Group 41
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Data

Number of trial	Falling Edge error (degrees)	Rising Edge error (degrees)
1	1.5	-4.5
2	1.4	3.5
3	-1.3	2.9
4	1.6	-3.0
5	-1.2	-5.8
6	2.5	-1.5
7	-1.8	2.5
8	-2.0	-4.0
9	2.7	3.8
10	-1.5	4.5

Type	Mean (degrees)	Standard Deviation (degrees)
Falling Edge	0.19	1.91
Rising Edge	-0.16	3.97

Observations and Conclusions

1) The falling edge routine had more consistent results than the rising edge. The ultrasonic sensor is likely to give false negatives (i.e. a large spike in reading), which can be mistaken as a rising edge to the robot's algorithm. This does not affect the falling edge routine.
2) The ultrasonic sensor has lower resolution because it scans in a 30-degree cone, can't detect certain geometries, and is vulnerable to noise. On the other hand, the color sensor does not have these weaknesses and scans in a very small point (i.e. high resolution).
3) After running the falling edge routine and having an approximate heading, the robot turns 360 degrees clockwise and searches for two minima's. These two minima's correspond to the distance to the back wall and the left wall, respectively. Using these two values, we can calculate the approximate position of the robot. However, with high noise, it will be hard to differentiate between false minima's and actual minima's, thus this will be more problematic than using the light sensor (which is done in the second part)

Error Calculation using ($\sigma = \sqrt{[(\Sigma (x - x_{avg})^2)/(n-1)]}$)

Falling Edge:

Mean = (1.5+1.4-1.3+1.6-1.2+2.5-1.8-2.0+2.7-1.5)/10 = 0.19
Standard deviation = $\sqrt{}$ [((1.5 ‑ 0.19)^2 + (1.4 ‑ 0.19)^2 + (-1.3‑ 0.19)^2 + (1.6 -0.19)^2+ (-1.2 – 0.19)^2 + (2.5 – 0.19)^2 + (-1.8 – 0.19)^2 + (-2.0 – 0.19)^2 + (2.7 – 0.19)^2 + (-1.5 – 0.19)^2))/9] = 1.91

Rising Edge:

Mean = (-4.5 +3.5+2.9-3.0-5.8-1.5+2.5-4.0+3.8+4.5)/10 = -0.16
Standard deviation = $\sqrt{}$ [((-4.5 +0.16)^2 + (3.5+0.16)^2 + (2.9 +0.16)^2 + (-3.0+0.16^2)+ (-5.8 +0.16)^2 + (-1.5 +0.16)^2 + (2.5+0.16)^2 + (-4.0 +0.16)^2 + (3.8+0.16)^2 + (4.5 +0.16)^2)/9] = 3.97

Further Improvements

1) The robot can use a median filter that takes several measurements and only uses the median value. These way errors in readings will be filtered out.

2) We can use a Light sensor instead of the Ultrasonic sensor. Firstly, the light sensor is not bottlenecked by the speed of sound and can poll more frequently. Furthermore, the resolution is much higher, meaning it can detect finer changes. The light sensor will detect any change on a straight line, which is better compared to the ultrasonic, which detects any change in a 30-degree cone.

3) One method is to rotate 360 degrees and attempt to map out the geometry of the environment. The robot should slowly rotate and collect many data points. Afterwards, the data is used with an algorithm, such as the Least Mean Squares method, to fit the data to a continuous curve. Afterwards we can get the left most point and right most point where the data stabilizes and use these points in our calculation (the curve will be a constant line-> non constant function -> constant line). The corner can be identified as the peak of the non-constant function (getting the derivative of the function will get the corner angle). This Algorithm will have less error as more points are used towards our calculation of the angle as well as that the Least Mean Squares method will discard any spike in the graph (noise).