Lab #3: Simulation of Mobile Robots

EE 552: Robotic Control System

by

Md Ali Azam

and

Shawon Dey

Code for control of mobile robots at [5,5] from randomly generated initial state:

```
clc
clear
close all

% Simulate the autopilot %
options = odeset('RelTol',1e-4,'AbsTol',[1e-5 1e-5 1e-5 1e-
5]);
tspan = linspace(0,20,5000);

n = 10; % number of mobile robots

a = randi([-20,20],[n,2]);
xx = zeros(5000,4,n);
target = [5,5];

for k = 1:n
    % Calling sequence: ode45(System function, time length,
ICs, options)
    [T,x] = ode45(@(t,x) MobileRobot(t,x),tspan,[a(k,1), 0,
a(k,2), 0]',options);
    xx(:,:,k) = x;
end

figure
plot(target(1),target(2),'r*')
hold on
grid on
axis([-20 20 -20 20])
hold on

for i = 1:length(T)
    for l = 1:n
        h(l) = plot(xx(i,1,l),xx(i,3,l),'ro');
        hold on
    end
    drawnow
    F(i) = getframe(gcf);
    for ll = 1:n
```

```
        delete(h(ll))
    end
end

for lll = 1:n
    plot(xx(i,1,lll),xx(i,3,lll),'ro');
    hold on
end

video = VideoWriter('Vid','MPEG-4');
video.FrameRate = 15;
open(video)
writeVideo(video,F);
close(video)



function [dx] = MobileRobot(t,x)

kp = 1; % Proportional control gain %

r = [5, 5]; % Desired target location %

% Enter system dynamics here %
% with no control input
dx = zeros(4,1);
dx(1) = x(2);
dx(2) = -kp.*(x(1) + x(2)) + r(1);
dx(3) = x(4);
dx(4) = -kp.*(x(3) + x(4)) + r(2);

end
```

Code for control of mobile robots at an unknown position from randomly generated initial state:

```
clc
clear
close all

% Simulate the autopilot %
options = odeset('RelTol',1e-4,'AbsTol',[1e-5 1e-5 1e-5 1e-
5]);
tspan = linspace(0,20,1000);
rng(1)
n = 10; % number of mobile robots

a1 = randi([-20,20],[n,2]);
% b = randi(20,[1,n]);
xx = zeros(1000,4,n);

for gg = 1:3
    b = zeros(n,2);
    counter = 0;
    if gg == 1
        a = a1;
    else
        targ = a;
    end
    for in = 1:n
        temp_targ = a(in,:);
        for kk = 1:n
            if kk ~= in
                if norm(a(kk,:) - a(in,:)) <= 15
                    temp_targ = temp_targ + a(kk,:);
                    counter = counter + 1;
                end
            end
        end
        b(in,:) = temp_targ./(counter+1);
        counter = 0;
    end
    a = b;
```

```
    for k = 1:n
        % Calling sequence: ode45(System function, time
length, ICs, options)
        if gg == 1
            [T,x] = ode45(@(t,x)
MobileRobot(t,x,k,a),tspan,[a1(k,1), 0, a1(k,2),
0]',options);
            xx(:,:,k,gg) = x;
        else
            [T,x] = ode45(@(t,x)
MobileRobot(t,x,k,a),tspan,[targ(k,1), 0, targ(k,2),
0]',options);
            xx(:,:,k,gg) = x;
        end
    end
end

figure
grid on
axis([-20 20 -20 20])
hold on

for gh = 1:gg
    for i = 1:length(T)
        for l = 1:n
            h(l) = plot(xx(i,1,l,gh),xx(i,3,l,gh),'ro');
            hold on
        end
        drawnow
        if gh == 1
            F1(i) = getframe(gcf);
        elseif gh == 2
            F2(i) = getframe(gcf);
        elseif gh == 3
            F3(i) = getframe(gcf);
        end
        for ll = 1:n
            delete(h(ll))
        end
    end
end

video = VideoWriter('Vid','MPEG-4');
video.FrameRate = 90;
```

```
open(video)
writeVideo(video,F1);
writeVideo(video,F2);
writeVideo(video,F3);
close(video)
```

```
function [dx] = MobileRobot(t,x,k,a)

kp = 1; % Proportional control gain %

r = a(k,:); % Desired target location %

dx = zeros(4,1);
dx(1) = x(2);
dx(2) = -kp.*(x(1) + x(2)) + r(1);
dx(3) = x(4);
dx(4) = -kp.*(x(3) + x(4)) + r(2);

if nargout>1
    aa = a;

end
```

Code for formation shape control of mobile robots (delta and diamond) from randomly generated initial state:

```
clc
clear
close all

% Simulate the autopilot %
options = odeset('RelTol',1e-4,'AbsTol',[1e-5 1e-5 1e-5 1e-
5]);
tspan = linspace(0,20,500);

n = 4; % number of mobile robots

a = randi([-20,20],[n,2]);
xx = zeros(500,4,n,2);
target = zeros(4,2,2);
target(:,:,1) = [0,10;
            0,0;
            5,0;
            -5,0];
target(:,:,2) = [0,10;
            0,-10;
            5,0;
            -5,0];

for shape = 1:2
    for k = 1:n
        % Calling sequence: ode45(System function, time
length, ICs, options)
        if shape == 1
            [T,x] = ode45(@(t,x)
MobileRobot(t,x,target,k,shape),tspan,[a(k,1), 0, a(k,2),
0]',options);
            % [T,x] = ode45(@MobileRobot,tspan,[0, 0, 0,
0]',options);
            xx(:,:,k,shape) = x;
        else
            [T,x] = ode45(@(t,x)
MobileRobot(t,x,target,k,shape),tspan,[target(k,1,1), 0,
target(k,2,1), 0]',options);
```

```
            xx(:,:,k,shape) = x;
        end
    end
end

figure
% plot(target(1),target(2),'r*')
% hold on
grid on
% plot(x1,x2,'r*')
axis([-20 20 -20 20])
hold on
% color_array = ['ro', 'ko', 'bo', 'go'];

for i = 1:length(T)
    for l = 1:n
        h(l) = plot(xx(i,1,l,1),xx(i,3,l,1),'ro');
        hold on
    end
    drawnow
%     F1(i) = getframe(gcf);
    for ll = 1:n
        delete(h(ll))
    end
end

for i2 = 1:length(T)
    for l = 1:n
        h(l) = plot(xx(i2,1,l,2),xx(i2,3,l,2),'ro');
        hold on
    end
    drawnow
%     F2(i2) = getframe(gcf);
    for ll = 1:n
        delete(h(ll))
    end
end

%
% video = VideoWriter('Vid','MPEG-4');
% video.FrameRate = 90;
% open(video)
% writeVideo(video,F1);
% writeVideo(video,F2);
```

```
% close(video)


function [dx] = MobileRobot(t,x,target,k,shape)

kp = 1; % Proportional control gain %

r = [target(k,1,shape), target(k,2,shape)]; % Desired
target location %

% Enter system dynamics here %
% with no control input
dx = zeros(4,1);
dx(1) = x(2);
dx(2) = -kp.*(x(1) + x(2)) + r(1);
dx(3) = x(4);
dx(4) = -kp.*(x(3) + x(4)) + r(2);
end
```