Chapter 8 Coding Challenge: Panel Methods

Table of Contents

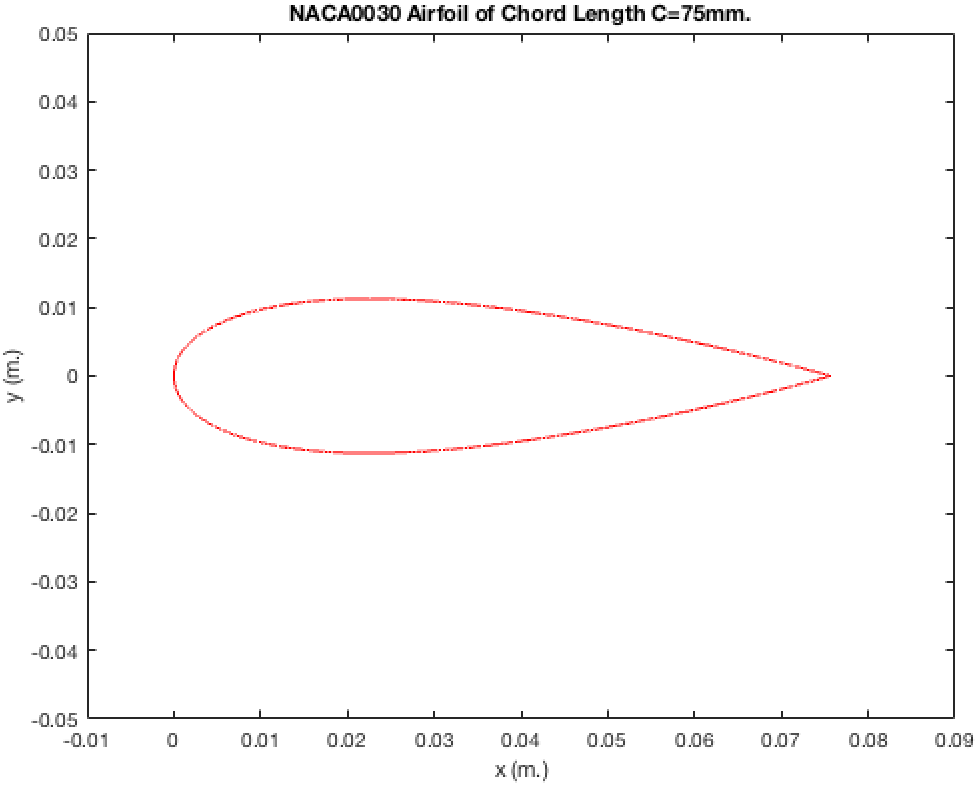
Zach Swain, 4/30/18, All files available at https://www.github.com/zswain/MEEG332

```
clear all
```

Part 1

```
x = [0:.0001:.0757]; %given polynomial doesn't converge to 0 at .075
 but at .0757, use to create finite domain
C = .075;            %given chord length in meters
Z = x/C;             %given zeta parameter
y1 = ((.0225)*((1.4845*sqrt(Z))-(.63*Z)-
(1.758*(Z.^2))+(1.4215*(Z.^3))-(.5075*(Z.^4)))); %given polynomial
 shape
y2 = -y1;            %symmetric airfoil, no camber or angle of attack

figure(1)            %plot airfoil shape
plot(x,y1,'r')
hold on
plot(x,y2,'r')
title('NACA0030 Airfoil of Chord Length C=75mm.')
xlabel('x (m.)')
ylabel('y (m.)')
xlim([-.01 .09])
ylim([-.05 .05])
hold off
```



Part2

```
N = 100;                              %use 100 corners/sides in
 approximate airfoil polygon
x1 = linspace(x(1),x(length(x)),N/2); %top finite x values for N = 100
x1 = x1(1:end-1);                     %as to not overlap points with
 bottom
x2 = linspace(x(length(x)),x(1),N/2); %bottom finite x values for N =
 100
x3 = [x1,x2];                         %finite x values for N = 100
Z2 = zeros(1,(N-1));                  %set up to store new finite zeta
 values
i = 1;                                %define i for iterating
while i <(N-1)
    Z2(1,i) = (x3(1,i))/C;            %define finite zeta values at
 the points of interest
    i = i+1;                          %iterate i
end

y3 = zeros(1,(N-1));                  %set up to store new finite y
 values
i = 1;                                %define i for iterating
while i < (N-1)
    if i < (N/2)
```

```
        y3(1,i) = ((.0225)*((1.4845*sqrt(Z2(1,i)))-
(.63*Z2(1,i))-(1.758*((Z2(1,i)).^2))+(1.4215*((Z2(1,i)).^3))-
(.5075*((Z2(1,i)).^4))));  %define top finite y values with finite
 zeta values
    end
    if i >= (N/2)
        y3(1,i) = -((.0225)*((1.4845*sqrt(Z2(1,i)))-
(.63*Z2(1,i))-(1.758*((Z2(1,i)).^2))+(1.4215*((Z2(1,i)).^3))-
(.5075*((Z2(1,i)).^4)))); %define bottom finite y values with finite
 zeta values
    end
    i = i+1;                             %iterate i
end
```

Part 3

```
L = zeros(length(x3)-1,1);                    %set up to store segment
 lengths
deltaXList = zeros(length(x3)-1,1);           %set up to store dx values
deltaYList = zeros(length(x3)-1,1);           %set up to store dy values
i=1;                                          %define i for iterating
while i < (N-1)
    deltaXList(i,1) = (x3(1,i+1)-x3(1,i)); %define dx per i
    deltaYList(i,1) = (y3(1,i+1)-y3(1,i)); %define dy per i
    L(i,1) =
 sqrt((deltaXList(i,1)).^2+((deltaYList(i,1)).^2)); %define segment
 length per i
    i = i+1;                                  %iterate i
end

L;
```

Part 4

```
mids = zeros(length(L),2);                  %set up to store midpoints
i = 1;                                      %define i for iterating
while i < (length(L))
    mids(i,1) = ((x3(1,i+1)+x3(1,i))/2); %define x values at midpoints
    mids(i,2) = ((y3(1,i+1)+y3(1,i))/2); %define y values at midpoints
    i = i+1;                                %iterate i
end
```

Part 5

```
e_t = zeros(length(L),2);                       %set up to store unit
 tangent vectors
e_n = zeros(length(L),2);                       %set up to store unit
 normal vecotrs
i = 1;                                          %define i for iterating
while i < (N-1)
    e_t(i,1) = ((x3(1,i+1)-x3(1,i))/L(i,1)); %define the x component
 of unit tangent vector per i
```

```
    e_t(i,2) = ((y3(1,i+1)-y3(1,i))/L(i,1)); %define the y component
 of unit tangent vector per i
    e_n(i,1) = -(e_t(i,2));                  %define the x component
 of unit normal vector per i
    e_n(i,2) = e_t(i,1);                     %define the y component
 of unit normal vector per i
    i = i+1;                                 %iterate i
end
```

Part 6

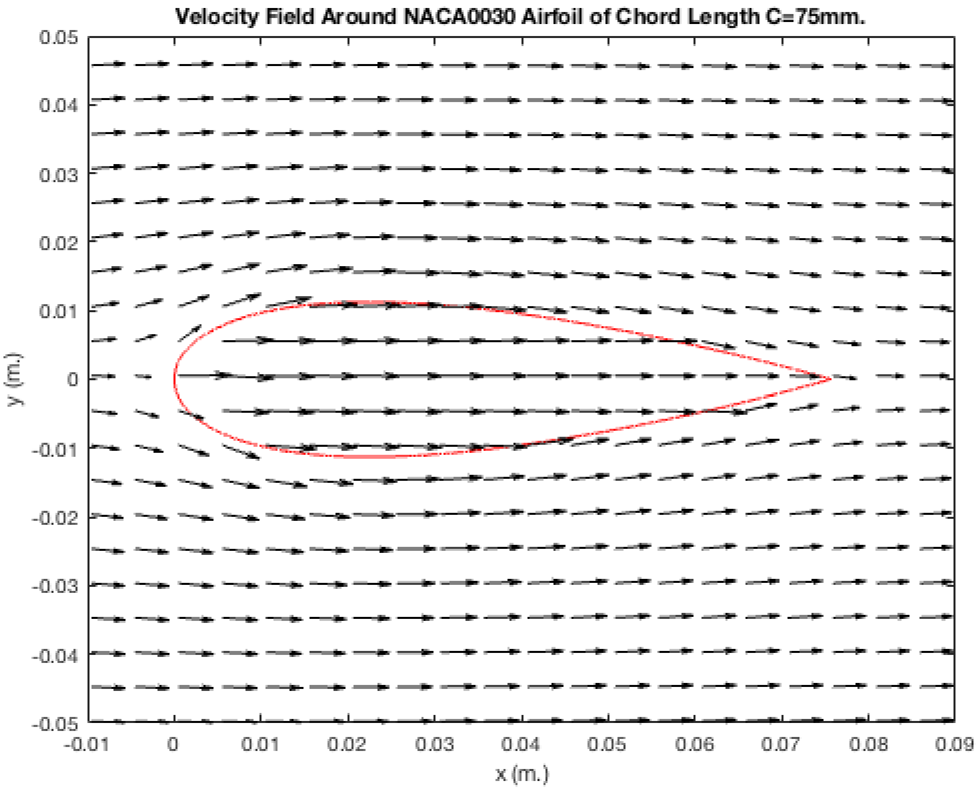
```
N = 100;                                    %N still > 50. only
 emphasizing, no redef
Uinf = 25;                                  %given U infinity in
 meters per second
b = zeros(length(mids),1);                  %set up to store given-
defined b parameter
A_ij = zeros(length(mids),length(mids));    %set up to store given-
defined Aij parameter
for j=1:length(mids)
    b(j,1) = Uinf*(deltaYList(j,1)/L(j,1)); %define b using Uinf, dy,
 and segment length
    for i=1:length(mids)
        if i ~= j
            A_ij(i,j) = (1/(2*pi*L(i,1)*((mids(i,1)-
mids(j,1))^2+(mids(i,2)-mids(j,2))^2)))*((mids(i,2)-
mids(j,2))*deltaXList(i,1)-(mids(i,1)-
mids(j,1))*deltaYList(i,1)); %define Aij in i!=j as per part 6
        end
        if i == j
            A_ij(i,j) = 1/(2*L(j,1));       %define Aij when i does
 equal j as per part 6
        end
    end
end
Q = (A_ij)\b;                               %define Q as per part 6
```

Part 7

```
x4 = linspace(-.1,.1,200);          %set up grid values in x
y4 = linspace(-.1,.1,200);          %set up grid values in y
[xMesh,yMesh] = meshgrid(x4,y4);    %set up meshgrid for velo quiver
u_ij = Uinf.*ones(length(xMesh));   %set up to store u_ij values
v_ij = zeros(length(xMesh));        %set up to store v_ij values
i = 1;                              %define i for iterating
while i <= length(Q)
    r_ij = sqrt((xMesh-mids(i,1)).^2+(yMesh-mids(i,2)).^2);  %define r
 values per i
    u_ij = u_ij+(Q(i,1)./(2*pi*r_ij.^2)).*(xMesh-mids(i,1)); %define
 u_ij values per i
    v_ij = v_ij+(Q(i,1)./(2*pi*r_ij.^2)).*(yMesh-mids(i,2)); %define
 v_ij values per i
    i = i+1;                        %iterate i
```

```
end

figure(2)                         %plot airfoil shape with overlaid
 velo field
plot(x,y1,'r')
hold on
plot(x,y2,'r')
title('Velocity Field Around NACA0030 Airfoil of Chord Length
 C=75mm.')
xlabel('x (m.)')
ylabel('y (m.)')
xlim([-.01 .09])
ylim([-.05 .05])
quiver(xMesh(1:5:end,1:5:end),yMesh(1:5:end,1:5:end),u_ij(1:5:end,1:5:end),v_ij(1:
hold off
```

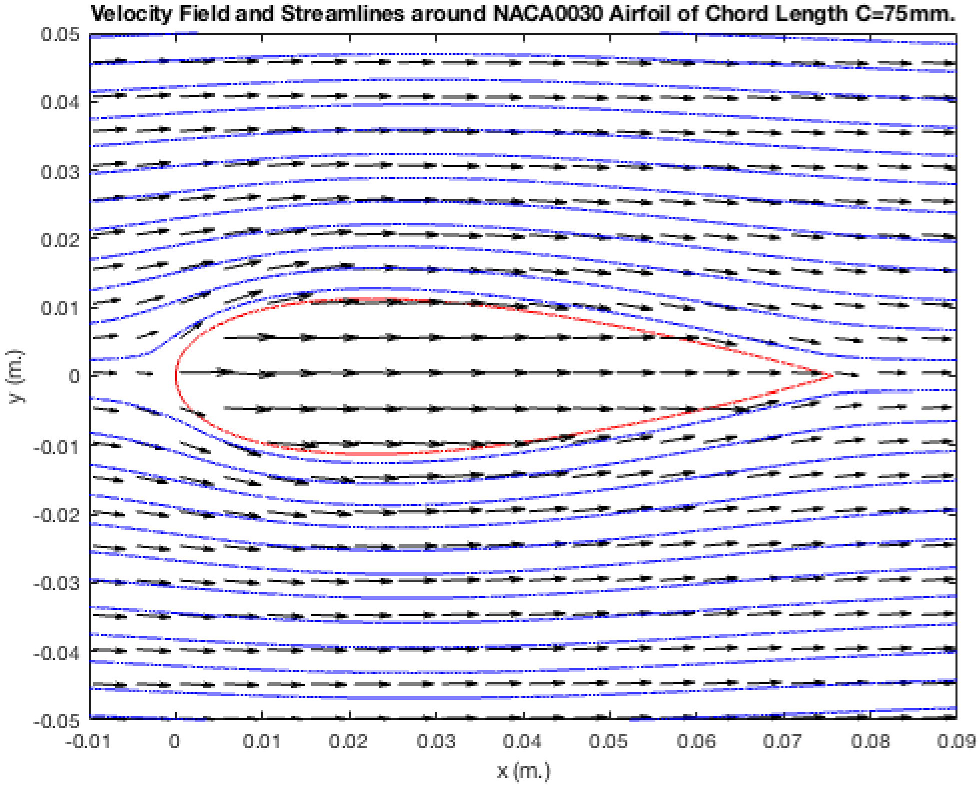


Part 8

```
x5 = linspace(-.1,-.1,50); %set up streamline values in x
y5 = linspace(-.1,.1,50);  %set up streamline values in y

figure(3)                  %plot airfoil shape overlaid with velo
 field and streamlines
plot(x,y1,'r')
hold on
plot(x,y2,'r')
```

```
title('Velocity Field and Streamlines around NACA0030 Airfoil of Chord
 Length C=75mm.')
xlabel('x (m.)')
ylabel('y (m.)')
xlim([-.01 .09])
ylim([-.05 .05])
quiver(xMesh(1:5:end,1:5:end),yMesh(1:5:end,1:5:end),u_ij(1:5:end,1:5:end),v_ij(1:
streamline(xMesh,yMesh,u_ij,v_ij,x5,y5)
hold off
```



Part 9

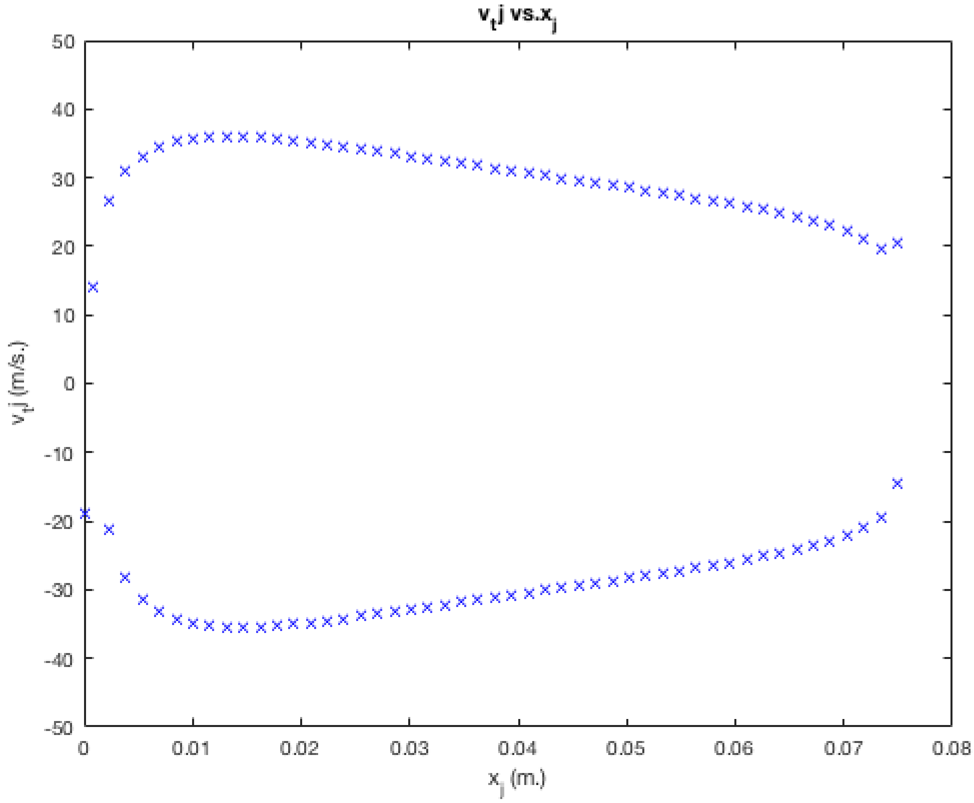
```
v_ijx = Uinf*ones(length(mids),1); %set up to store v_ij x values
v_ijy = zeros(length(mids),1);     %set up to store v_ij y values
v_ij = zeros(length(mids),2);      %set up to store v_ij values

for i=1:length(mids)
    for j=1:length(mids)
        if i~=j
            r_ij = sqrt(((mids(j,1)-mids(i,1)).^2)+((mids(j,2)-
mids(i,2)).^2));  %define r_ij values per i,j
            v_ijx(j) = v_ijx(j)+Q(i,1)./(2*pi*(r_ij).^2).*(mids(j,1)-
mids(i,1)); %define v_ijx values per i,j
            v_ijy(j) = v_ijy(j)+Q(i,1)./(2*pi*(r_ij).^2).*(mids(j,2)-
mids(i,2)); %define v_ijy calues per i,j
        end
    end
end

for i=1:length(mids)
    v_ij(i,1) = v_ijx(i,1);        %store v_ij x values in v_ij
    v_ij(i,2) = v_ijy(i,1);        %store v_ij y values in v_ij
end

v_tj = dot(v_ij',e_t');            %transpose dot to define v_tj as
 given-defined

figure(4)                          %plot v_tj vs x_j as prompted
plot(mids(:,1),v_tj,'bx')
xlim([0 .08])
ylim([-50 50])
title('v_tj vs.x_j')
xlabel('x_j (m.)')
ylabel('v_tj (m/s.)')
```

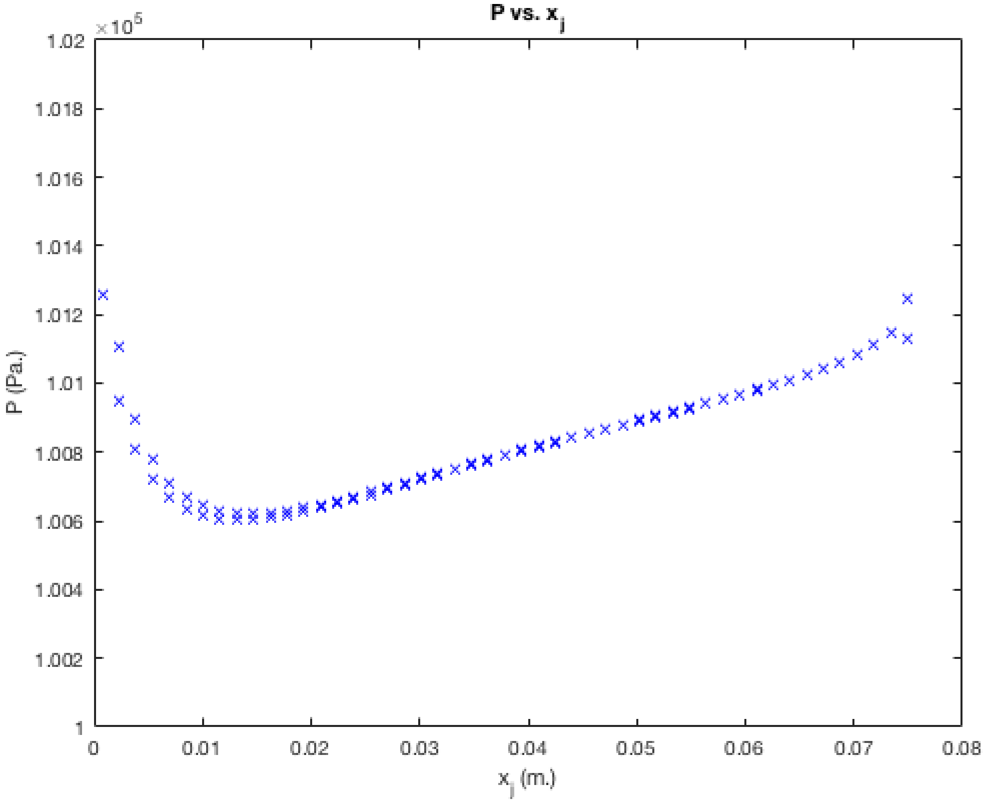


Part 10

```
rho = 1.2;                         %define rho as given
Pinf = 101000;                     %define P infinity as given
P = zeros(length(mids),1);         %set up to store pressure values
i=1;                               %define i for iterating
while i<length(mids)
```

```
    P(i,1) = Pinf+(rho/2)*(((Uinf).^2)-(v_tj(1,i)).^2); %define P per
 i
    i = i+1;                            %iterate i
end

figure(5)                               %plot P vs. x_j as prompted
plot(mids(:,1),P(:,1),'bx')
xlim([0 .08])
ylim([100000 102000])
title('P vs. x_j')
xlabel('x_j (m.)')
ylabel('P (Pa.)')
```



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