

Robo HW 7

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clf; clc; clear;

load playpensample.mat
known_radius = 0.1329;

% eliminate zeros
index = find(r~=0 & r<3);
r_clean = r(index);
theta_clean = theta(index);

% conver to cartesian
[x, y] = pol2cart(deg2rad(theta_clean),r_clean);
points = [x, y];
% example points
% points = [0, 1; 2, 5; 1, 6; 7, 6];

% set threshold and number of times to try algorithm
d = 0.01;
n = 1000;

bestCenterPoint = [];
bestRadius = 0;
bestInlierSet = zeros(0,2);
bestOutlierSet = zeros(0,2);
for i=1:n

    % have a set radius
    if known_radius > 0
        seedPoints = datasample(points,2,'Replace', false);
        [center,r] = fitCircle2(seedPoints, known_radius);
        if isnan(center)
            continue;
        end
    else
        % select three points and fit a circle to the points
        seedPoints = datasample(points,3,'Replace',false);
        [px,py,r] = fitCircle3(seedPoints);
        center = [px py];
    end
    diffs = points - repmat([center(1), center(2)], [size(points, 1) 1]);
    radii = sqrt(sum(diffs.^2,2));
    inliers = abs(radii - r) < d;

    % probably deal with gaps

    if sum(inliers) > size(bestInlierSet, 1)
        bestCenterPoint = center;
        bestRadius = r;
        bestInlierSet = points(inliers,:); % set inliers
        bestOutlierSet = points(~inliers,:); % set outliers
    end
end
end
```

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syms x y
circle_equation_explicit = (x-bestCenterPoint(1))^2 + (y-bestCenterPoint(2))^2 == bestRadius^2;

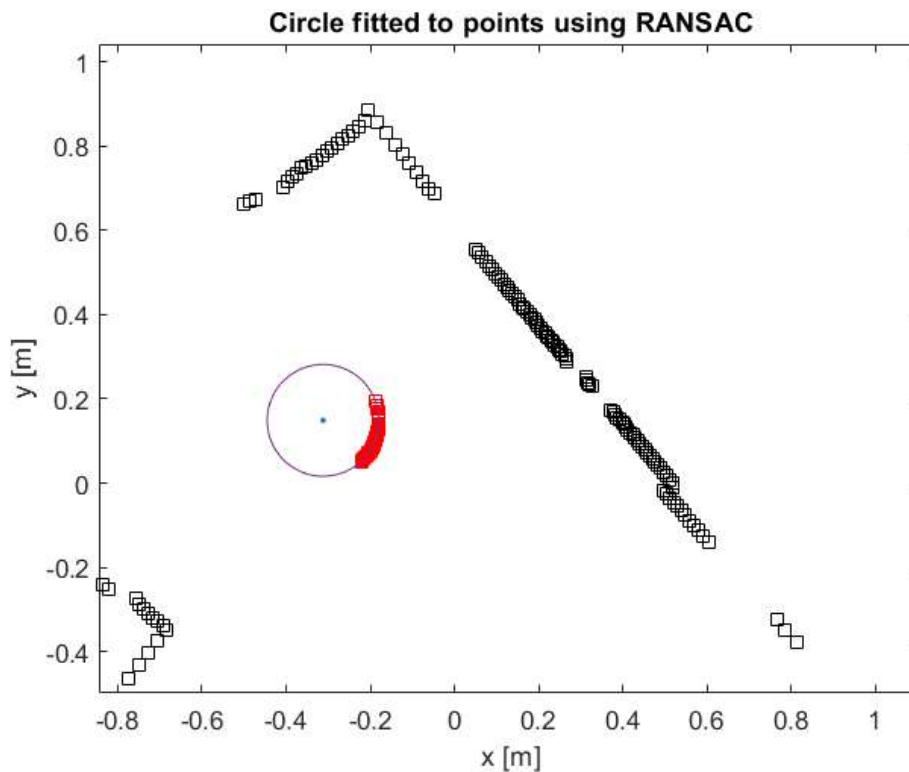
% plot center point
plot(bestCenterPoint(1), bestCenterPoint(2), '.'); hold on;

% plot inliers
plot(bestInlierSet(:,1),bestInlierSet(:,2), 'rs');

% plot outliers
plot(bestOutlierSet(:,1),bestOutlierSet(:,2), 'ks');

% plot circle
fimplicit(circle_equation_explicit,[-4*pi 4*pi]); axis equal;
title('Circle fitted to points using RANSAC')
xlabel('x [m]')
ylabel('y [m]')

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function [center, r] = fitCircle2(seedPoints, known_radius)
    chord = seedPoints(1,:) - seedPoints(2,:);
    chord_length = norm(chord);

    if (known_radius^2 - (chord_length/2) ^ 2) > 0
        midpoint_chord_to_center = sqrt(known_radius^2 - (chord_length/2)^2);
        midpoint_chord = (chord / 2) + seedPoints(2,:);
        orthov = [-chord(2); chord(1)];

        orthov_unit = orthov/norm(orthov); % make unit vector
        orthov_radius = orthov_unit * midpoint_chord_to_center;

        % you will end up with two centers...
        center = [];
    end

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        center(1) = midpoint_chord(1)+orthov_radius(1);
        center(2) = midpoint_chord(2)+orthov_radius(2);
        r = known_radius;
    else
        center = NaN;
        r = NaN;
    end
end

function [px, py, r] = fitCircle3(seedPoints)
    x1 = seedPoints(1,1);
    x2 = seedPoints(2,1);
    x3 = seedPoints(3,1);
    y1 = seedPoints(1,2);
    y2 = seedPoints(2,2);
    y3 = seedPoints(3,2);

    a = (x2-x3)^2 + (y2-y3)^2;
    b = (x3-x1)^2 + (y3-y1)^2;
    c = (x1-x2)^2 + (y1-y2)^2;

    s = 2*(a*b + b*c + c*a) - (a*a + b*b + c*c);
    px = (a*(b+c-a)*x1 + b*(c+a-b)*x2 + c*(a+b-c)*x3) / s;
    py = (a*(b+c-a)*y1 + b*(c+a-b)*y2 + c*(a+b-c)*y3) / s;
    ar = a^0.5;
    br = b^0.5;
    cr = c^0.5;
    r = ar*br*cr / ((ar+br+cr)*(-ar+br+cr)*(ar-br+cr)*(ar+br-cr))^0.5;
end

```

HW 7 Best Fit Circle (Robo)

20.1 1) parametric: $x = R \cos(\theta) + a$
 $R \sin(\theta) + b$

implicit: $r = \sqrt{(x-a)^2 + (y-b)^2}$

explicit: $x^2 + y^2 + Ax + By + C = 0$

2) explicit where $Aw = b$

$$\begin{bmatrix} x^2 & y^2 & 1 \end{bmatrix} \begin{bmatrix} a \\ -b \\ c \end{bmatrix} = \begin{bmatrix} -x^2 & -y^2 \end{bmatrix}$$

3) solve for w by $A^T A w = A^T b$

$$w = A^T b / A^T A$$

4) if you know the radius: choose a center point and create circle of that point's radius then determine how many points fall within a distance of circumference

5) if you don't know the radius: select 2 points and use the distance bet them as the radius

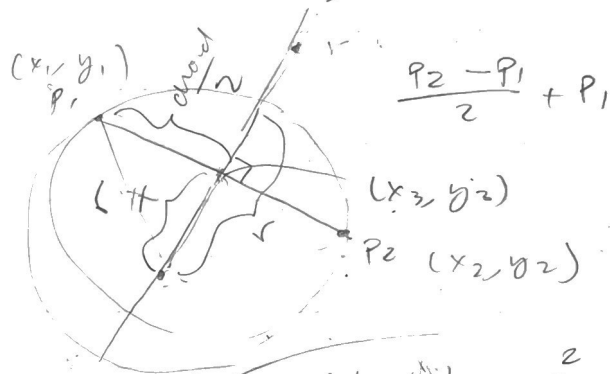
20.2 Pseudocode:

- 1) eliminate zeros, convert to cartesian
- define threshold, define radius
- set # points, # outliers, best candidate for



$$\begin{bmatrix} \sum x_i^2 & \sum x_i y_i & \sum x_i \\ \sum x_i y_i & \sum y_i^2 & \sum y_i \\ \sum x_i & \sum y_i & n \end{bmatrix} \begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} \sum x_i (x_i^2 + y_i^2) \\ \sum y_i (x_i^2 + y_i^2) \\ \sum x_i^2 + y_i^2 \end{bmatrix}$$

- 1) select any 3 points
 - 2) find circle passing through 3 points
 - 3) use it to find inlier/outlier
- 4) given (x_1, y_1) (x_2, y_2) and (x_3, y_3)



$$x^2 + \left(\frac{chom-1}{2}\right)^2 = r^2$$

$$x = \sqrt{r^2 - \left(\frac{chom-1}{2}\right)^2}$$