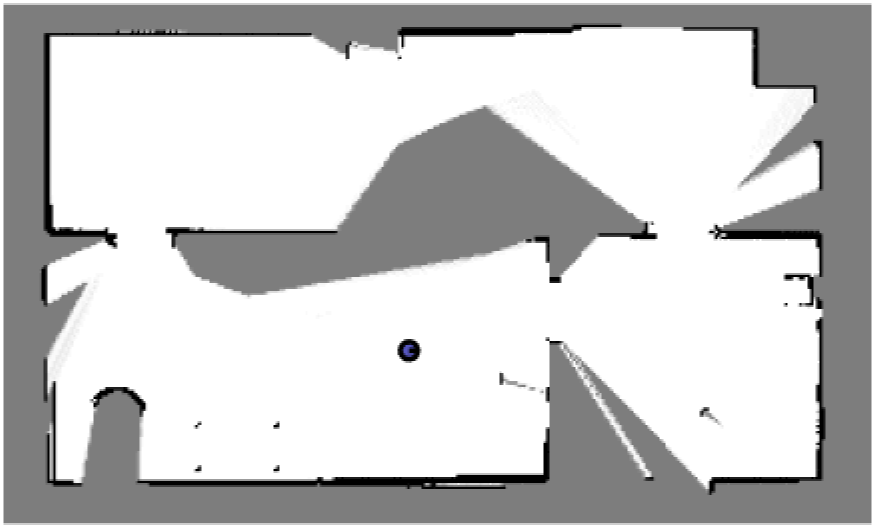
```
% =========
% ass3_q1.m
% =========
%
% This assignment will introduce you to the idea of first building an
% occupancy grid then using that grid to estimate a robot's motion using a
% particle filter.
%
% There are two questions to complete (5 marks each):
%
%    Question 1: code occupancy mapping algorithm
%    Question 2: see ass3_q2.m
%
% Fill in the required sections of this script with your code, run it to
% generate the requested plot/movie, then paste the plots into a short report
% that includes a few comments about what you've observed.  Append your
% version of this script to the report.  Hand in the report as a PDF file
% and the two resulting AVI files from Questions 1 and 2.
%
% requires: basic Matlab, 'gazebo.mat'
%
% T D Barfoot, January 2016
%
clear all;

% set random seed for repeatability
rng(1);

% ==========================
% load the dataset from file
% ==========================
%
%    ground truth poses: t_true x_true y_true theta_true
% odometry measurements: t_odom v_odom omega_odom
%           laser scans: t_laser y_laser
%    laser range limits: r_min_laser r_max_laser
%    laser angle limits: phi_min_laser phi_max_laser
%
load gazebo.mat;

% =======================================
% Question 1: build an occupancy grid map
% =======================================
%
% Write an occupancy grid mapping algorithm that builds the map from the
% perfect ground-truth localization.  Some of the setup is done for you
% below.  The resulting map should look like "ass2_q1_soln.png".  You can
% watch the movie "ass2_q1_soln.mp4" to see what the entire mapping process
% should look like.  At the end you will save your occupancy grid map to
% the file "occmap.mat" for use in Question 2 of this assignment.

% allocate a big 2D array for the occupancy grid
```

```
ogres = 0.05;                   % resolution of occ grid
ogxmin = -7;                    % minimum x value
ogxmax = 8;                     % maximum x value
ogymin = -3;                    % minimum y value
ogymax = 6;                     % maximum y value
ognx = (ogxmax-ogxmin)/ogres;   % number of cells in x direction
ogny = (ogymax-ogymin)/ogres;   % number of cells in y direction
oglo = zeros(ogny,ognx);        % occupancy grid in log-odds format
ogp = zeros(ogny,ognx);         % occupancy grid in probability format

% precalculate some quantities
numodom = size(t_odom,1);
npoints = size(y_laser,2);
angles = linspace(phi_min_laser, phi_max_laser, npoints);
dx = ogres*cos(angles);
dy = ogres*sin(angles);

% interpolate the noise-free ground-truth at the laser timestamps
t_interp = linspace(t_true(1),t_true(numodom),numodom);
x_interp = interp1(t_interp,x_true,t_laser);
y_interp = interp1(t_interp,y_true,t_laser);
theta_interp = interp1(t_interp,theta_true,t_laser);
omega_interp = interp1(t_interp,omega_odom,t_laser);

% set up the plotting/movie recording
vid = VideoWriter('ass2_q1.avi');
open(vid);
figure(1);
clf;
pcolor(ogp);
colormap(1-gray);
shading('flat');
axis equal;
axis off;
M = getframe;
writeVideo(vid,M);

BETA = 0.5;
ALPHA = 3;


% loop over laser scans (every fifth)
for t=1:5:size(t_laser,1)

    % ------insert your occupancy grid mapping algorithm here------




    for i = 1:npoints

        if ~isnan(y_laser(t,i)) && r_min_laser < y_laser(t,i) && y_laser(t,i)
 < r_max_laser
```

```
        %convert to map frame
        x_start = (x_interp(t)-ogxmin);
        y_start = (y_interp(t)-ogymin);

        range_mes = y_laser(t,i);
        cur_angle = angles(i) + theta_interp(t);

        % x_end and y_end calculation
        x_end = x_start + range_mes * cos(cur_angle);
        y_end = y_start + range_mes * sin(cur_angle);



        % convert to map coordinates
        x_start = round(x_start/ogres);
        y_start = round(y_start/ogres);
        x_end = round(x_end/ogres);
        y_end = round(y_end/ogres);


        % ray trace
        [rr, cc] = ray_trace(x_start, y_start, x_end, y_end);

        % shape
        [row_bound, col_bound] = size(oglo);


                % iterate over each cell index pair
        for j=1:size(rr, 1)

            % skip over any instances where index is outside map
            if rr(j) > row_bound || cc(j) > col_bound || rr(j) <= 0 || ...
                    cc(j) <= 0
                continue
            end
            % update log-odds
            if j < (size(rr,1))
                % all cells except last cell are set as free
                oglo(rr(j),cc(j)) = oglo(rr(j),cc(j)) - BETA;
            else
                % last cell is set as occupied
                oglo(rr(j),cc(j)) = oglo(rr(j),cc(j)) + ALPHA;
            end

        end

    end

end
oglo;
% recovering probabilities from log-odds
ogp = exp(oglo)./(1 + exp(oglo));
```

```
    % ------end of your occupancy grid mapping algorithm-------

    % draw the map
    clf;
    pcolor(ogp);
    colormap(1-gray);
    shading('flat');
    axis equal;
    axis off;

    % draw the robot
    hold on;
    x = (x_interp(t)-ogxmin)/ogres;
    y = (y_interp(t)-ogymin)/ogres;
    th = theta_interp(t);
    r = 0.15/ogres;
    set(rectangle( 'Position', [x-r y-r 2*r 2*r], 'Curvature', [1
 1]),'LineWidth',2,'FaceColor',[0.35 0.35 0.75]);
    set(plot([x x+r*cos(th)]', [y y+r*sin(th)]', 'k-'),'LineWidth',2);

    % save the video frame
    M = getframe;
    writeVideo(vid,M);

    pause(0.1);

end

close(vid);
print -dpng ass2_q1.png

save occmap.mat ogres ogxmin ogxmax ogymin ogymax ognx ogny oglo ogp;


% given two points in a matrix, returns the diagonal indices
function [rr, cc] = ray_trace(x1, y1, x2, y2)
    % Initialize the return arrays
    rr = [];
    cc = [];

    % Calculate the x and y distances between the two points
    dx = abs(x2 - x1);
    dy = abs(y2 - y1);

    % Calculate the step size for the x and y axes
    if x1 < x2
        sx = 1;
    else
```

```
        sx = -1;
    end

    if y1 < y2
        sy = 1;
    else
        sy = -1;
    end

    % Initialize the error term
    err = dx - dy;

    % Traverse the line using Bresenham's algorithm
    while true
        % Add the current point to the return arrays
        rr = [rr; y1];
        cc = [cc; x1];

        % Check if we've reached the end point
        if x1 == x2 && y1 == y2
            break;
        end

        % Update the error term
        e2 = 2*err;
        if e2 > -dy
            err = err - dy;
            x1 = x1 + sx;
        end
        if e2 < dx
            err = err + dx;
            y1 = y1 + sy;
        end
    end
end
```



Published with MATLAB® R2022a