Lab 4 - Localization

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Data

	Falling Edge (in degrees)			Rising Edge (in degrees)		
Observation	**Odometer**	**Actual**	**Error**	**Odometer**	**Actual**	**Error**
1	0	1	1	0	-2	-2
2	0	-1	-1	0	0	0
3	0	0	0	0	-2	-2
4	0	0	0	0	-1	-1
5	0	1	1	0	0	0
6	0	0	0	0	-1	-1
7	0	0	0	0	2	2
8	0	0	0	0	0	0
9	0	1	1	0	-1	-1
10	0	0	0	0	-2	-2
Mean			0.2			-0.7
Std deviation			0.63245553			1.25166556

Observation and Conclusions

1. The performance of the Falling Edge routine was better than the Rising Edge one. This is because the mean for the Falling Edge was closer to zero than for the Rising Edge. Also the standard deviation was higher in the rising edge routine, which means that it is less reliable. In the falling edge the robot had to detect the presence of a wall, while in the rising edge it had to detect its absence. For rising edge, the robot occasionally detected the corner of the walls as the absence of a wall. We also know that the US sensor occasionally reports an incorrect reading of 225. Since we need to filter these out, it takes the robot time to notice absence of the wall.

2. The light sensor was more accurate than the ultrasonic sensor. This is because the light sensor is placed close to the floor, which reduces noise. It also has its own floodlights, which reduce the effect of ambient lighting. While the ultrasonic sensor must send a signal and then wait for it to

return. Sometimes the signal may not return if it's too close to the object or at a very large angle. It also picks up more noise due to the range of travel.

3. The robot may start facing a wall, or away from one. We turn the robot clockwise until it doesn't see a wall. Then we continue rotation until it detects a wall and then records the angle. The robot continues rotating. We record a minimum distance when the robot is perpendicular to the wall. We add the distance from the center of the robot to the sensor and the minimum distance recorded to find the position on y axis. We continue the motion, wait for distance to increase (corner) and then decrease again (facing the wall). Similarly we record the minima, to determine position on x axis. In this way we can determine the position of the robot. This is quite problematic as the US sensor gets false positives and records a lot of noise in general.

Error calculation

Mean value

Mean = $\boldsymbol{\Sigma (x_n/n)}$

For falling edge: (1 – 1 + 0 + 0 +1 + 0 + 0 + 0 +1 + 0) / 10 = **0.2**

For rising edge: (-2 + 0 + -2 + -1 + 0 + -1 + 2 + 0 + -1 + -2) / 10 = **-0.7**

Standard deviation

Standard deviation = $\boldsymbol{((\Sigma [(x_i - \overline{x})^2]/(n-1))^{(1/2)}}$

i.e. The mean of the sum of squares of the deviation of each sample from the mean

Falling edge standard deviation = $(\Sigma [(xi - \overline{x})^2]/n - 1)^{(1/2)} = (((1 - 0.2)^2 + (-1 - 0.2)^2 + (0 - 0.2)^2 + (0 - 0.2)^2 + (1 - 0.2)^2 + (0 - 0.2)^2 + (0 - 0.2)^2 + (0 - 0.2)^2 + (1 - 0.2)^2 + (0 - 0.2)^2)/9)^{1/2}$ = **0.63**

Rising edge standard deviation = $(\Sigma [(xi - \overline{x})^2]/n - 1)^{(1/2)} = (((-2 +0.7)^2 + (0 +0.7)^2 + (-2 +0.7)^2 + (-1 +0.7)^2 + (0 +0.7)^2 + (-1 +0.7)^2 + (2+0.7)^2 + (0 + 0.7)^2 + (-1 + 0.7)^2 + (-2 + 0.7)^2)/9)^{1/2}$ = **1.25**

Future improvements

1. Rotating robot in a lower speed to avoid slipping and at the same time polling out ultrasonic sensor in a faster speed. In this case, we will get more data points to increase accuracy. If robot slips while navigating, its position changes as well as angle deviates from the expected value. If we have more data points, we can easily filter out the noise by comparing the adjacent data points.

2. Using laser sensor technology we can obtain more accurate and stable results. A laser emitter transmits visible laser light through a lens, towards a target or object. The laser light is reflected

from the surface of the target, where a receiver lens on the sensor then focuses that reflected light, creating a spot of light on the linear imager. The target's distance from the sensor determines the angle the light travels through the receiver lens; this angle then determines where the received light will hit the linear imager. If the target is far away (at the maximum specified range), then the light will fall toward the end of the imager closest to the laser emitter. Alternatively, if the target is at its closest position (at the minimum specified range), then the light will land at the opposite end of the imager farthest away from the laser emitter.
Advantage: small beam footprint, and ability to penetrate air-borne particulates, and distance measure at light speed compare to ultra-sound distance measurement. Ideal for near real time positioning of an object.
Referenced from: http://www.bannerengineering.com/en-US/ljyhs

3. One way is to localize using only the Ultra Sonic sensor as discussed in Observations and Conclusions point 3. Another way is to use a combination of Rising Edge and Falling Edge routines. i.e. we do not change direction once the robot has detected a wall (falling edge). Instead we continue in the same direction until the robot detects no wall (rising edge). These two angles are used in the calculation. This method is prone to errors of the rising edge routine.