Homework 4

MacMillan, Kyle

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1 Problem 5.2

The meat and potatoes of this problem is in bump and gps callbacks, the rest is filler but can be found here. The environment used is shown in Figure 1.

```
def bumpCallback(self, msg):
    hit_obj = False
    for i in range(len(msg.data)):
        hit = unpack('b', msg.data[i])[0]
        if hit != 0:
            hit_obj = True

    if hit_obj:
        # Turn right
        self.bumps += 1
        self.setVel(0.0, 2.0)
    else:
        self.bumps = 0
        self.setVel(2.0, 2.0)

def gpsCallback(self, msg):
    # we need to move to goal if we are not bumping a wall
    if self.bumps == 0:
        # Wraps deals with the robot if it spins around somehow
        wraps = np.abs(int(msg.theta / (2 * np.pi)))
        theta = np.fabs(msg.theta) - (wraps * 2 * np.pi)
        beta = np.arctan2(self.goal[1] -
                          msg.y, self.goal[0] -
                          msg.x)
        k = 0.25
        alpha = beta - theta
        w1 = 2.0 + k * alpha
        w2 = 2.0 - k * alpha
        self.setVel(w1, w2)
```

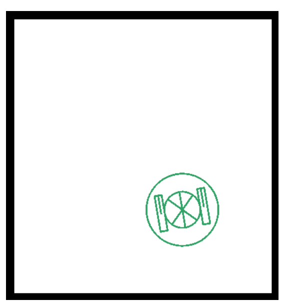

Figure 1: Problem 5.2 Stuck Robot

2 Problem 9

2.1 Problem 9.1

Figure 2 shows the required plot. The robot location is:
$x = 803.84497$
$y = 485.52026$
$z = 517.26977$

With an error of $E = 2720.65$

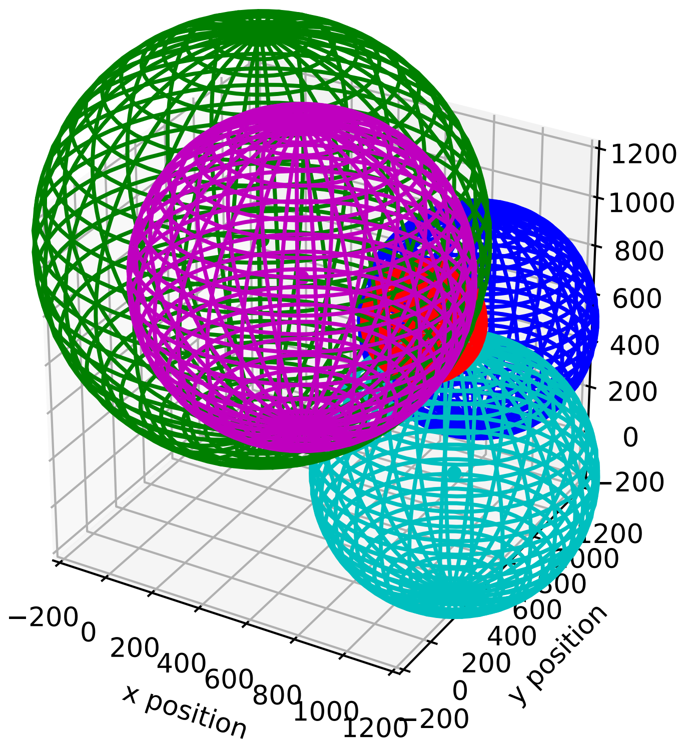

Figure 2: Problem 9.1

2.2 Problem 9.2

$\lambda = c * 10MHz$
$\lambda = 30\ meters$

Assuming phase shift $\theta = 10$ we can plug that into our formula to get

$$D' = L + \frac{\theta}{2\pi}\lambda$$

Therefore $D = \frac{D'}{2} = 0.833333333 + 15k$ where k denotes an integer interval. We make the assumption that L is arbitrarily small compared to the distance travel and is therefore set to 0. If the system has noise we will have to identify a range for $\frac{D'}{2}$, in this case it's $0.825\ to\ 0.841666667 + 15k$. In order to differentiate between 20 and 250 meters we would need a second system at a λ multiple that doesn't overlap before a distance of 250 meters.

3 Problem 10

3.1 Problem 10.1

$f = 0.8cm$
$b = 30cm$
$a = tan^{-}1(\frac{z}{b-x})$
$u = \frac{fx}{z}$

Given the above formulas we can say a is in the range of: $45 < a < 90$ and for u: $3 < u < 45$.

3.2 Probelm 10.2

$e = 10\%$
$v_1 = 0.2cm$
$v_2 = 0.3cm$
$z = \frac{fb}{v_1+v_2}$

Given the above formulas we can say that $f * b = 0.7 * 10 = 7$ but the range of z is dependent on $v_1 + v_2$, or:
$\frac{7}{0.18+0.27} <= z <= \frac{7}{0.22+0.33}$

With zero error we would expect $z = 14$, on the low end we expect $z = 12.72$ and on the upper end we expect $z = 15.56$, leaving an error of 3.7037%.