ECSE 211: Wall Following Lab Report

Ezz Aboulezz 260 677 463
Oscar Deceus 260 744 646

Group 57

Design Evaluation:

Hardware: The robot has a simple design. It consists of 2 motors with attached wheels at the front of the EV3 brick and is supported at the back by a metal sphere. The sensor is placed on the left side of the brick at an angle of approximately 45 degrees. The assembling of the robot was mostly driven by several videos and ideas found online.

Software:

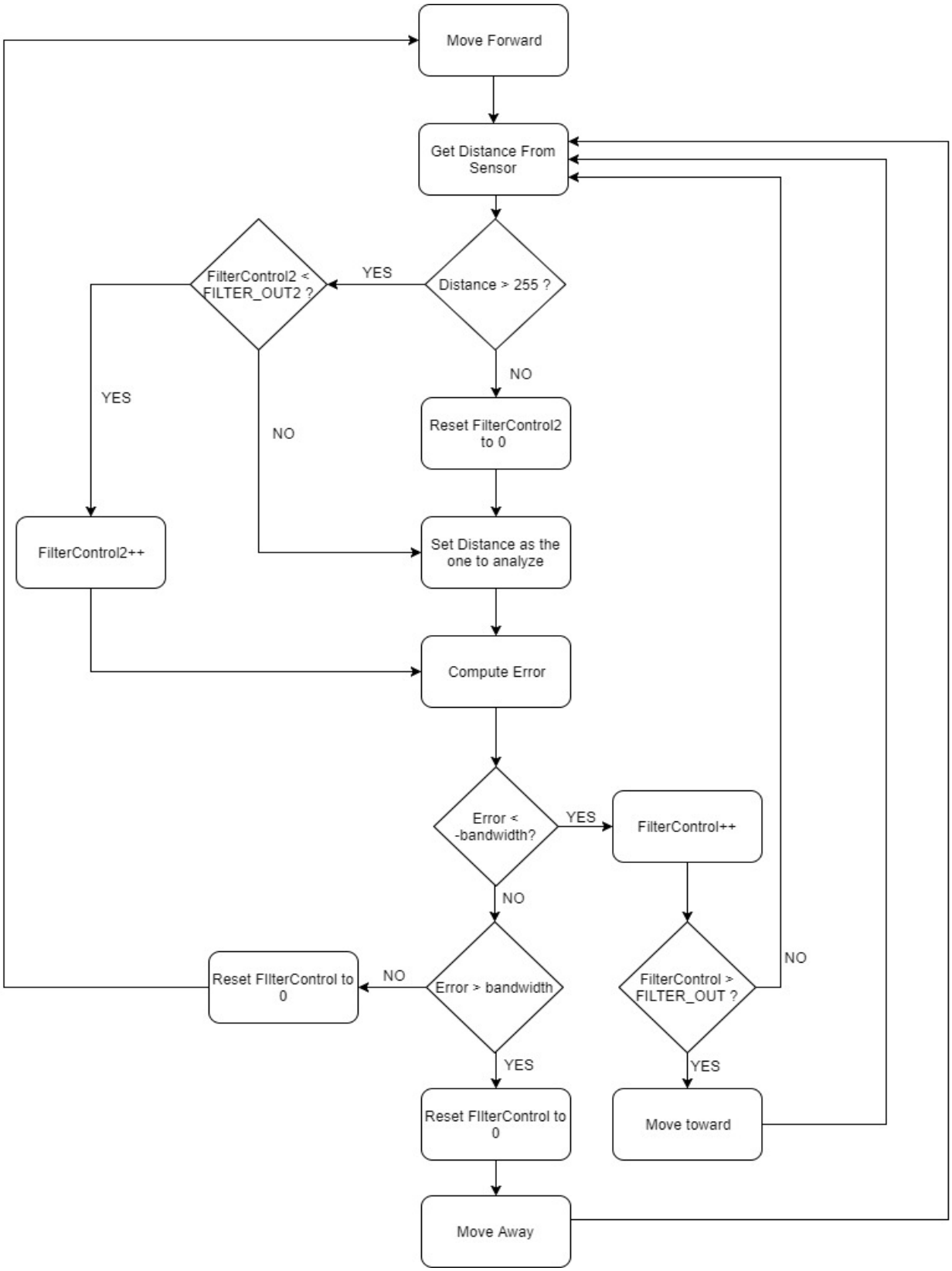
Bang-Bang Controller

The Bang-Bang Controller implemented a wall following system. First, it calculated the error (difference between bandcenter and distance from the wall) and chose accordingly the speed of the wheels to either move away, towards the wall or just keep moving forward. It checked whether the robot was close to or far from the wall in order to determine which wheel needed to increase in speed and which needed to decrease. We also had a counter that dealt with gaps. When we receive a 'too far' reading instead of moving towards right away we waited for 19 counts to account for the possibility that maybe this was just a gap and not the end of the wall.

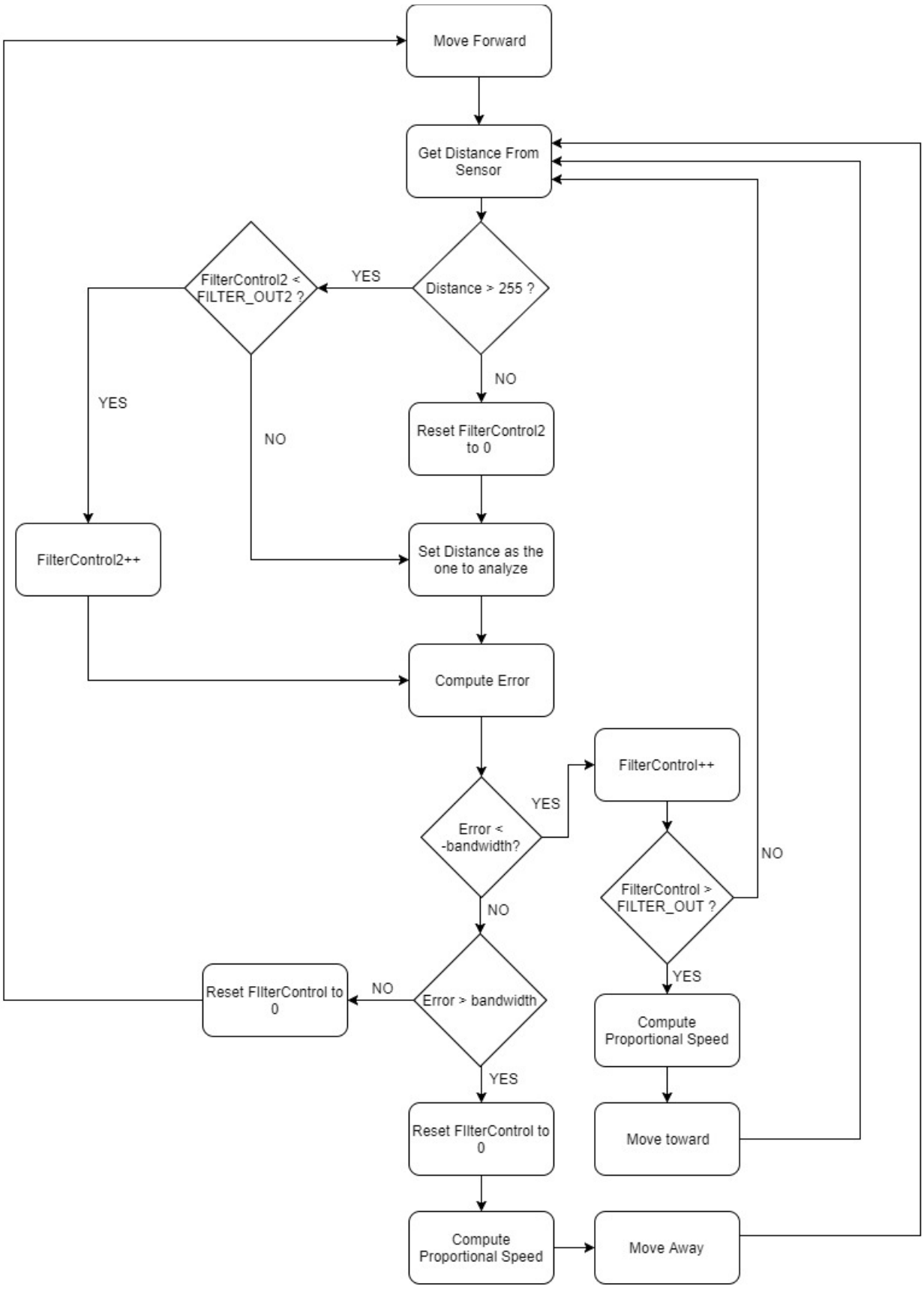
P-Type Controller

The P-Type Controller was very similar to the Bang-Bang Controller except that the speed of the wheels was changed to a value proportional to the error rather than a fixed change. In other words, the speed that was added or subtracted was always a function of the error. This was done by increasing/decreasing the speed by a factor that consisted of the error multiplied by a proportional constant. That was the main difference between both controllers.

Bang-Bang Controller Flowchart:



P-Type Controller Flowchart:



Test Data:

Bang-Bang Controller:

Trial Number:	1	2	3
Wall Touches:	0	1, skimmed	0
Band Center:	40 cm, it gets bigger around corners	40 cm, it gets slightly bigger when at a corner	40 cm, mostly maintains that distance
Oscillation	Many oscillations when at a corner and few when moving straight	Oscillations at the convex corners but fewer at the concave ones	Few oscillations, mainly occur during turns

P-Type Controller:

Trial Number	1	2	3
Wall Touches	0	0	0
Band Center	40 cm maintained	40 cm maintained	40 cm maintained
Oscillation	Fewer oscillations compared to B-B	Some oscillations after taking U-turns	Few oscillations throughout and deals with corners better

Test Analysis:

- Does the Bang-Bang controller keep the robot a fixed distance from the wall?

The Bang-Bang controller failed to keep the robot at fixed distances from the wall. When we tested the robot we found that it can only stay within the bandwidth when it is moving forward. Otherwise the distance oscillates around the desired band-center, moving farther at U-turns. This is due to two things in the controller. The fact that we only fix the speed of the wheels by a constant amount made it oscillate often. Also, the sensor often gave us poor readings.

- Does your design oscillate from one side of the band to the other? Describe how this occurs for each controller.

Bang-Bang Controller: This controller causes the robot to oscillate from one side of the band to the other and often goes beyond the bandwidth due to the fact that even if its not that far away, it still corrects itself with a fixed speed that makes it get too close to the wall. It takes time for the robot to realize that it overcorrected and now that it's too close it moves away from the wall. This behaviour became increasingly occasional when making sharp turns or U-turns due to the limited vision angle provided by the Ultrasonic sensor as sometimes the sensor gets caught at a corner, sending a wave and not receiving it back.

P-Type Controller: This controller also makes the robot oscillate from one side of the band to the other. This oscillation could be due to incorrect readings by the Ultrasonic sensor. However, the oscillations that occur are not very far from the bandwidth compared to the oscillations of the Bang-Bang controller. It is noticeable that even through the oscillations, it follows a smooth path and does not visibly zigzag as in the other controller.

Observation & Conclusion:

- Several errors we encountered with the Ultrasonic Sensor:
Sensor could not be fixed at 45 degrees exactly. Also, the motor would start and the robot would move before the sensor starts detecting distances. A lot of the readings were wrong which meant we had to deal with sensor inaccuracy. Sometimes obstacles would not return a signal for the sensor to read and sometimes other obstacles such as other robots and students walking around the lab would interfere with the robot's readings.

- How we tried to solve some of these issues:
We thought we could tape the sensor as to not allow it to rotate. We also made the motor very slow in the initialization to solve the problem of the motor starting before the sensor. To deal with the wrong readings we had to implement a filter to remove the huge readings we got as well as implement a method that takes the average of five values, which helped the robot deal with the small inaccuracies. We also realized that we should only use the bricks provided, as other polished surfaces would make the robot act unpredictably. Finally we would not use the track when more than one robot was being tested as other robots greatly affected the US readings.

We did not get any false positives during testing and development meaning there was no detection of objects that were not there. However, we failed to detect the bricks sometimes and the only explanation we thought of was that maybe the block was not uniform and interfered with the returning signal.

Further Improvements:

We could design the robot to be more compact to make sure that undistributed weight does not affect it. Clean the wheels as to avoid slip. We can also use 2 sensors instead of 1 for a greater vision angle and better accuracy. We can also store the readings of the Ultrasonic Sensor for analysing its behaviour.

Additional Controller Types:
- PID (Proportional-integral-derivative controller). This gives a correction based on the derivative and the integral creating less oscillations and a smoother path.