Localization

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The data we collected for the distances of 10, 20, 30 and 40 centimeters is as follows

Distance (cm)	Measurements	Mean	Variance
10	15 14 13 13 12 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 11 12 12	10.8	2.05
20	18 18 19 19 19 19 19 19 19 19	19.72	.98
30	28 29 29 29 29 29 29 29 29 29	29.82	.92
40	40 40 40 40 40 40 41 41 41 41	40.76	.415

The Equations we found for σ_x^2 and σ_y^2 are

$$\sigma_x^2=\frac{(r_1^2+r_2^2)}{L^2}*\sigma_r^2$$

$$\sigma_y^2=\left(\frac{(1-\frac{x}{L})}{\sqrt{(r_1^2-x^2)}}\right)^2*\sigma_r^2+\left(\frac{r_2*x}{\sqrt{(r_1^2-x^2)}}\right)^2*\sigma_r^2 \quad \text{where} \quad x=\frac{(L^2+r_1^2+r_2^2)}{(2L)}$$

2. From this information we've determined that as $L\Rightarrow\infty$, $\sigma_x^2\Rightarrow 0$ and as $L\Rightarrow\infty$, $\sigma_y^2\Rightarrow c$ where 'c' is some constant, and if $L=(r_1+r_2),\sigma_y^2=0$.

3. So, this position estimate would be most reliable when close to the objects that we have scanned or when we have been calculating odometry for a length of time that would produce a concerning amount of error. Our odometry estimate will be most useful when we have either just begun moving or recently used objects to calculate a position estimate.

4. We could estimate our bearing θ by taking a position estimate for Sparki, then moving forward and taking another position estimate. The differences in the two position estimates should be enough to determine an approximation for our bearing. Another way we could do this is by noting the angle that we see the markers at. With the distance measurements r1 and r2, as well as the recorded angle

between them , we would be able to solve that triangle to get the angle between marker2 and Sparki as seen from marker1. We could then measure the angle from Sparki's servo center, and marker1. Using these angles, we could establish an estimate for bearing.