Lab Group: 43

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ECSE 211: Lab 1 Report

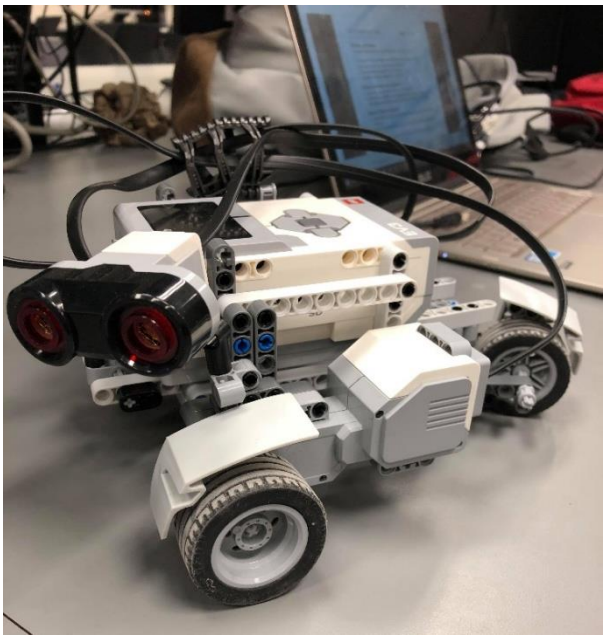
Section 1:

Our robot consists of four (4) main parts, two (2) motors to which we connected wheels, one (1) ultrasonic sensor, and one (1) EV3 LEGO brick. To add more stability and for better rotation, we added a wheel back of the robot which can rotate 180 degrees allowing sharp turns in curves or to maintain distance. The motors are on each side of the brick, and the sensor is attached to the side of the brick above the motors at an angle of forty-five (45) degrees and all the wires are clipped so that they are not touching the wall. Both the motors and the sensor are connected to the brick with wires, the motors are connected to the output of the brick and the sensor is connected to the input.

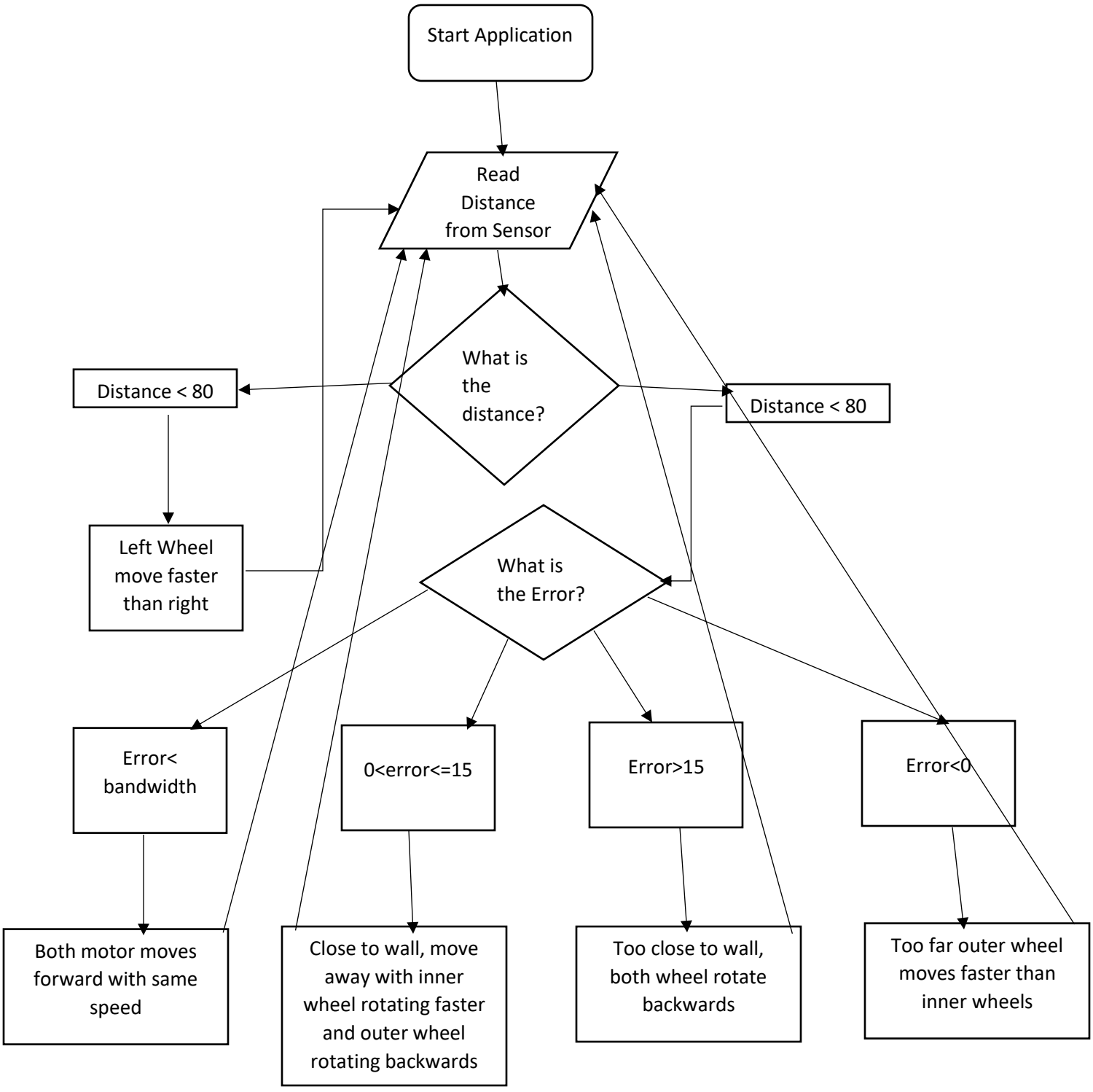
Bang-Bang is a simple controller that is based on the distance between the robot and the wall. There are two (2) different turn speeds per direction so four (4) in total. The closer the robot is to the wall, the faster it will turn away from the wall and vice versa. The further the robot is to the wall the faster it will turn towards the wall and vice versa. When the robot is at a good distance from the wall (bandcenter +- bandwidth) the robot moves forward in a straight line.

The P-type uses a slightly more complicated code where the speed of the turn will depend on the distance from the wall. It does that by subtracting the calculated distance with the band Center and the further the result is from zero (0), the faster the turn will be in any direction. Each motor is of course set to a different speed depending on which direction the robot should turn in.

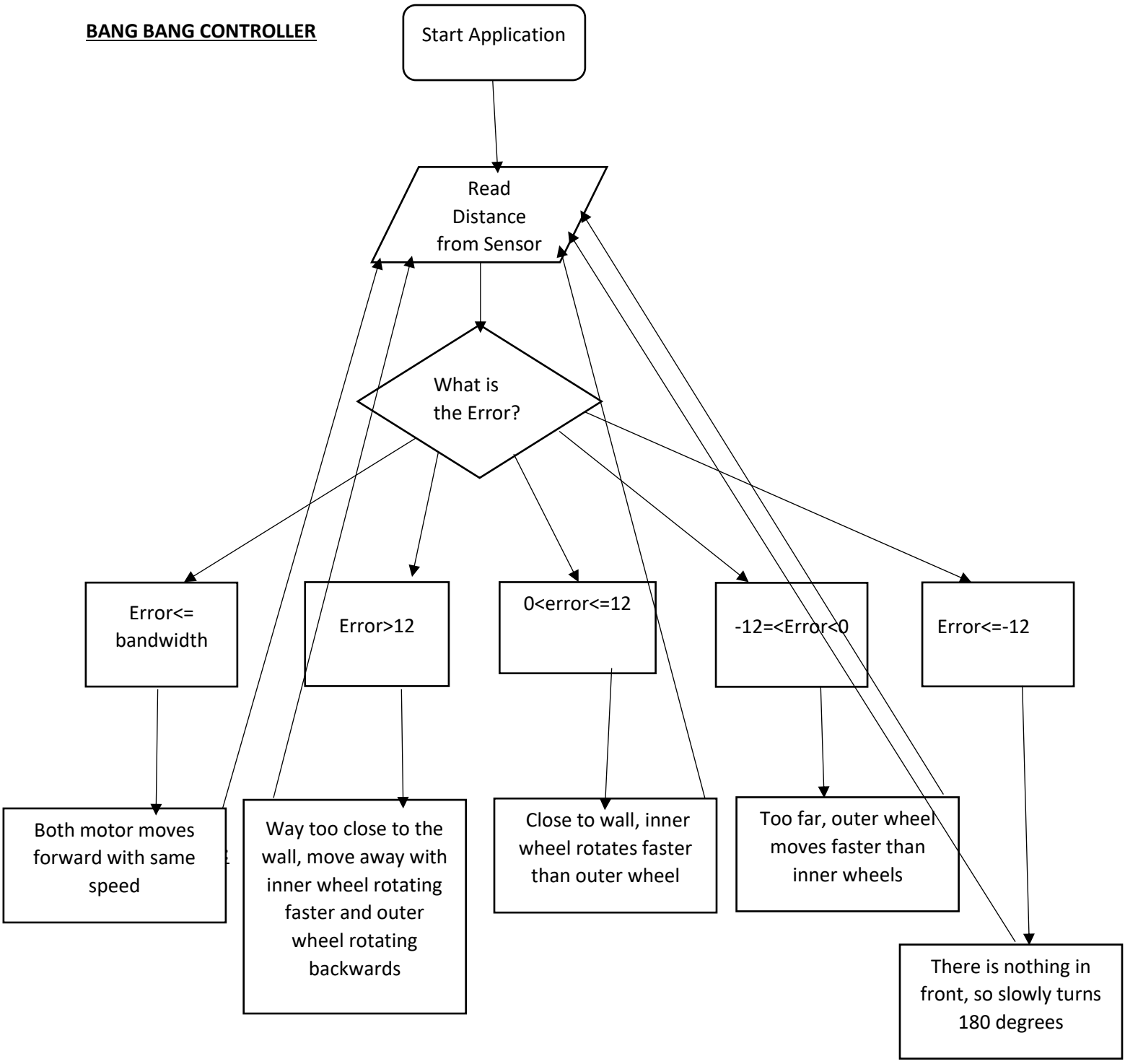
We also use a filter to get more accurate values of the distance and not consider the errors that the sensor might input. We also implemented that filter in Bang Bang.



P CONTROLLER



BANG BANG CONTROLLER



SECTION 2:

P Controller: (test done by changing the pathway)

Test No	Bandcenter	Complete Lap	Observations
1	32	Yes	The robot completes 2 laps out of 3. In 2nd lap it hits the wall due to gap at the turns. The robot was slower and turns were not smooth and more oscillations
2	33	No	The robot fails the lap. In first lap it detects the gap after the turn and acts well but in the next 2 lap it fails to detect the gap and crashes. The ride was not smooth and with lot of oscillations
3	32	No	The robot fails the lap as it could not turn a sharp corner and it oscillated more

Bang Bang Controller: (test done by changing the pathway)

Test No	Bandcenter	Complete Lap	Observations
1	32	Yes	It was a pretty smooth with few oscillations and the robot completed the laps flawlessly.
2	34	No	The robot fails to complete the lap. It fails to detect a gap after a turn. So when the sensor detects, it's too late and as it turns it hit. There were few oscillations.
3	33	No	The robot failed the test. When its too close to the block it doesn't move backwards to rectify. The movement was smooth.

P Controller: (test done by changing the constant lower and higher than default which was 4)

Constant Value	Bandcenter	Complete Lap	Observations
2 (lower than default)	32	Yes	There were small but smooth oscillations. The correction was small and slow due to low constant value. However it completed the lap.
6 (higher than default)	32	Yes	There were more oscillations and the robot was faster in turns. However it touches the wall but quickly rectifies itself

Section 3:

A lower constant resulted in slower, smoother turns while the higher constant caused the turning speed to be faster. The higher constant also caused the robot to oscillate more.

When the robot is close to the band center (within the bandwidth), the robot goes in a straight line (not necessarily parallel to the wall). Once the robot goes outside the bandwidth, the P controller allows small and smooth turns while the bang bang controller corrects the robot's path with a pre-set turning speed.

Yes, the robot is allowed to go a bit wider than the band center before trying to rectify itself. In our case, the bandwidth was 2 cm which means that the robot could be 2 cm to the left or to the right of the band center.

Section 4:

We would use the P controller as it resulted in a smoother movement. Sometimes, the oscillation of the bang bang controller causes the robot to be unable to recognize a gap and then crashes in the wall. The P controller was also more reliable for that reason.

The ultrasonic sensor did indeed produce a lot of errors. Most of them were false negative and often occur after a 180° turn around a block. We think it was caused by the sensor being too slow to update and failed to detect the wall even if it was really close. It might have also been due to a fast turning speed causing the sensor to struggle to get accurate readings. The filter was able to mitigate the impact of those errors and in most cases, prevent the robot from crashing. False positives were much less frequent and we are still not sure why they occurred. We think they were caused by interference or noise and they were not filtered. Fortunately, they were not frequent enough to cause problems.

Section 5:

To improve performance of the robot, we could:

- Firstly, we could tweak the sensor's polling rate through trial and error to see if it would prevent the sensor from picking up wrong data. We could also use a moving average filter to replace the filters that we are given. Another improvement could be to modify the filter to allow the robot to wait a bit more before turning which would allow us to reduce the impact of bad data from the sensor. We could also add two (2) more motors parallel to the two (2) existing ones and give the new ones the same instructions as the old ones (respectively to their sides of the robot) to add more stability to the robot. This would also be a physical improvement.
- Tweaking, through trial and error, the angle at which the sensor points would allow the robot to see the corners earlier and not crash when going towards a wall. Adding a second sensor at 90° would allow the robot to get more accurate reading from the wall. Lastly, using a better sensor would help getting more accurate data reliably.
- The PID controller would be an alternative controller to use which uses integrals and derivatives in order to be more accurate.