Instituto Tecnológico y de Estudios Superiores de Monterrey

TE3002B.502

Implementación de robótica Inteligente (Gpo 502)

Semestre: febrero - junio 2023

Actividad 5: Landmarks

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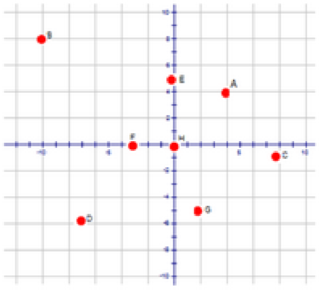
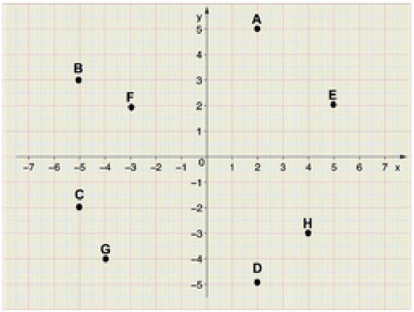
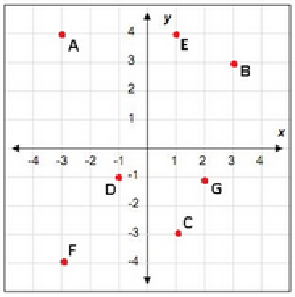
Profesor: Dr. Alfredo García Suárez

Fecha de entrega: 03 de Mayo del 2023

1. Implementar el código requerido para generar el seguimiento de los siguientes waypoints (puntos de referencia), ajustando el tiempo de muestreo: “sampleTime”, vector de tiempo: “tVec”, pose inicial: “initPose”, y los waypoints: “waypoints”.







Trayectoria 1:

sampleTime = 0.1;

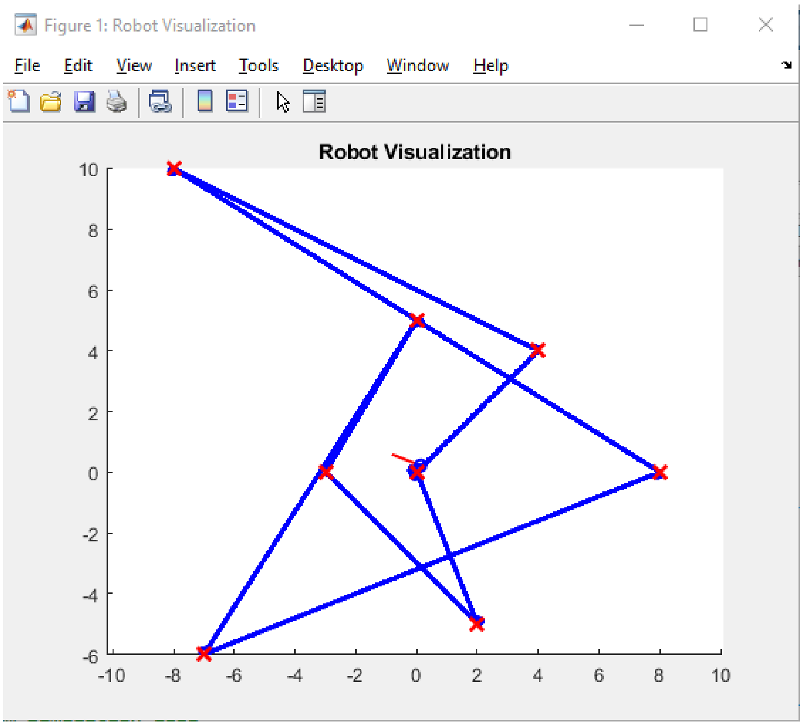
tVec = 0:sampleTime:400;

controller.LookaheadDistance = 0.1;

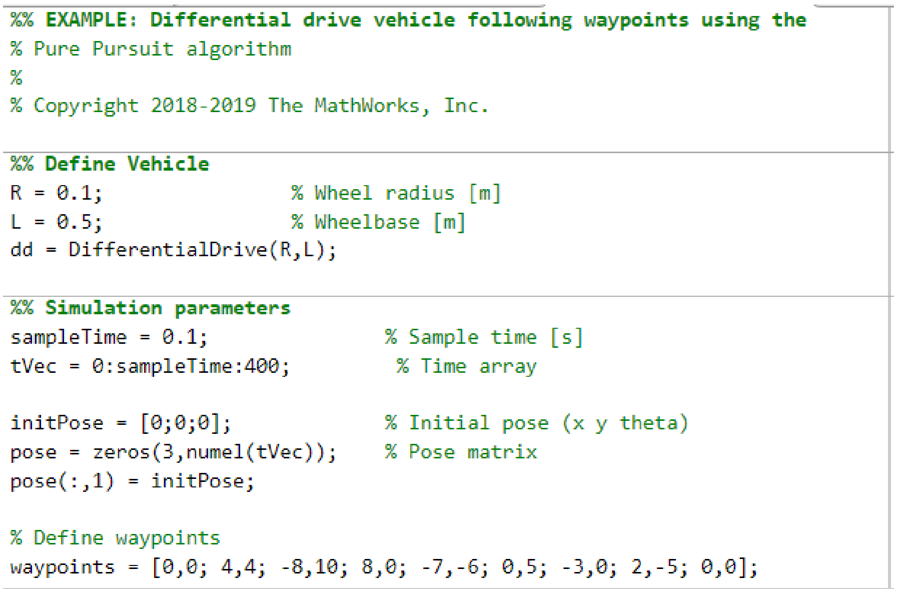
controller.DesiredLinearVelocity = 0.5;

controller.MaxAngularVelocity = 5;

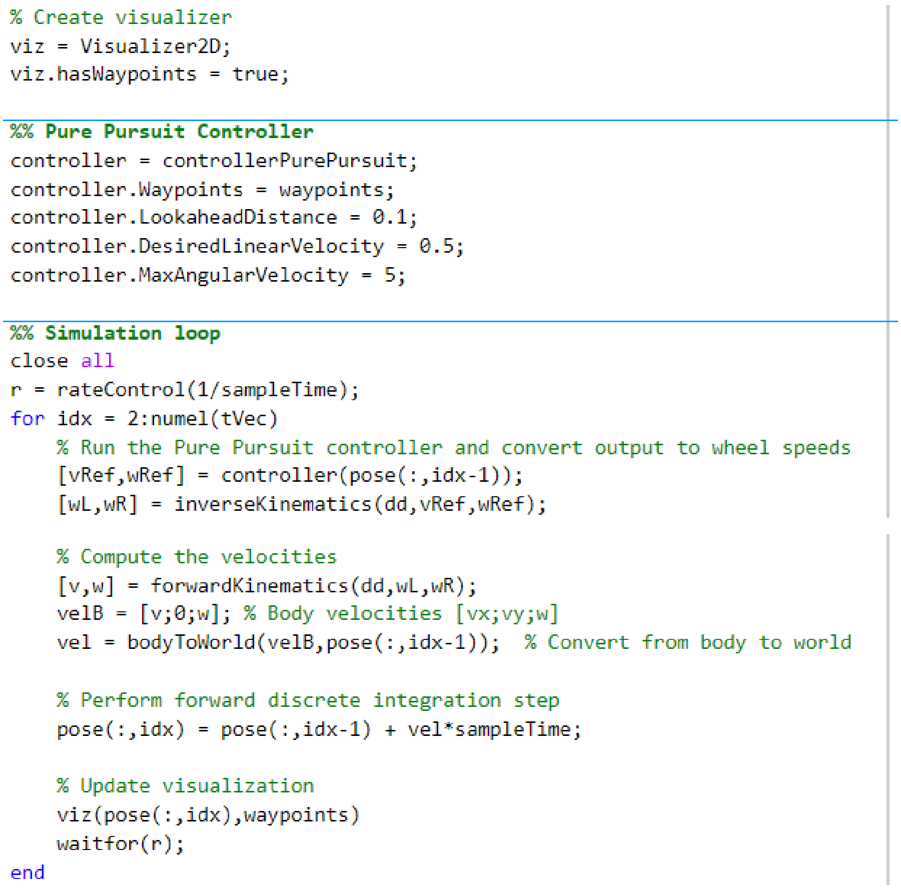
Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.



Código Desarrollado



```
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:400;         % Time array

initPose = [0;0;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [0,0; 4,4; -8,10; 8,0; -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 = 0.1;
controller.DesiredLinearVelocity = 0.5;
controller.MaxAngularVelocity = 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);
end
```

Trayectoria 2:

sampleTime = 0.1;

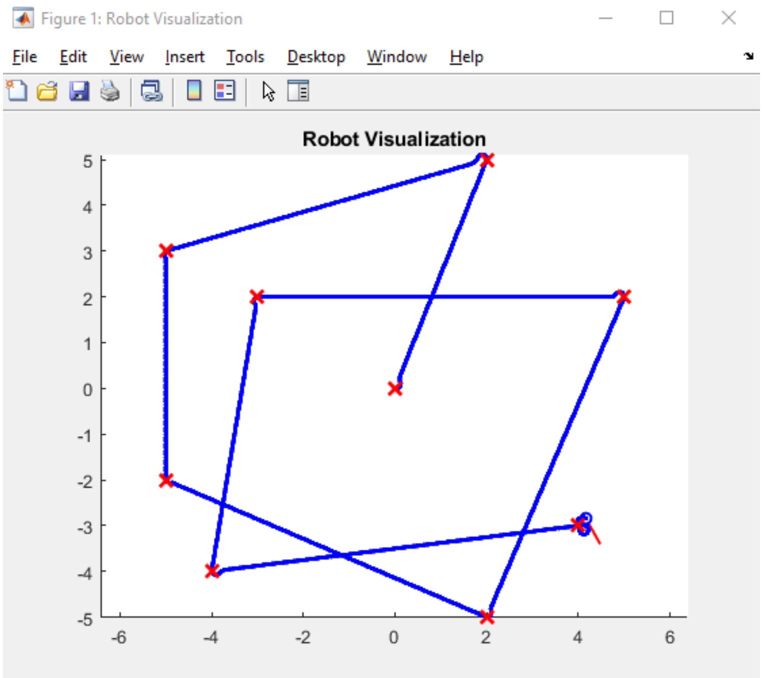
tVec = 0:sampleTime: 300;

controller.LookaheadDistance = 0.1;

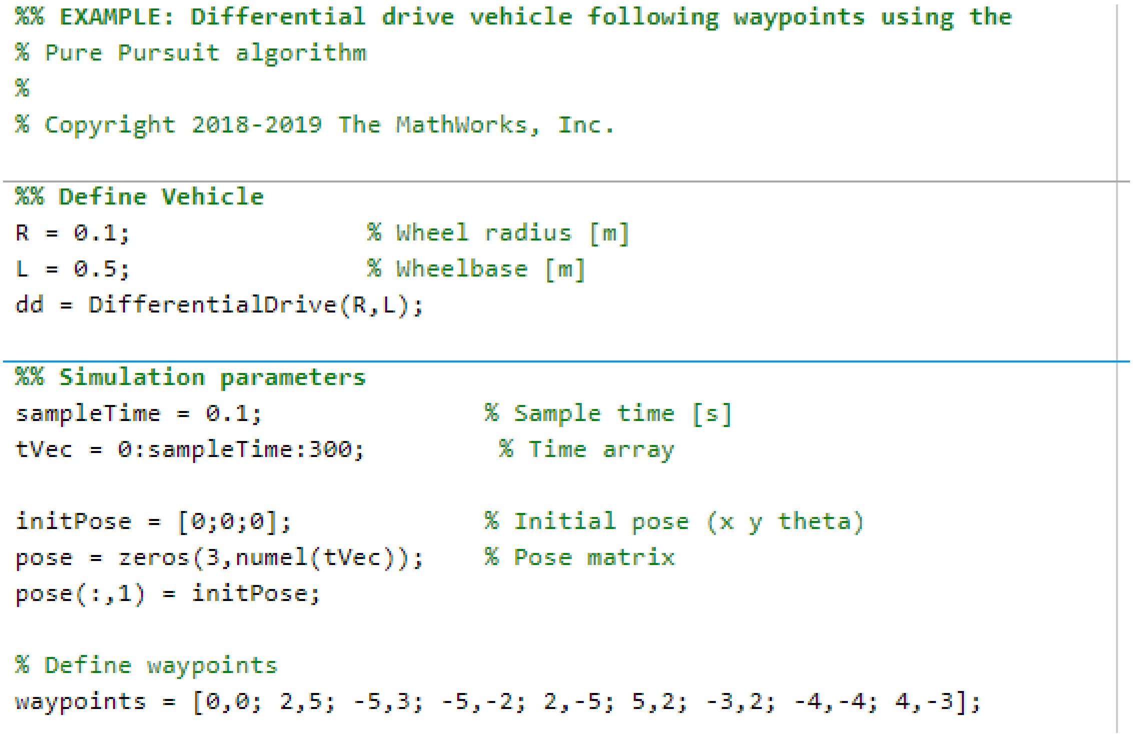
controller.DesiredLinearVelocity = 0.5;

controller.MaxAngularVelocity = 5;

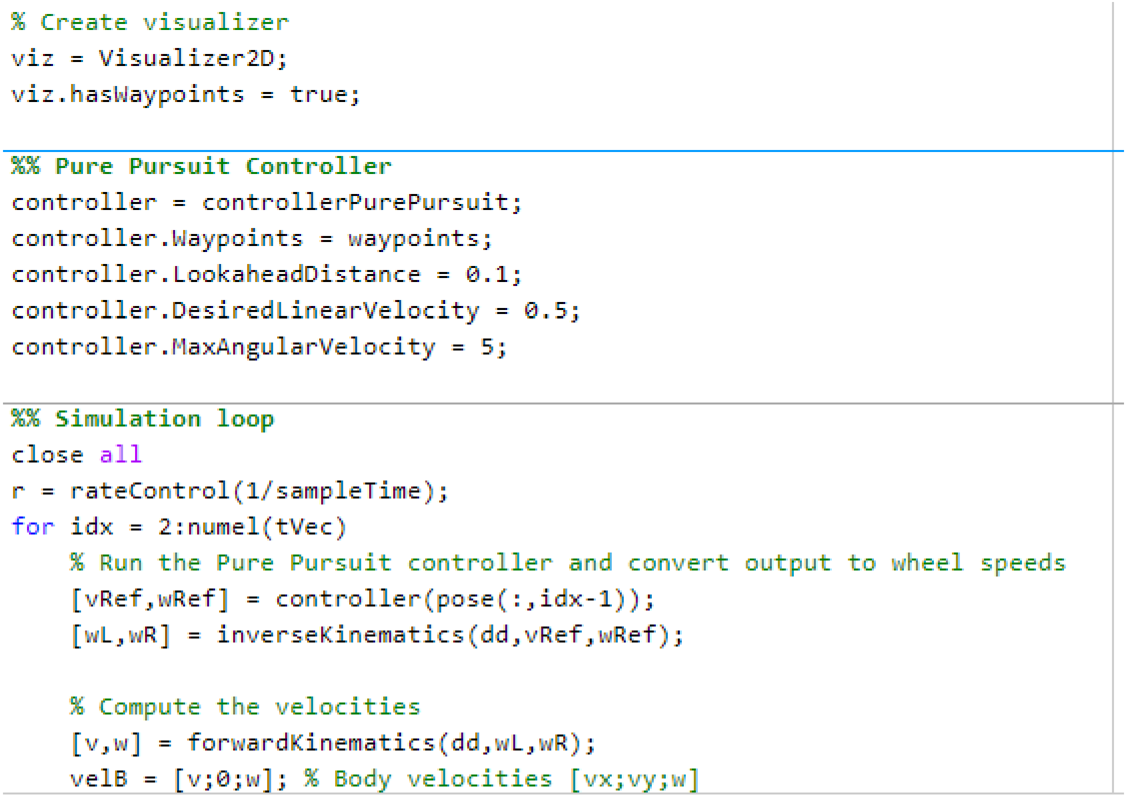
Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.



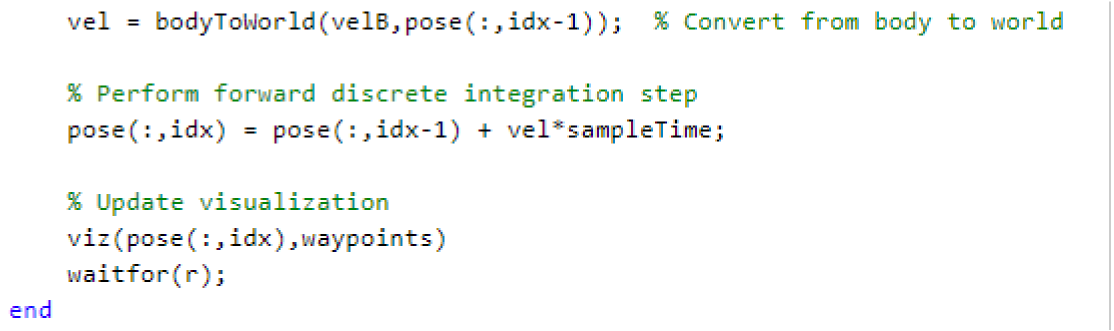
Código Desarrollado



```
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:300;         % Time array

initPose = [0;0;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [0,0; 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 = 0.1;
controller.DesiredLinearVelocity = 0.5;
controller.MaxAngularVelocity = 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);
end
```

Trayectoria 3:

sampleTime = 0.1;

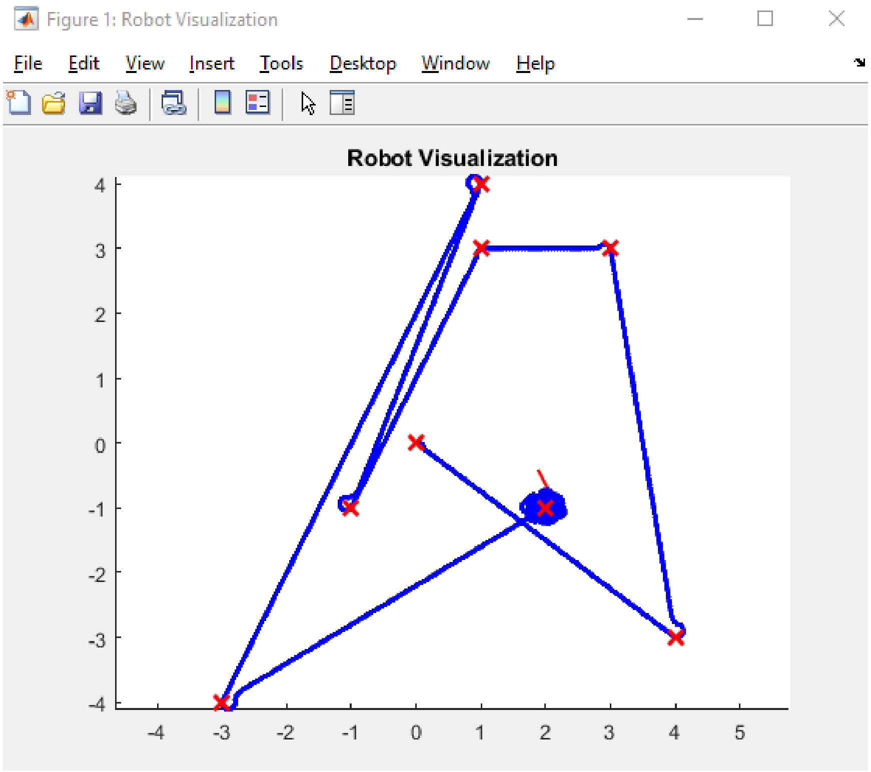
tVec = 0:sampleTime: 300;

controller.LookaheadDistance = 0.1;

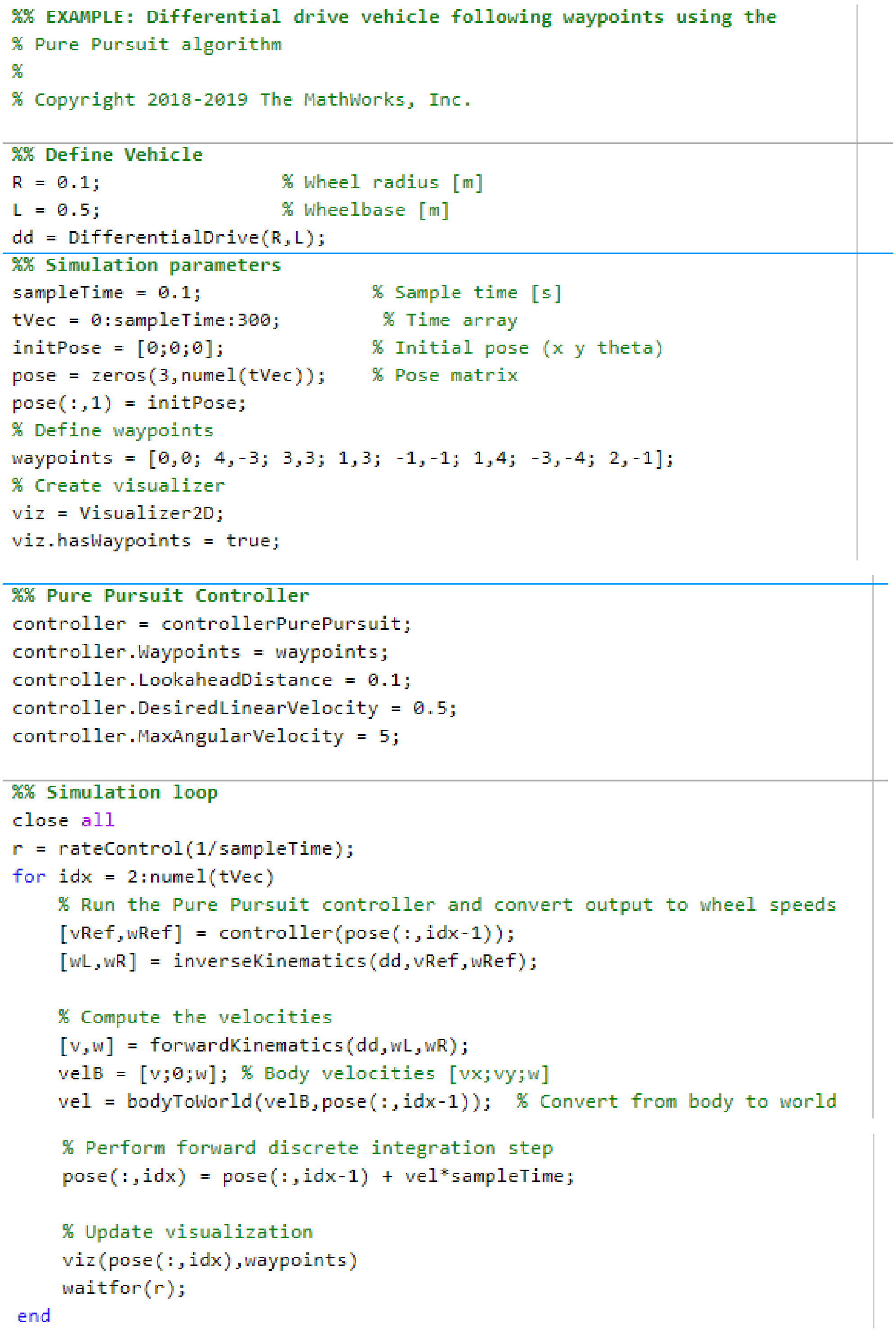
controller.DesiredLinearVelocity = 0.5;

controller.MaxAngularVelocity = 5;

Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.

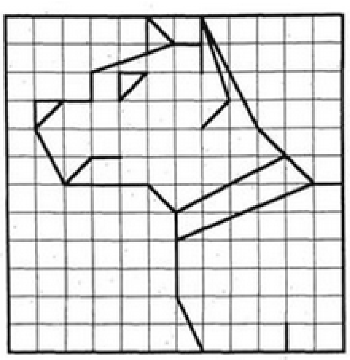


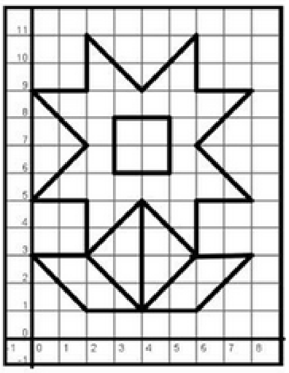
Código Desarrollado



```
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:300;         % Time array
initPose = [0;0;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;
% Define waypoints
waypoints = [0,0; 4,-3; 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 = 0.1;
controller.DesiredLinearVelocity = 0.5;
controller.MaxAngularVelocity = 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);
end
```

2. Generar los waypoints (puntos de referencia) necesarios para obtener las siguientes trayectorias, ajustando el tiempo de muestreo: “sampleTime”, vector de tiempo: “tVec”, pose inicial: “initPose”, y los waypoints: “waypoints”.





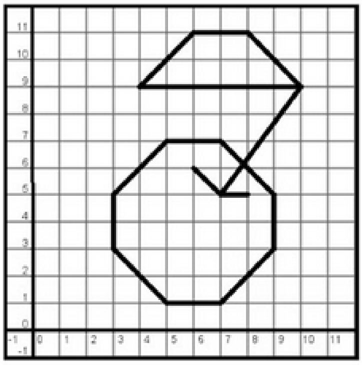


Figura 1 (Perro):

sampleTime = 0.1;

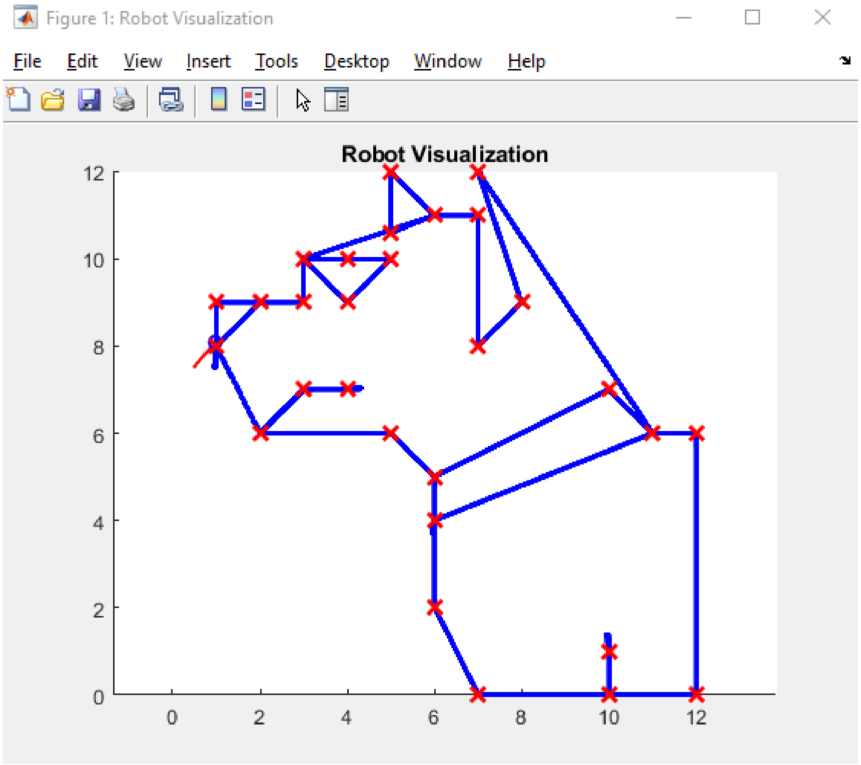
tVec = 0:sampleTime: 290;

controller.LookaheadDistance = 0.1;

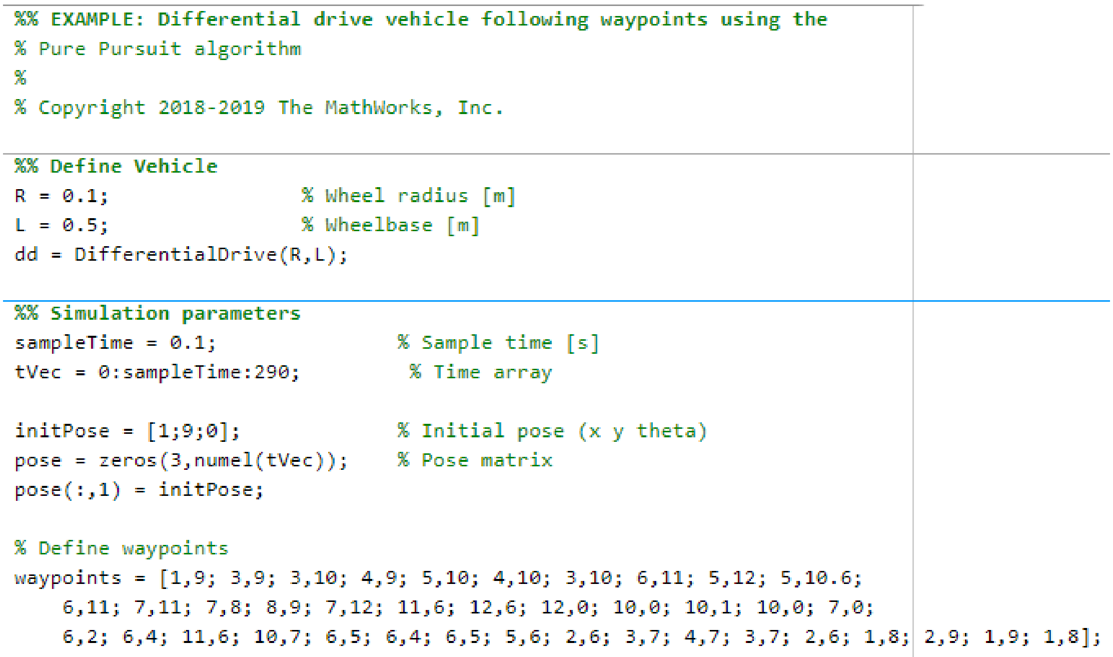
controller.DesiredLinearVelocity = 0.3;

controller.MaxAngularVelocity = 20;

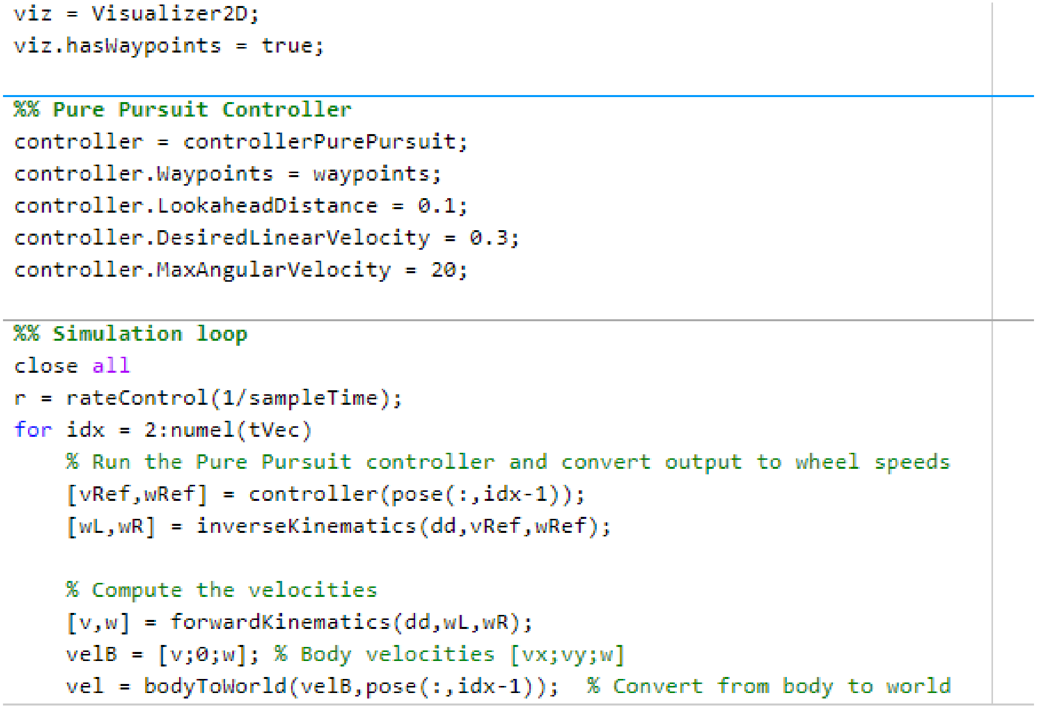
Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.



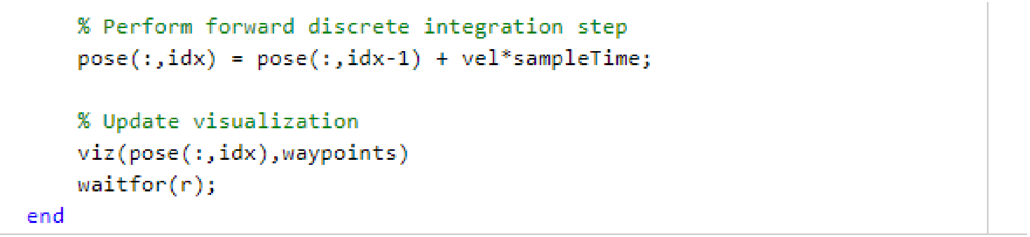
Código Desarrollado



```
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:290;         % Time array

initPose = [1;9;0];             % 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];
```



```
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.1;
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);
end
```

Figura 2 (Flor):

sampleTime = 0.1;

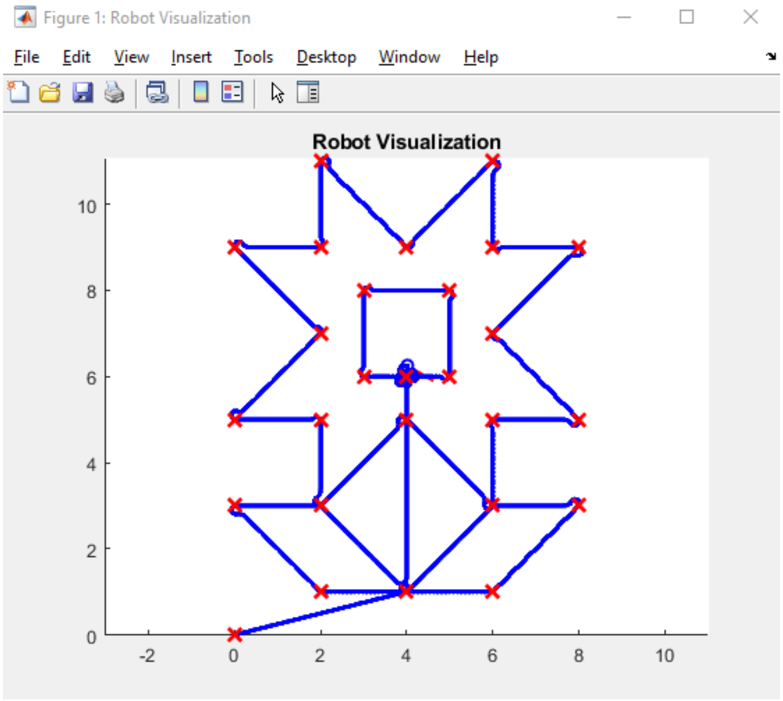
tVec = 0:sampleTime: 300;

controller.LookaheadDistance = 0.1;

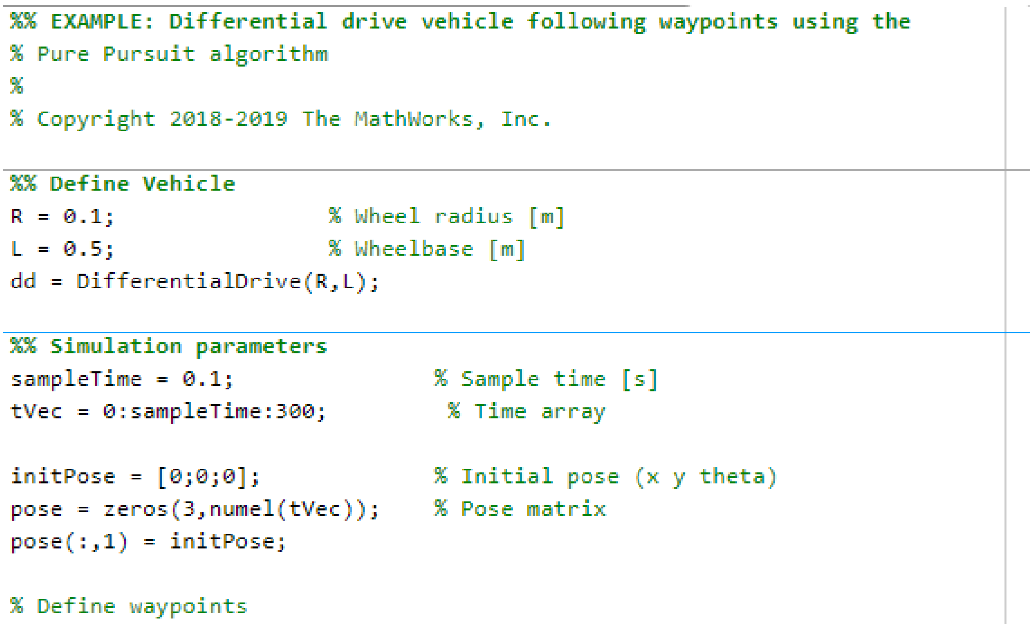
controller.DesiredLinearVelocity = 0.5;

controller.MaxAngularVelocity = 5;

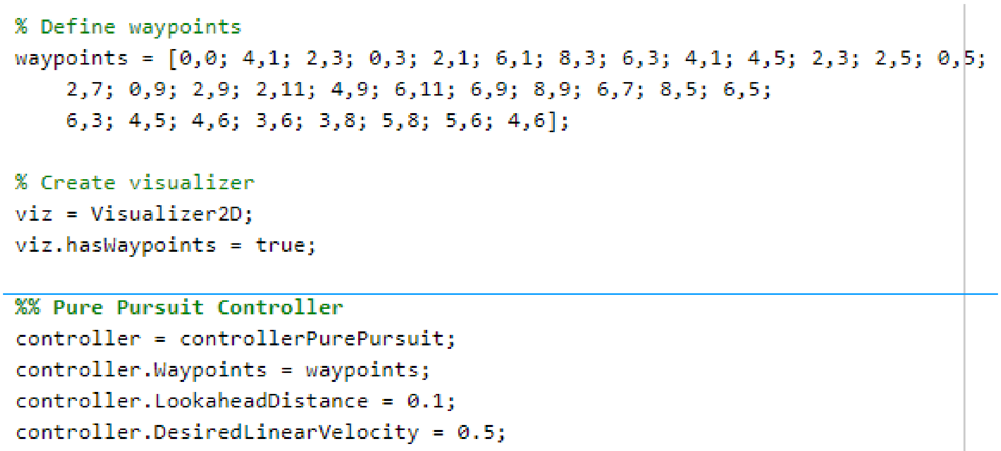
Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.



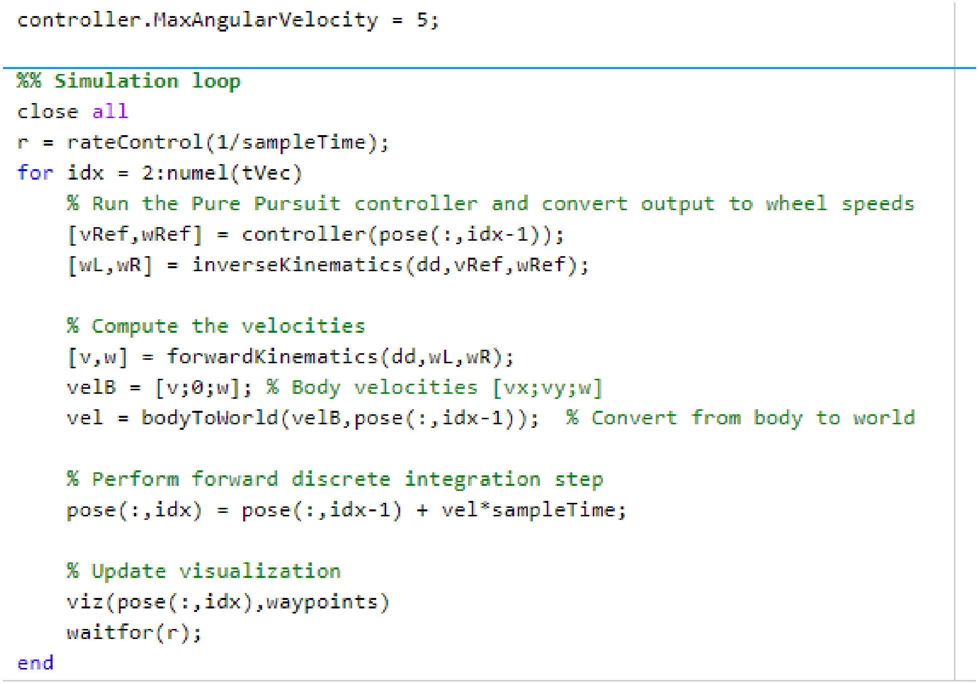
Código Desarrollado



```matlab
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:300;         % Time array

initPose = [0;0;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
```



```matlab
% Define waypoints
waypoints = [0,0; 4,1; 2,3; 0,3; 2,1; 6,1; 8,3; 6,3; 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];

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

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.1;
controller.DesiredLinearVelocity = 0.5;
```



```matlab
controller.MaxAngularVelocity = 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);
end
```

Figura 3 (Pera):

sampleTime = 0.1;

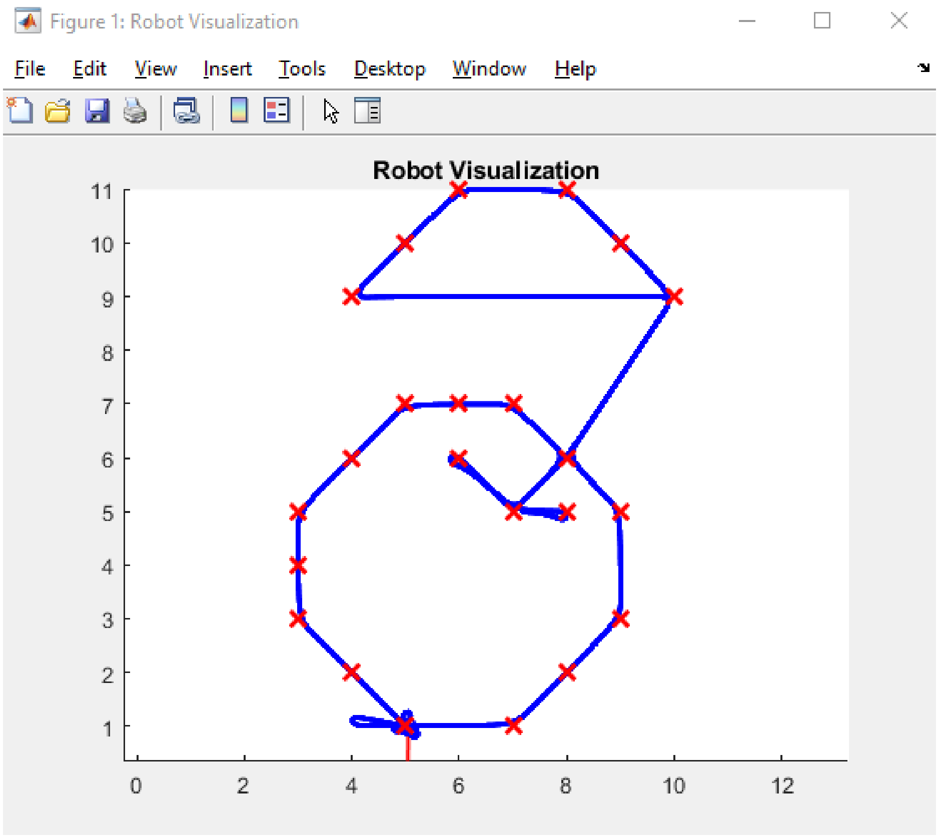
tVec = 0:sampleTime: 200;

controller.LookaheadDistance = 0.1;

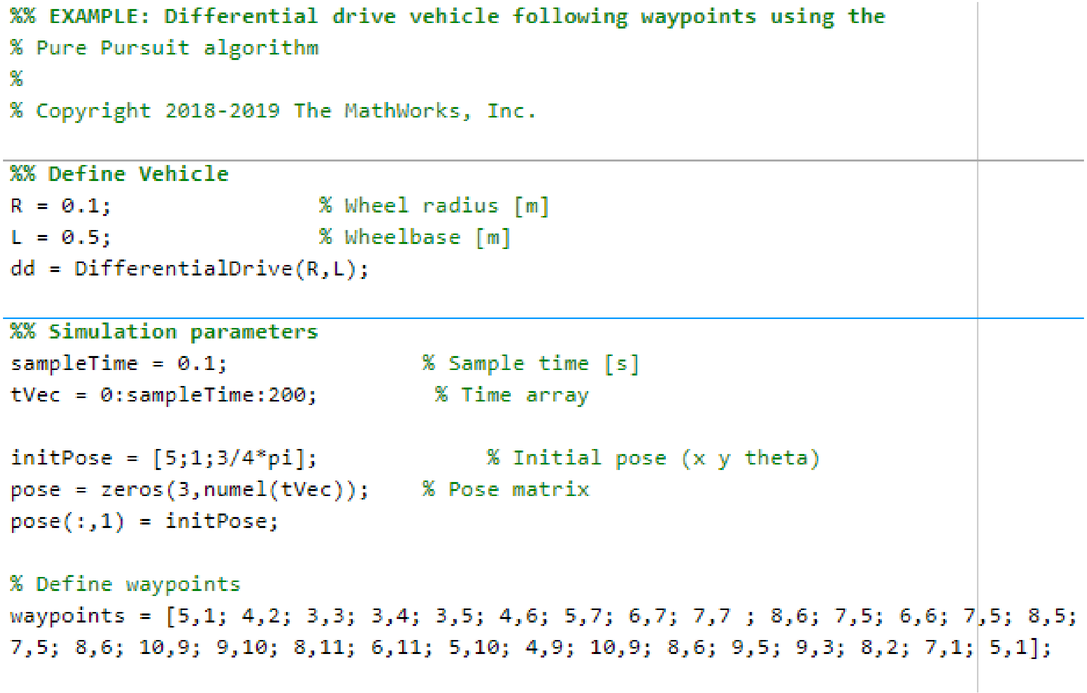
controller.DesiredLinearVelocity = 0.3;

controller.MaxAngularVelocity = 20;

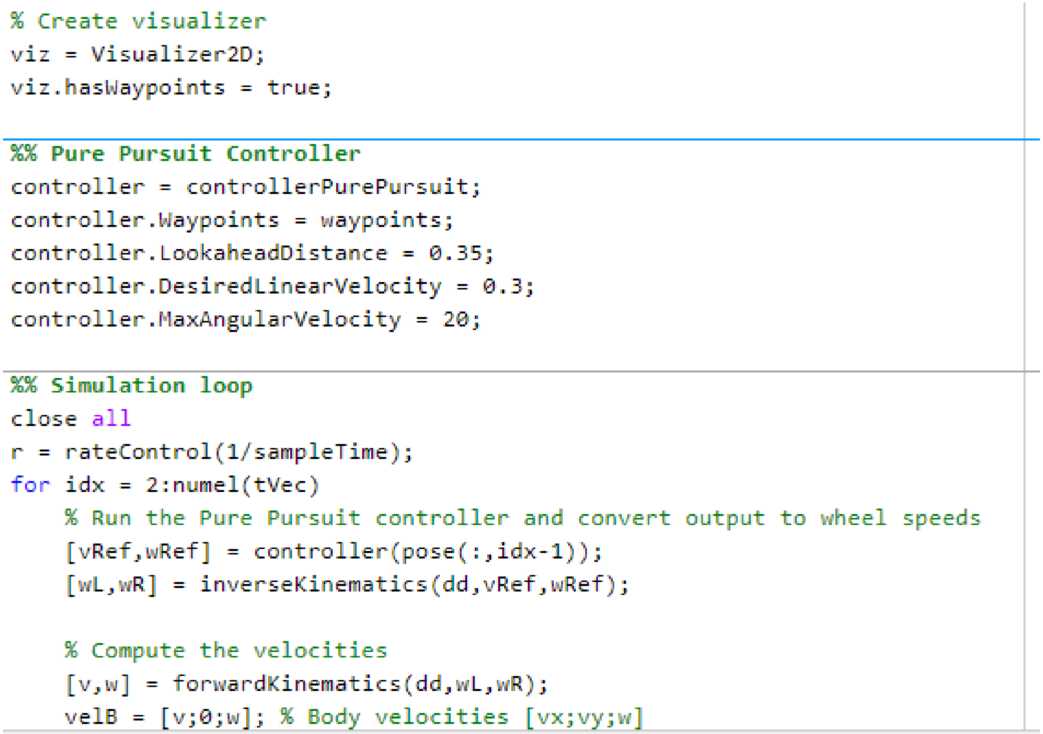
Los parámetros anteriores se utilizaron ya que tenían una respuesta considerablemente buena y rápida ante los puntos establecidos, esto porque se probaron algunas otras configuraciones y no tenían una ejecución tan buena comparado con estas.



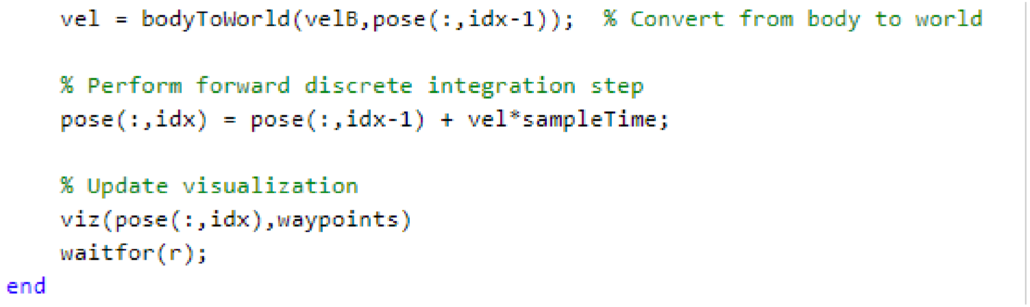
Código Desarrollado



```
%% EXAMPLE: Differential drive vehicle following waypoints using the
% Pure Pursuit algorithm
%
% Copyright 2018-2019 The MathWorks, Inc.

%% 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:200;         % 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
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);
end
```