% Define Vehicle
R = 0.1; % Wheel radius [m]
L = 0.5; % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters (settings for best performance)
sampleTime = 0.05;                % Sample time [s]
tVec = 0:sampleTime:231;          % Time array
initPose = [4;1;pi];              % Initial pose (x y theta)
pose = zeros(3,numel(tVec));     % Pose matrix
pose(:,1) = initPose;
```

```
% Define waypoints
waypoints = [4,1; 2,1; 0,3; 2,3; 4,1; 4,5;  2,3; 2,5; 0,5; 2,7; 0,9; 2,9;
             2,11; 4,9; 6,11; 6,9; 8,9; 6,7; 8,5; 6,5; 6,3; 4,5; 4,6; 3,6;
             3,8; 5,8; 5,6; 4,6; 4,1; 6,3; 8,3; 6,1; 4,1;];
% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller (settings for best performance)
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.45;
controller.DesiredLinearVelocity = 0.3;
controller.MaxAngularVelocity = 20;

%% Simulation loop
close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
   % Run the Pure Pursuit controller and convert output to wheel speeds
   [vRef,wRef] = controller(pose(:,idx-1));
   [wL,wR] = inverseKinematics(dd,vRef,wRef);

   % Compute the velocities
   [v,w] = forwardKinematics(dd,wL,wR);
   velB = [v;0;w]; % Body velocities [vx;vy;w]
   vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

   % Perform forward discrete integration step
   pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

   % Update visualization
   viz(pose(:,idx),waypoints)
   waitfor(r);
   grid on;
   hold on;
end
```

Resultado:

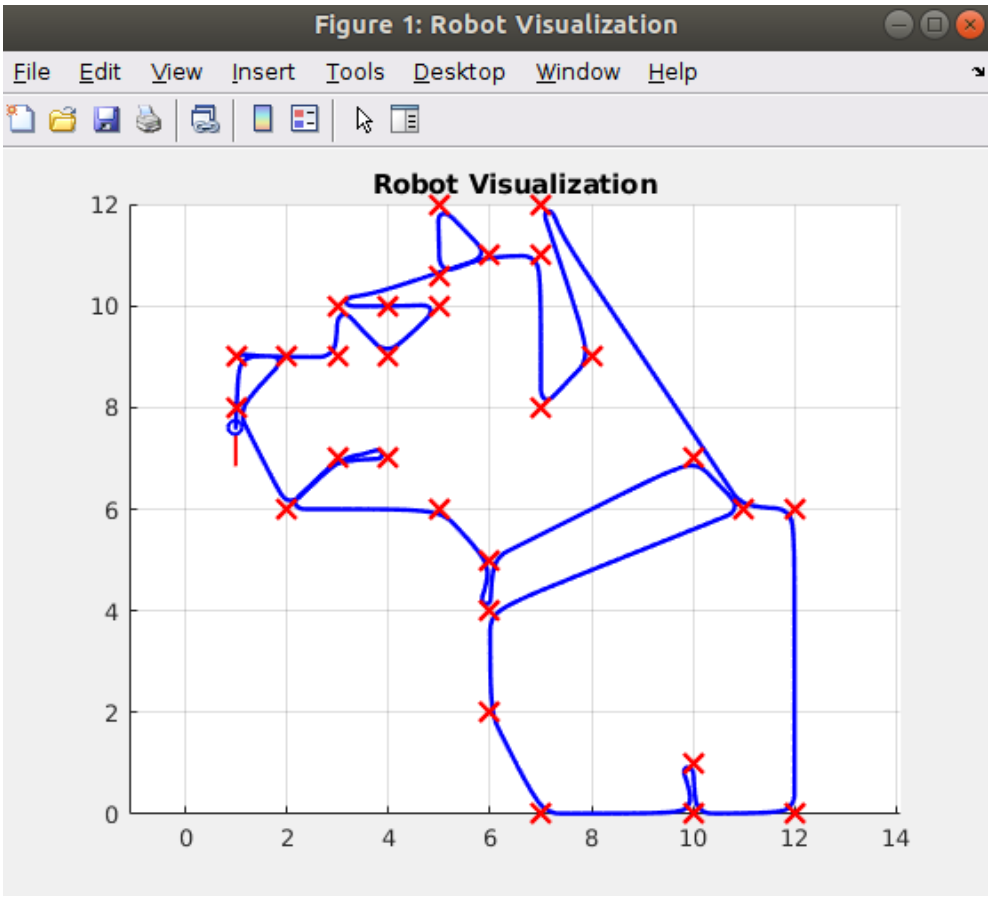


Código de la trayectoria del perro:

```
%% Define Vehicle
R = 0.1; % Wheel radius [m]
L = 0.5; % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters (settings for best performance)
sampleTime = 0.1; % Sample time [s]
tVec = 0:sampleTime:241; % Time array
initPose = [1;9;pi/4]; % Initial pose (x y theta)
pose = zeros(3,numel(tVec)); % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [1,9; 3,9; 3,10; 4,9; 5,10; 4,10; 3,10; 6,11; 5,12; 5,10.6;
   6,11; 7,11; 7,8; 8,9; 7,12; 11,6; 12,6; 12,0; 10,0; 10,1; 10,0; 7,0;
   6,2; 6,4; 11,6; 10,7; 6,5; 6,4; 6,5; 5,6; 2,6; 3,7; 4,7; 3,7; 2,6; 1,8;
2,9; 1,9; 1,8];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller (settings for best performance)
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.45;
```

```
controller.DesiredLinearVelocity = 0.3;
controller.MaxAngularVelocity = 20;

%% Simulation loop
close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);

    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints)
    waitfor(r);
    grid on;
    hold on;
end
```

Resultado:



Código de la trayectoria de la fruta:

```
%% Define Vehicle
R = 0.1; % Wheel radius [m]
L = 0.5; % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters (settings for best performance)
sampleTime = 0.1; % Sample time [s]
tVec = 0:sampleTime:160; % Time array
initPose = [5;1;3/4*pi]; % Initial pose (x y theta)
pose = zeros(3,numel(tVec)); % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [5,1; 4,2; 3,3; 3,4; 3,5; 4,6; 5,7; 6,7; 7,7 ; 8,6; 7,5; 6,6;
7,5; 8,5;
7,5; 8,6; 10,9; 9,10; 8,11; 6,11; 5,10; 4,9; 10,9; 8,6; 9,5; 9,3; 8,2; 7,1;
5,1];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller (settings for best performance)
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 0.3;
controller.MaxAngularVelocity = 20;

%% Simulation loop
close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
   % Run the Pure Pursuit controller and convert output to wheel speeds
   [vRef,wRef] = controller(pose(:,idx-1));
   [wL,wR] = inverseKinematics(dd,vRef,wRef);

   % Compute the velocities
   [v,w] = forwardKinematics(dd,wL,wR);
   velB = [v;0;w]; % Body velocities [vx;vy;w]
   vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

   % Perform forward discrete integration step
   pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

   % Update visualization
   viz(pose(:,idx),waypoints)
   waitfor(r);
   grid on;
   hold on;
end
```

Resultado.

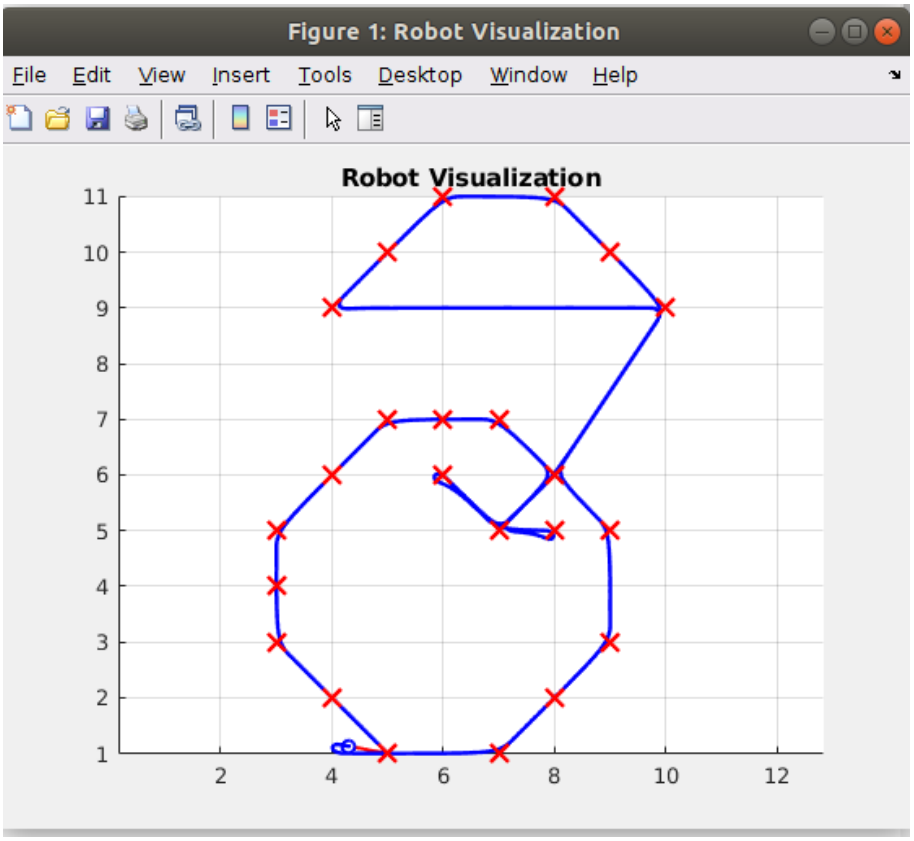


Figure 1: Robot Visualization
File Edit View Insert Tools Desktop Window Help
Robot Visualization
11
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