CSB310: Artificial Intelligence

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CSE (5th Sem)

Group : 2

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2023

LAB 8

PART A: Explore Motion Planning with MATLAB.

1. MATLAB Navigation Toolbox. [LINK]

-Navigation Toolbox provides algorithms and analysis tools for motion planning, simultaneous local-
ization and mapping (SLAM), and inertial navigation.

-The toolbox includes customizable search and sampling-based path planners, as well as metrics for
validating and comparing paths.

-You can create 2D and 3D map representations, generate maps using SLAM algorithms, and interac-
tively visualize and debug map generation with the SLAM map builder app.

2. Task: Apply any two motion planning algorithms available in MATLAB Navigation Toolbox:

Observation:

I have successfully implemented RRT and SLAM using the toolbox

Create a state space.

```
ss = stateSpaceSE2;
```

Create an `occupancyMap`-based state validator using the created state space.

```
sv = validatorOccupancyMap(ss);
```

Create an occupancy map from an example map and set map resolution as 10 cells/meter.

```
load exampleMaps.mat
map = occupancyMap(simpleMap,10);
sv.Map = map;
```

Set validation distance for the validator.

```
sv.ValidationDistance = 0.01;
```

Update state space bounds to be the same as map limits.

```
ss.StateBounds = [map.XWorldLimits; map.YWorldLimits; [-pi pi]];
```

Create RRT* path planner and allow further optimization after goal is reached. Reduce the maximum iterations and increase the maximum connection distance.

```
planner = plannerRRTStar(ss,sv, ...
          ContinueAfterGoalReached=true, ...
          MaxIterations=2500, ...
          MaxConnectionDistance=0.3);
```

Set the start and goal states.

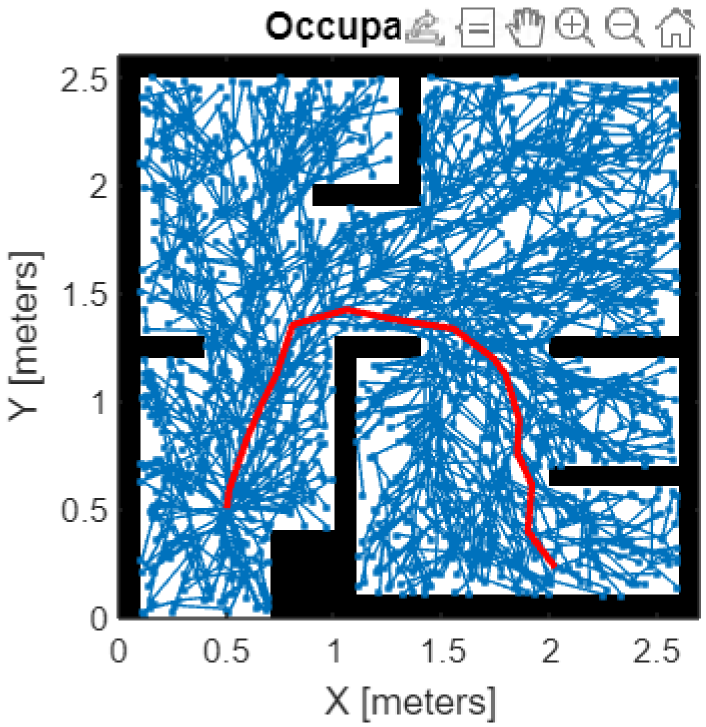
```
start = [0.5 0.5 0];
goal = [2.5 0.2 0];
```

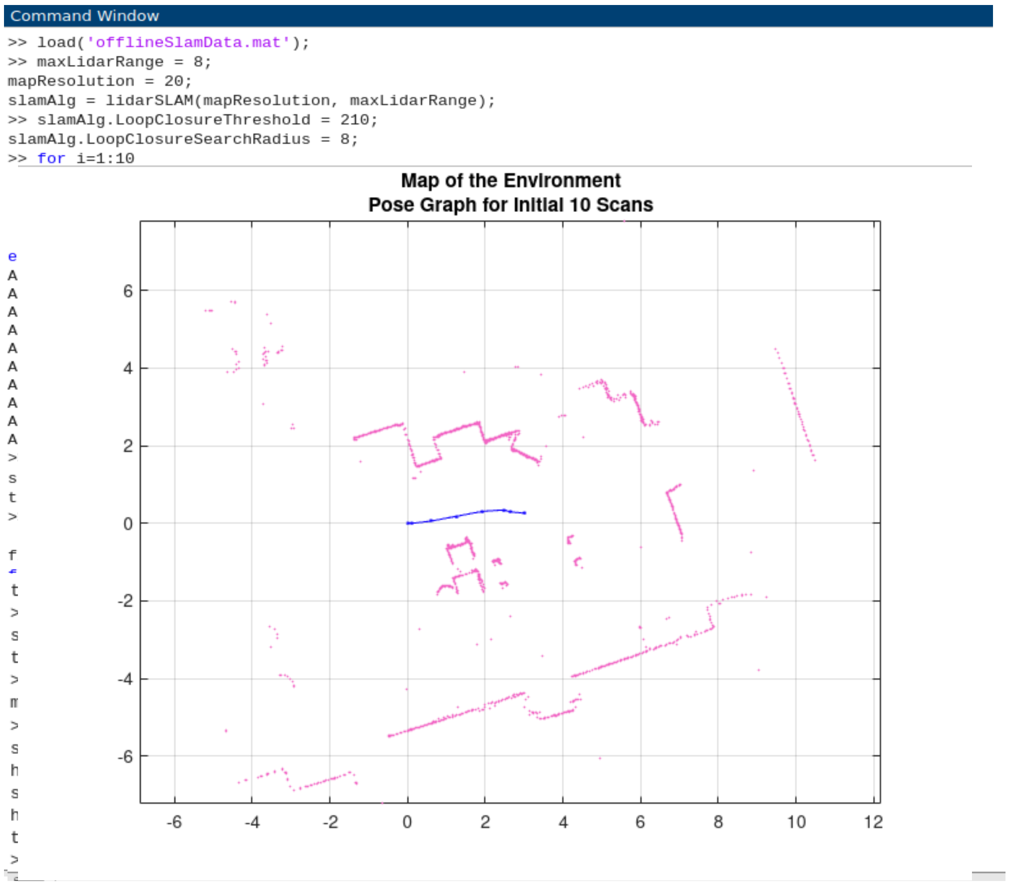
Plan a path with default settings.

```
rng(100,'twister') % repeatable result
[pthObj,solnInfo] = plan(planner,start,goal);
```

Visualize the results.

```
map.show
hold on
% Tree expansion
plot(solnInfo.TreeData(:,1),solnInfo.TreeData(:,2),'.-')
% Draw path
plot(pthObj.States(:,1),pthObj.States(:,2),'r-','LineWidth',2)
```





```
>> load('offlineSlamData.mat');
>> maxLidarRange = 8;
mapResolution = 20;
slamAlg = lidarSLAM(mapResolution, maxLidarRange);
>> slamAlg.LoopClosureThreshold = 210;
slamAlg.LoopClosureSearchRadius = 8;
>> for i=1:10
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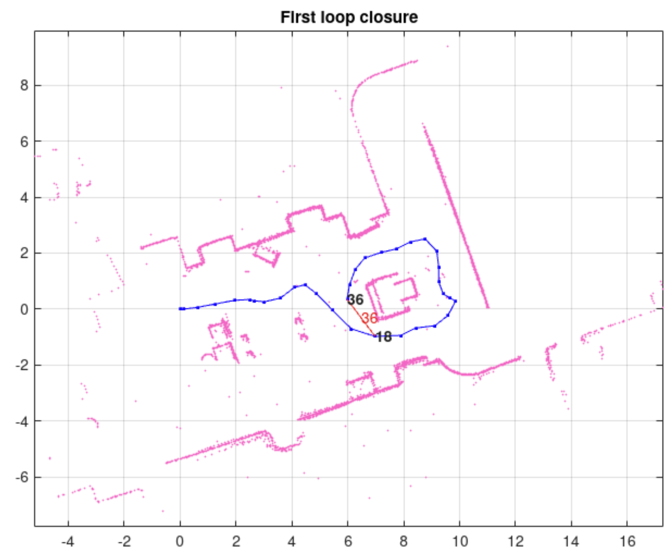
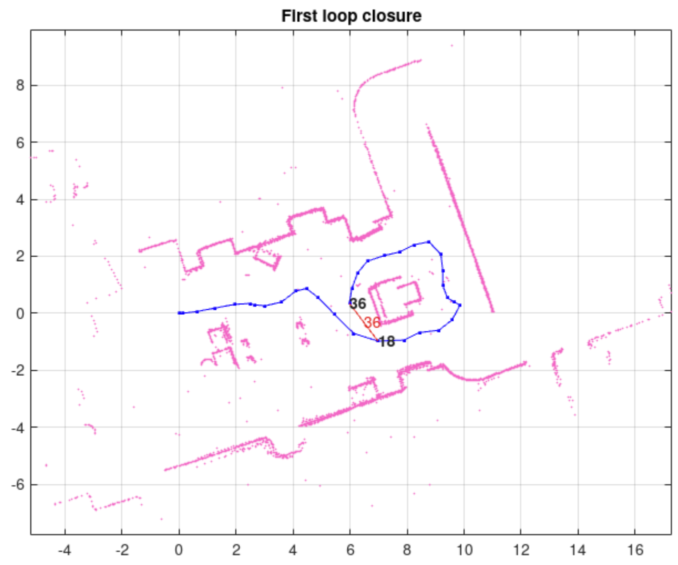

First loop closure
36
36
18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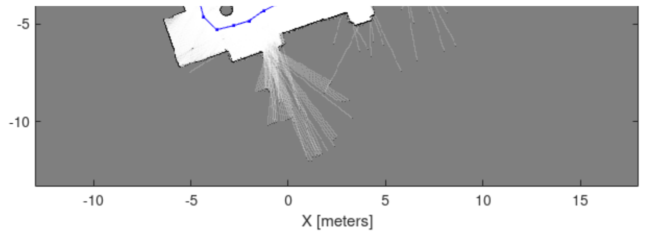

X [meters]

PART B: Explore MATLAB Mobile Robotics Simulation Toolbox. [LINK]

Task: Run the example code of Differential Drive Path Planning and Navigation, it uses a path found

in an occupancy grid using a probabilistic roadmap (PRM). Draw a flow chart of the workflow and

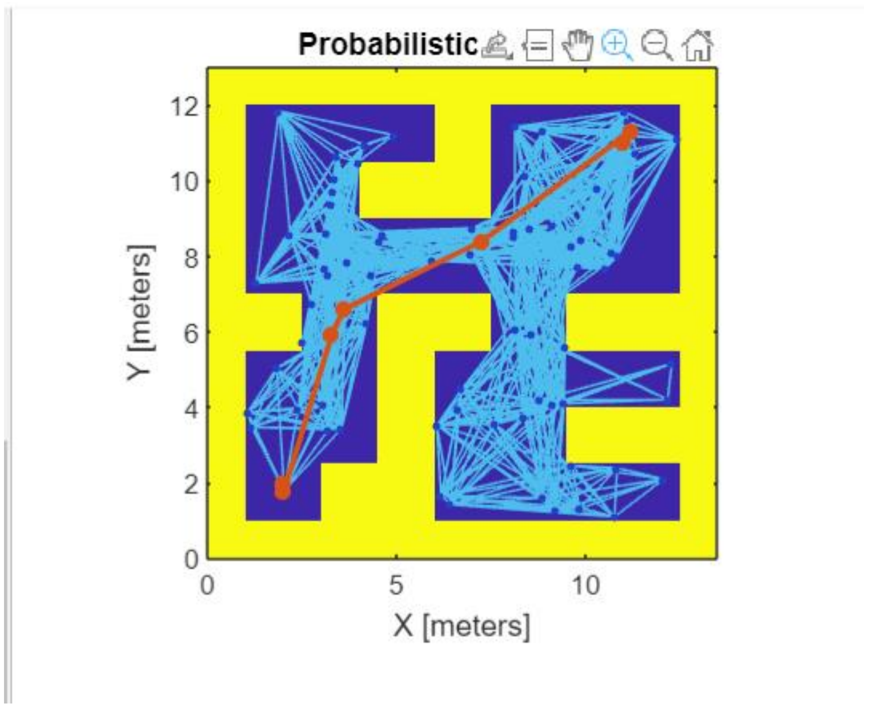
functional dependencies for the sample code.

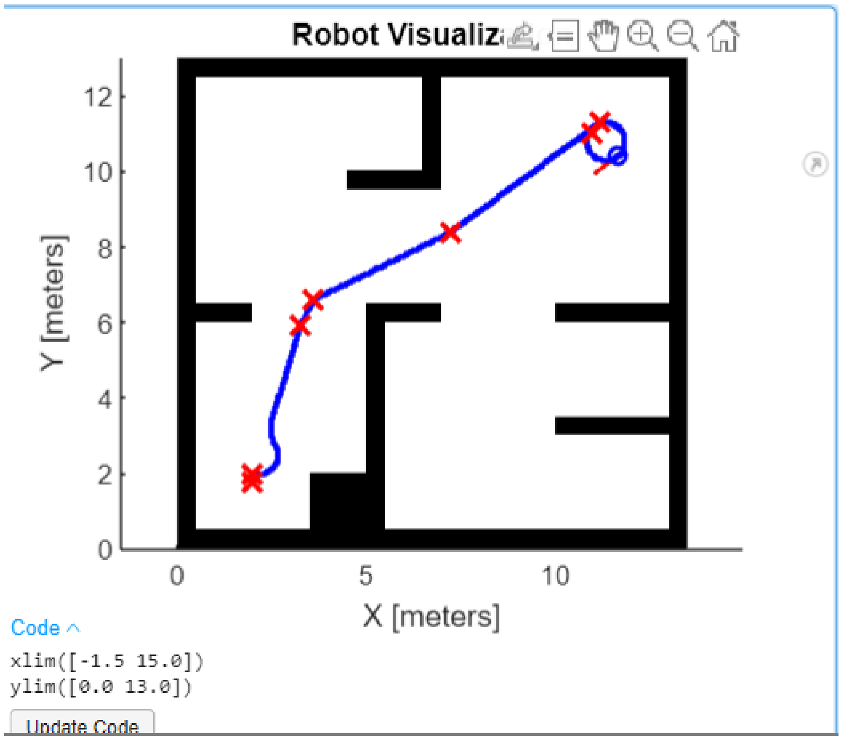
```
%% EXAMPLE: Differential Drive Path Planning and Navigation
% In this example, a path is found in an occupancy grid using a
% probabilistic roadmap (PRM) and followed using Pure Pursuit
%
% Copyright 2018-2019 The MathWorks, Inc.
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);
%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:25;         % Time array
initPose = [2;2;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;
%% Path planning
% Load map and inflate it by a safety distance
close all
load exampleMap
inflate(map,R);
% Create a Probabilistic Road Map (PRM)
planner = mobileRobotPRM(map);
planner.NumNodes = 75;
planner.ConnectionDistance = 5;
% Find a path from the start point to a specified goal point
startPoint = initPose(1:2)';
goalPoint  = [11, 11];
waypoints = findpath(planner,startPoint,goalPoint);
show(planner)
%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 0.75;
controller.MaxAngularVelocity = 1.5;
%% Create visualizer
load exampleMap % Reload original (uninflated) map for visualization
viz = Visualizer2D;
viz.hasWaypoints = true;
viz.mapName = 'map';
%% Simulation loop
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
```



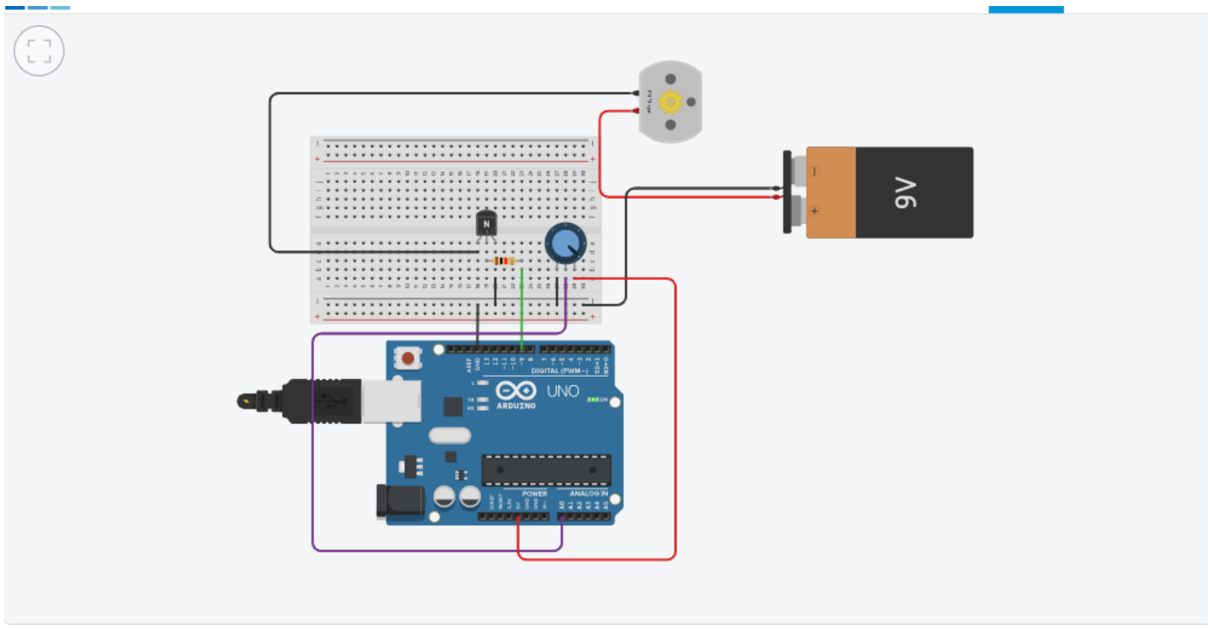


```
xlim([-1.5 15.0])
ylim([0.0 13.0])
```

PART C: Exploratory Problem

5. Using Tinkercad, design a circuit for controlling a DC motor using a potentiometer. Program the

Arduino board for the operation and stimulate the scenario over Tinkercad.


9V
UNO
ARDUINO
DIGITAL (PWM~)
POWER
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N