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My first design is to use sonar sensor to find the gallery between each obstacle. Because my sonar sensor on the right, so first I let my robot make left turn. Then go forward and record some data which loop run time(*data1*) and how far distance box(*data2*) until the light sensor find the black line or sonar sensor find the gallery(value > 250 cm), make right turn go forward(*data2* - 20 cm) let robot close the obstacle area with record loop run time(*data3*); if didn't find the gallery until the black line, fast go back to start position (go back *data1* times), then still go back to find the gallery; When my robot close the obstacle area, make left turn again, small move back (0.05s) to find the edge between gallery and obstacle(first data > 25 cm ; second data < 25 cm), then go 1 second and let left motor make right turn, now my robot can pass the obstacle; Let my robot go forward (*total loop run time* “which the run time from the left side to the right side” - *data3* “which the run time from the left side to obstacle area”). Theoretically, my robot is passed the obstacle and reach other side, make some turn record some data, then go forward or go back to find the colour paper by light sensor, but I never successful reach other side by some reason. Sometime robot can't walk a straight line, and sometime robot can't make real 360 degree turn. In some case, the sensor work didn't very well, so the data not very accurate form sensor, have few error when i comparison two data. I think the program is right when I design in my mind, but when my robot run it, there are many bug can't solve.

After the first fail, I change my design. I need some reference to help my robot run have accuracy, so I change whole program. First make right turn, then go forward until the black line and make left turn. I use the same program with form lab2, and let my robot go forward follow the black line until bump sensor back value. Now my robot is in obstacle area, so the main job for my robot is to find the correct gallery and get through. Make left turn let robot parallel to the obstacle, then let robot have small move for each time go other black line; in this part, there are two gallery in obstacle area, so I need to find out which one my robot can get through. I put if loop in this part, if the sonar sensor back value less than 20 cm still move, if greater than 20 cm , than still move 2 second to check the value form sonar sensor, if still greater than 20 cm, make right turn and go pass the obstacle; if less than 20 cm, robot have small move to find next gallery then pass the obstacle. After pass the obstacle, I still need my robot back to black line, so make the right turn then go forward until black line. Use the same program form lab2, follow the black line to find the same color paper. After find the same color paper, make left turn initialize the robot same as start. Run the same program again. At this time, my robot don't have good efficiency, because the robot need move the maximum route to finish all job. Look like the robot have used three sensor, but the bump and sonar sensor didn't use a lot, most of time the light sensor can replace them. If I have three light sensor, I can use one to check there is nothing in front of robot to find the obstacle area, and use other one to find the correct gallery by some value greater than 25 %. This design not very good, because this nxt robot don't have real robot's performance.

In my mind, the robot is a very precise machine. If I ask the motor run 1 cycle, each time the movement must same; the two side wheel have same radius, theoretically, in the same power the robot must go a straight line, if with some friction or resistance the error must keep very small. In this case, If I do not have guide lines(like black line) to help robot to move in my way, the robot can't use any sensor if the value from sensor is big, because the data will anomalous change when robot move. If in theory inside to done this case, very easy and efficient, just need

to calculate 5 to 6 datas and compare, and also can let motor run faster.

In the real life, we need to consider the machine wear rate by friction and irresistible resistance. Just like robots in the Mars, I believe them can't go straight line very well. Robot needs have some wireless navigation to help self, not the guide lines(like black line), such like GPS, compass, triangulation, or some straight line sonar, etc. Robot can use those navigation to correct the data. If robot have compass or triangulation, it will be much efficient to complete this case, and I think don't need bump sonar for this case.

Final, I try few efficient way to complete this lab, and first few program I believe robot too much, so fail every time. And then I think may be our robot too old, so I got new one in weekend, but the issue is same as old one. I can't find universal wheel in my packaging, so my robot use four-wheel drive; two additional rear wheel gave the robot a larger friction, so the new one issue more than old one. After few fail, I think I may need use same program from lab2 and lab3 to improve my second design, use lab2 to close the obstruct, and use lab3 to get through the obstruct.