Homework 3

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Contents

1 Problem 6.5

Figure 1 shows the required plot.

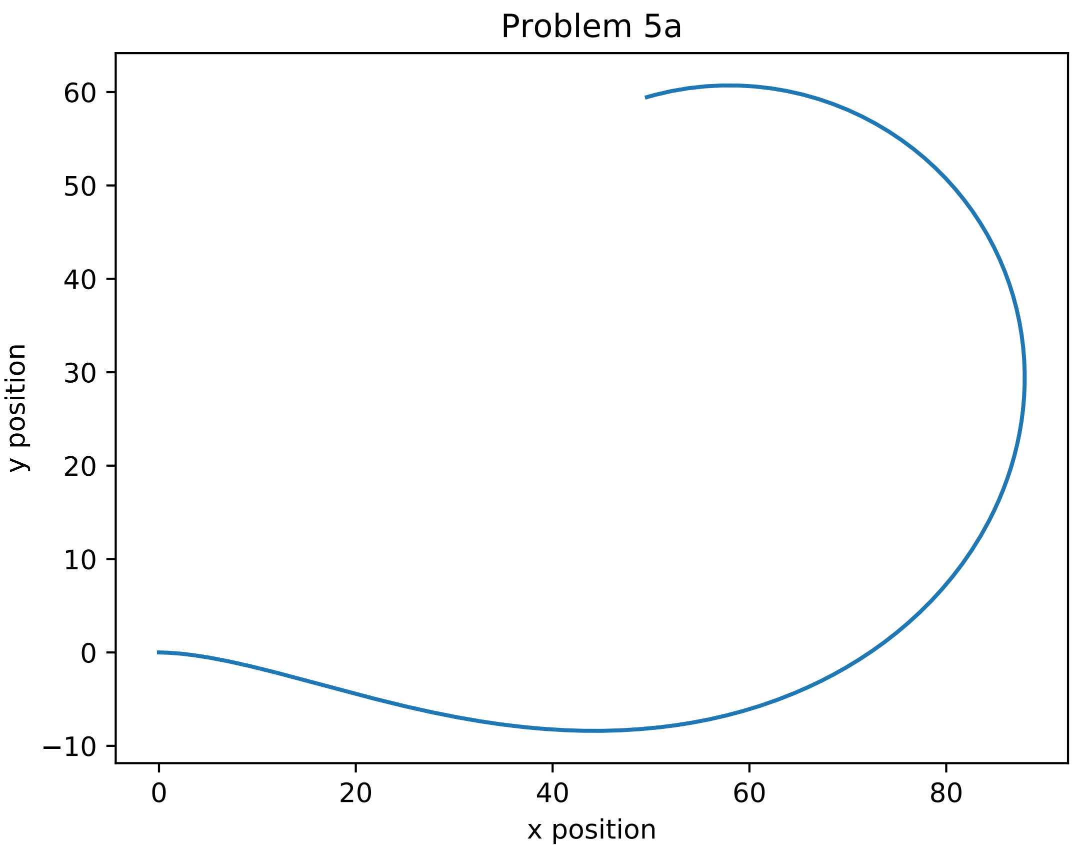

Figure 1: Problem 6.5.a

Figure 2 shows the data points that were saved. The code is as follows:

```
def ddstep(self, xc, yc, qc, r, l, dt, w1, w2):
    xn = xc + (r * dt / 2.0) * (w1 + w2) * np.cos(qc)
    yn = yc + (r * dt / 2.0) * (w1 + w2) * np.sin(qc)
    qn = qc + (r * dt / (2.0 * l)) * (w1 - w2)
    return (xn, yn, qn)

def d():
    runs = 100
    iterations = int(5.0 / dt + 1)
    x = []
    y = []
    for i in range(runs):
        xerr = np.random.normal(mu, sigma, iterations)
        yerr = np.random.normal(mu, sigma, iterations)
        j = 0
        while (t < 5.0 - dt):
            xc, yc, qc = ddstep(xc + xerr[j],
                                yc + yerr[j],
                                qc,
                                r,
                                L,
                                dt,
                                w1 * t * t,
                                w2 * t)
            t = t + dt
            j += 1

        x.append(xc)
        y.append(yc)

    f = open("problem6-5-b.txt", "w")
    f.write('x, y\n')
    for i in range(len(x)):
        x = str(x[i])
        y = str(y[i])
        f.write(x + ' ' + y + '\n')
```

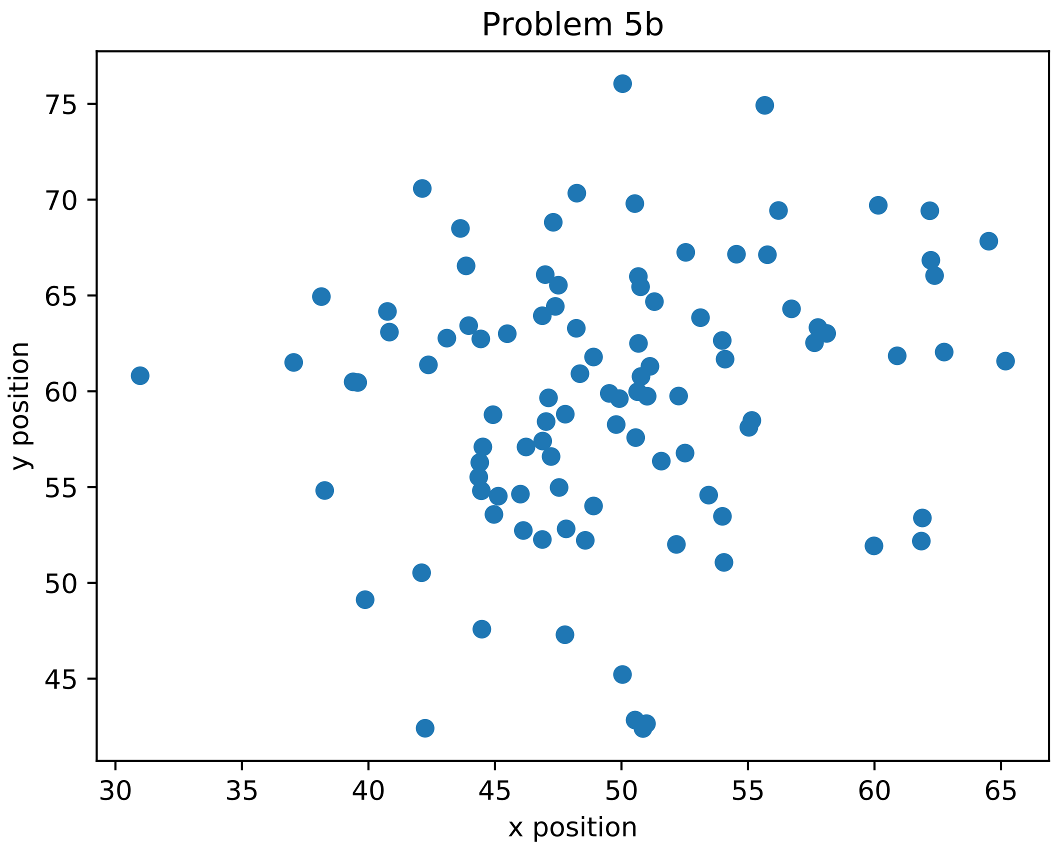

Figure 2: Problem 6.5.b

Figure 3 shows the data points that were saved.

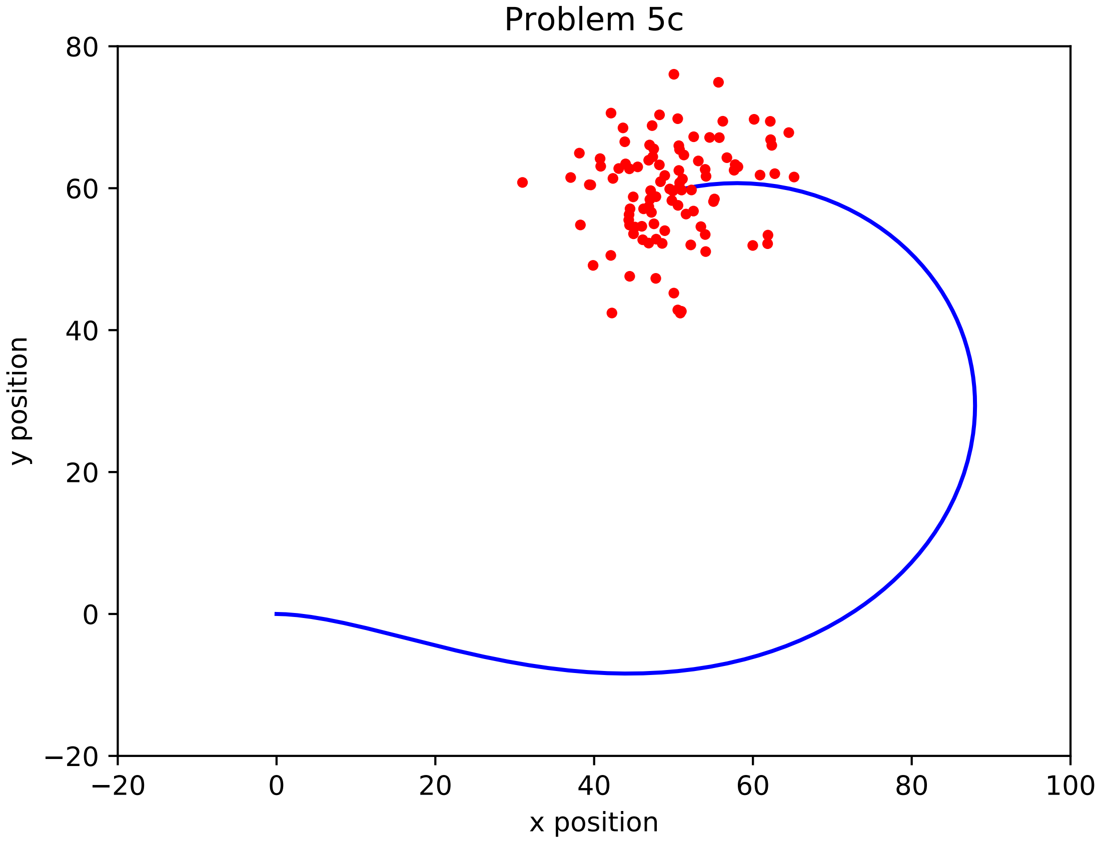

Figure 3: Problem 6.5.c

Figure 4 shows the data points that were saved.

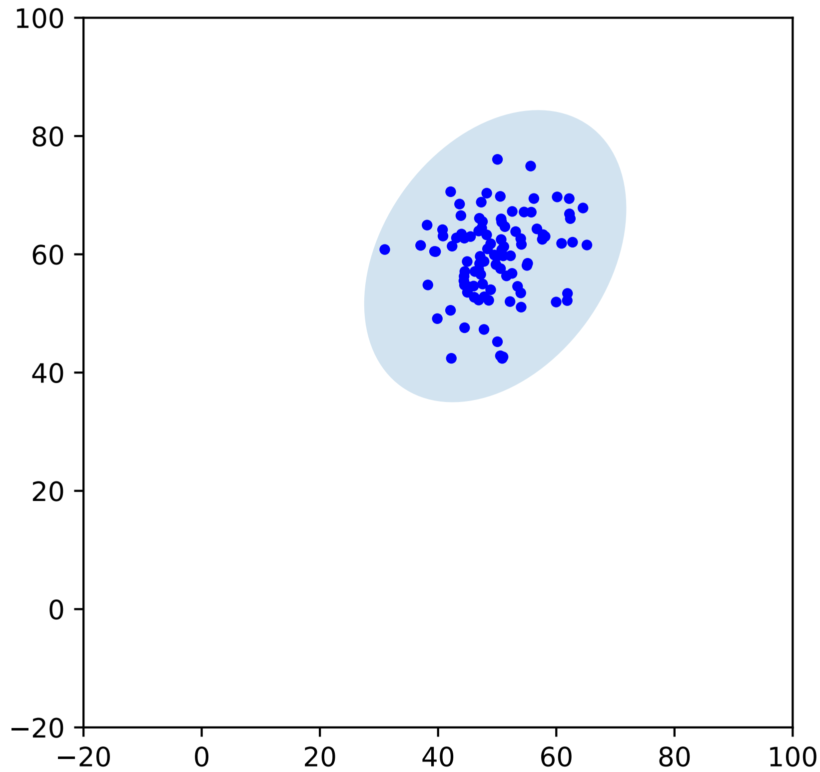

Figure 4: Problem 6.5.d

2 Problem 6.8

For this problem we have to take into account x, y, and θ derivatives with respect to time for the parametric form of an ellipse. We also make the assumption that velocity is constant. Parametric forms of x, y, and θ are as follows:

$$x(t) = 3 + 4cos(t)$$

$$y(t) = 2 + 3sin(t)$$

$$\theta(t) = \pi + \phi(t)$$

The derivatives are as follows:

$$\hat{x}(t) = -4sin(t)$$

$$\hat{y}(t) = 3cos(t)$$

$$\hat{\theta}(t) = \frac{12sec^2(t)}{9tan^2(t) + 16}$$

The only reason $\hat{\theta}(t)$ is differentiable without chaos is because as the robot moves around, the angle is independent of the starting x and y position, so the equation used to calculate $\hat{\theta}(t)$ are as follows:

$$\theta(t) = \pi + arctan\Big(\frac{3sin(t)}{4cos(t)}\Big)$$

You then plug and chug those into the inverse kinematic equations to get wheel speed of each wheel at every time step.