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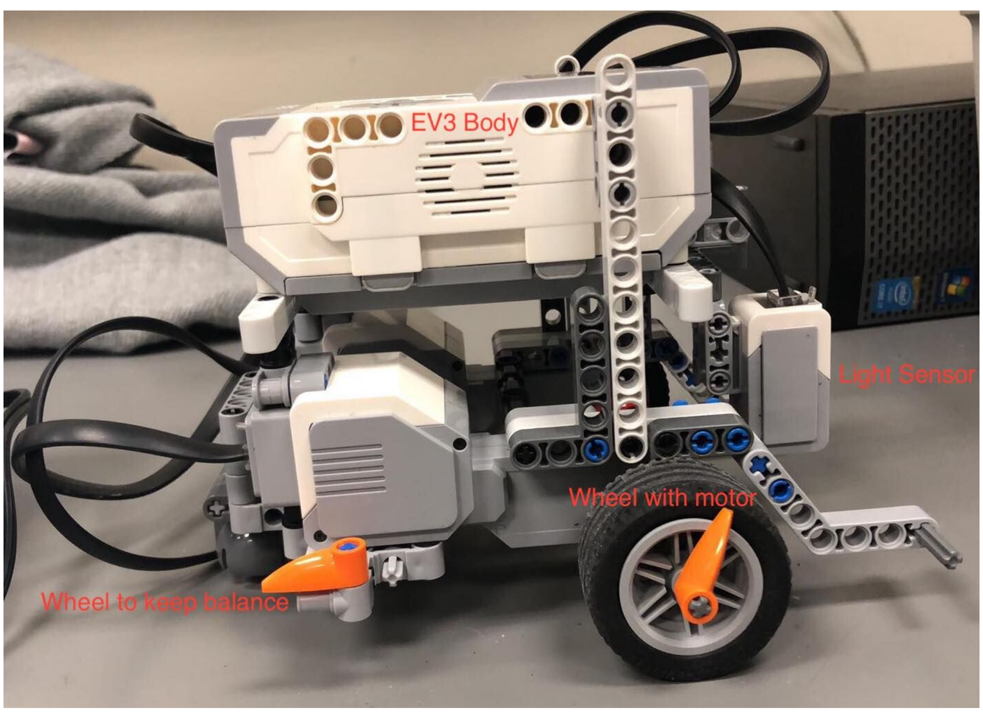
Report Lab 2- Odometry

1. Design evaluation

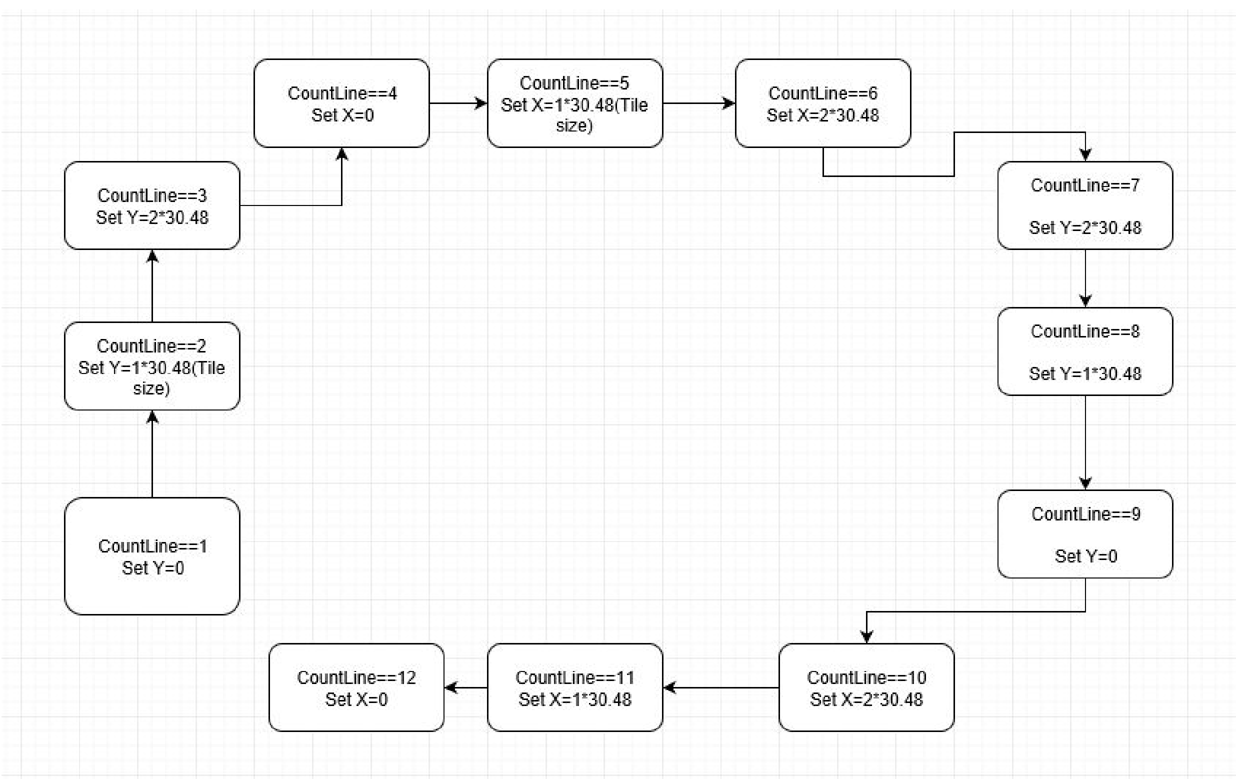
Hardware Design: The robot this time is the same as the one used in lab 1 consisting of two wheels which provided movement and a third wheel at the back for balance. This time around, the only difference is the absence of the ultrasonic sensor. In place of the ultrasonic sensor, this time we used a light sensor.

The light sensor is placed as close to the floor as possible and is attached very close to the body and at the middle of the robot. The distance between the two wheels were kept the same.



Software Design: The odometer class was used to implement the equations used to calculate the change in distance and angle found by using a tachometer count. The tachometer count basically gives us the change in angle in the two wheel of the robot. The instantaneous position of the robot was found by counting the number of wheel rotations. The diameter of a wheel is known and this was used to calculate the circumference which was then used to measure the distance travelled by the robot (the getTachoCount method was used to do this).

For the odometer correction class, the precise length of the square blocks was utilized. Using a line counter and theta values, the axis in which the robot is currently traveling in is accurately calculated giving the precise distance the robot has travelled at any instant.



Test data & analysis:

$\varepsilon = \sqrt{((X - Xf)^2 + (Y - Yf)^2)}$

The following table shows our results for Odometer:

Trial	X at start	Y at start	X odometer (cm)	Y odometer (cm)	X actual (cm)	Y actual (cm)
1	0	0	0.33	0.43	4.5	5.1
2	0	0	0.57	0.64	6.0	4.5
3	0	0	0.22	0.64	12.8	9.8
4	0	0	0.45	0.21	3.3	1.8

Trial	X at start	Y at start	X odometer (cm)	Y odometer (cm)	X actual (cm)	Y actual (cm)
5	0	0	0.63	0.64	2.1	5.1
6	0	0	0.71	0.65	5.3	6.3
7	0	0	0.96	0.11	1.2	4.0
8	0	0	-0.11	-.75	5.3	4.0
9	0	0	0.45	-.98	2.1	3.5
10	0	0	0.64	-.65	7	8.2

The following table shows the mean and standard deviation:

Position	Mean µ	Standard Deviation σ
X	0.342691	-0.853
Y	0.542312	.0.524

The following table shows our values for Odometer with correction:

Trial	X dist init	Y dist init	X Odometer	Y Odometer	X Actual	Y Actual
1	0	0	-8.2	-12.2	-7.3	11.6
2	0	0	-12.4	-12.9	-14.5	-13.1
3	0	0	-13.9	-8.4	-15.1	-12.6
4	0	0	-12.1	-10.4	-7.2	-11.2
5	0	0	-11.8	-10.1	-11.2	-8.9
6	0	0	-6.2	-4.2	-13.5	-13.0
7	0	0	-7.8	-8.9	-6.3	-9.3

8	0	0	-9.2	-12.0	-7.9	-8.9
9	0	0	-11.5	-11.2	-8.2	-9.1
10	0	0	-9.4	-9.6	-11.4	-12.0

Mean and standard deviation for Odometry with correction:

Position	Mean μ	Standard Deviation σ
X	-10.43542	3.1124
Y	-11.24324	4.5321

Test analysis:

Euclidean error distance (Odometer):

Trial	Error
1	3.2354
2	6.4353
3	4.2345
4	6.3565
5	3.4546

Mean:4.4335

Standard Deviation: 1.6682

6	5.3243
7	4.2345
8	2.2495
9	6.3532
10	2.4625

Euclidean error distance (Odometer with correction):

Trial	Error
1	2.4512
2	3.7638
3	4.6325
4	3.7282
5	4.4572
6	2.7631
7	4.3234
8	3.3425
9	4.2453
10	2.2452

Mean:3.7132

Standard Deviation: 3.5425

Q: How does the mean and standard deviation change between the design with and without the correction? What causes this variation and what does this mean for the designs?

A: From the results we have obtained, it is clear that the standard deviation is closer to 0 when the odometer with correction is used. Accuracy is much greater when the odometer with correction is used. The results from the odometer with correction are hence also more reliable.

Q: Given the design which uses correction, do you expect the error in the X direction or in the Y direction to be smaller?

A: From the results we can see that the expected error in the Y position is smaller. The drift factor might play a role in this. We find the final value of X before the final value of Y; this lead to errors due to drift to be more in the case of X than for Y.

Observations and Conclusions

Q: Is the error you observed in the odometer, when there is no correction, tolerable for larger distances? What happens if the robot travels 5 times the 3-by-3 grids' distance?

A: The error is not tolerable for larger distances. The error will only build up as the robot travels further and further, if it travels 5 time the distance, the robot will deviate greatly. This occurs mainly due to the wheels skidding on the surface.

Q: Do you expect the odometer error to grow linearly with respect to travel distance?

A: Yes, the odometer error can be expected to grow linearly with respect to the distance it travels. The main reason for this error is the skidding of the tires which leads to the odometer not recording the correct theta values. The further the robot travels the more chance that the tyres skid and the more chances of error building up. The robot cannot account for this slip either. SInce the robot is travelling on a similar type of surface, the occurrence of a slip will be quiet regular, so the error will grow linearly.

Further improvements

Q: Propose a means of reducing the slip of the robots wheels using software.

A: In general if the wheel speed is low, the chances of slipping will be less. But if we are looking to travel at the same speed, an algorithm could be implemented to recognize if the wheels are skidding. Sensors can also be utilized to constantly scan the distance being travelled and adjust the wheel speed accordingly.

Q: Propose a means of correcting the angle reported by the odometer using software when the robot has two light sensors.

A: We can place one sensor at either side. When crossing a line the time difference of when the two sensors cross a black line can be noted, the angle can be calculated and the wheel speeds can be adjusted accordingly.

Q: Propose a means of correcting the angle reported by the odometer using software when the robot has only one light sensor.

A: Using one light sensor we can find the time taken to cross a number of black lines in a row. Then the distance between the lines can be compared to the time taken to go from one line to another and using simple trigonometry the error in angle can be found.