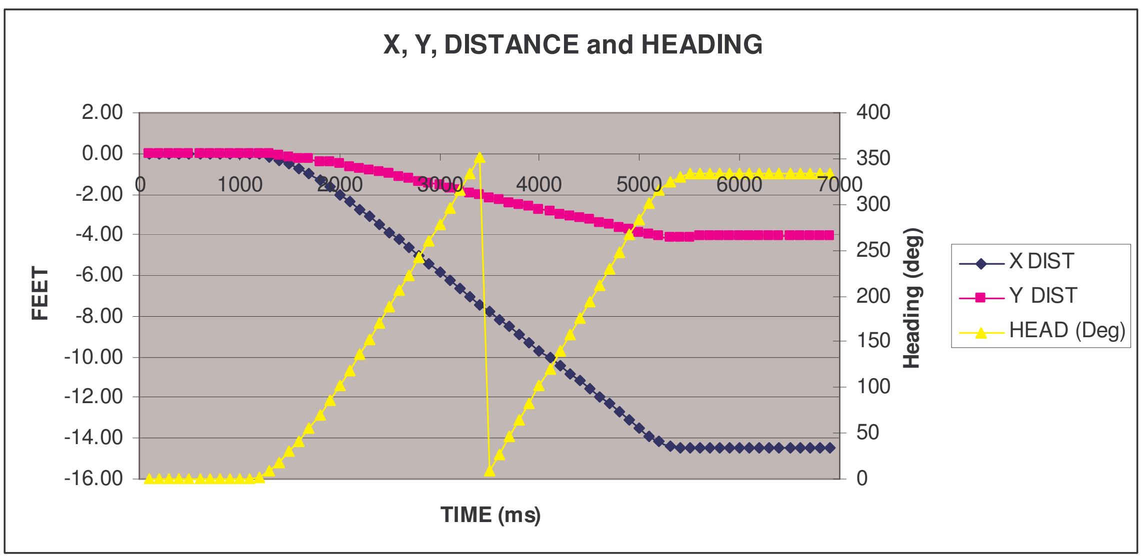
TEAM 116 Test Report
Revision A – with some more insights

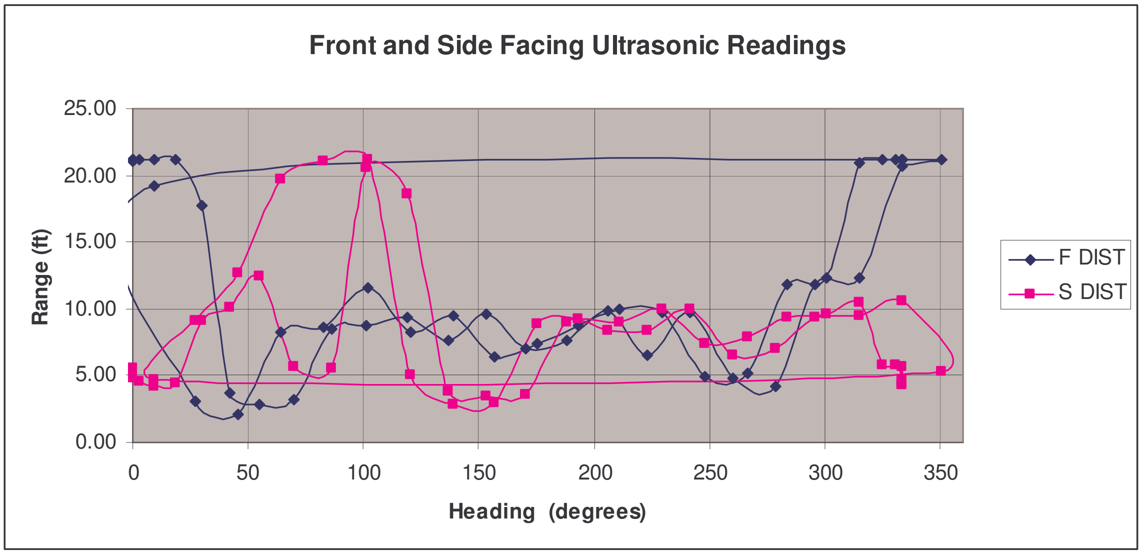
Major changes include:
Observation that center of rotation is not in the middle of the robot
Estimated ultrasonic beam angle
Logging printf() statements may be contributing to the gyro falling behind for the rotation case.

This data was taken in the drama room 2/23/08. The robot was run in autonomous mode and executed a rotate only command of magnitude 50 for 4 seconds for the first trial and a linear movement command of 50 in the positive Y direction for 3 seconds. Two ultrasonic detectors were mounted on the robot. A forward facing sensor on the front right corner and a left side facing sensor approximately mounted on the mid left side.



Full Circle

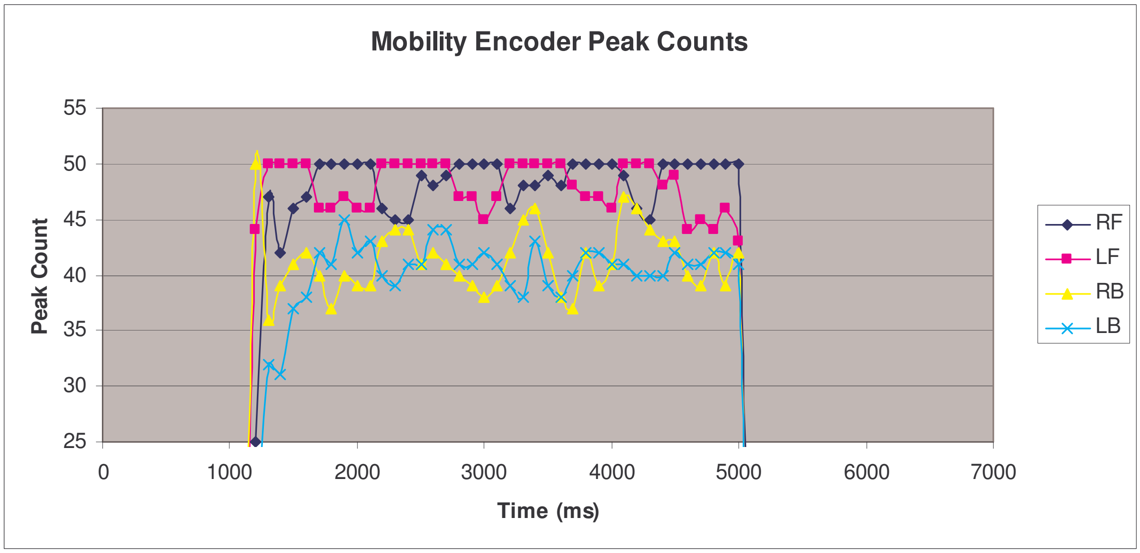
Here the robot was commanded to rotate only. It almost made it two revolutions in 4 seconds with a PWM value of 50 out of 127 – although the PWM setting is not linear with speed. You should be able to back out how far off the rotation axis the X and Y wheels are from this data.



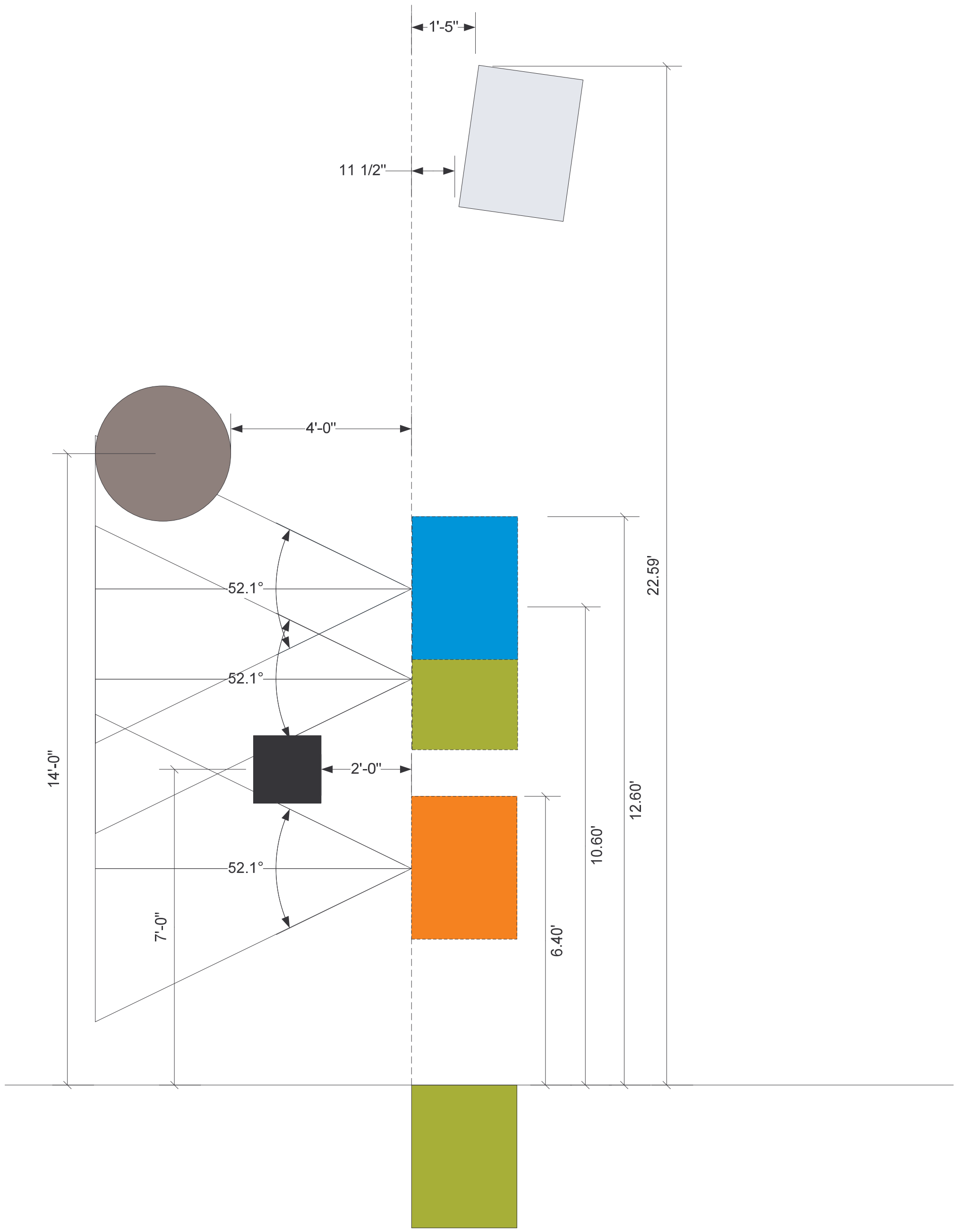
Full Circle

The ultrasonic range readings do not correspond 100% for both passes. They are roughly 90 degrees out of phase. And there was movement of people in the room while the robot was spinning. I wonder if the offset (especially the forward looking sensor from 270 to 360 degrees is due to the gyro not keeping up with the rate since the second pass data lags the first pass data. The logging printf() statements caused 10 or so delays in processing the gyro data and these may have caused the loss of integrated angular rate information. This experiment should be repeated with the printf() string shortened until no loading errors are recorded.

The following plot shows the relative Mobility Encoder latched peak counts during the test. I didn't include this data the first time because it can be very misleading if you don't understand how the mobility encoders work. As a quick explanation, each of the encoders count ticks until the first encoder reaches the PWM setting value for the fastest wheel before the PWM values are adjusted to compensate for different motor outputs, gearbox loss, etc. For this test, all 4 wheels are set to a "speed" of 50. When the first encoder reaches a count of 50 the counts for all encoders are latched or saved and these latched values are what was recorded. This information gives the relative speed of the 4 wheels. The code attempts to make the relative encoder counts match the relative calculated PWM settings and in this case it is trying to make all the wheels spin at the same rate. Right now the adjustment is limited to 25 out of 127. Anyway, the actual output PWM values were not recorded (and this would be good data except the printfs are already too long) but if they were you would see that the back wheels are receiving more power or higher PWM settings even though they are spinning slower. So what does this mean? I think that because the battery is closer to the back wheels the center of rotation of the robot is also more toward the back wheels and they can't be made to spin as fast as the front wheels!

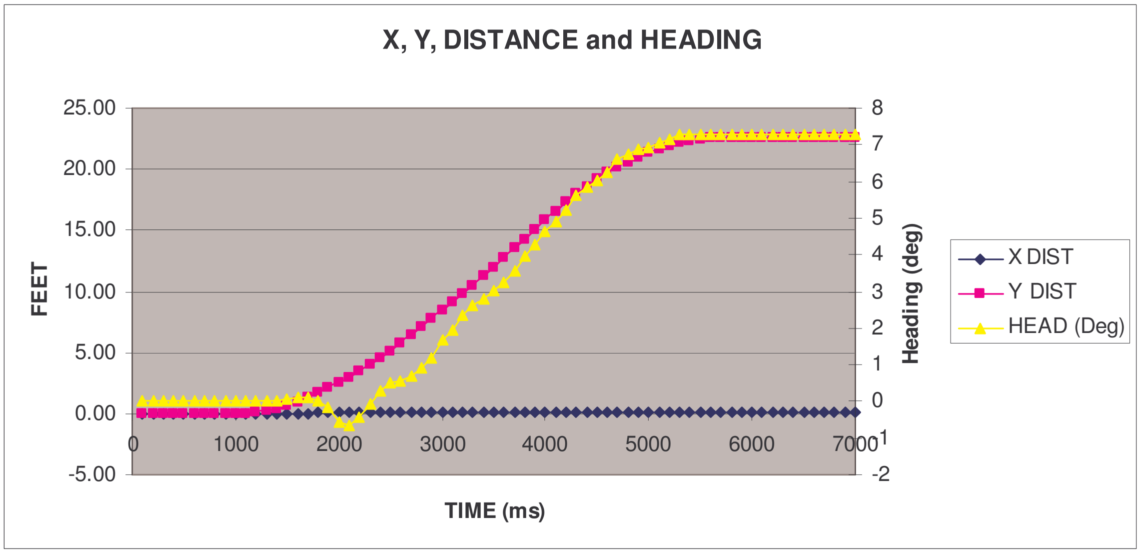

Mobility Encoder Peak Counts
Peak Count
Time (ms)
55
50
45
40
35
30
25
0
1000
2000
3000
4000
5000
6000
7000
RF
LF
RB
LB

Linear movement "find" box test

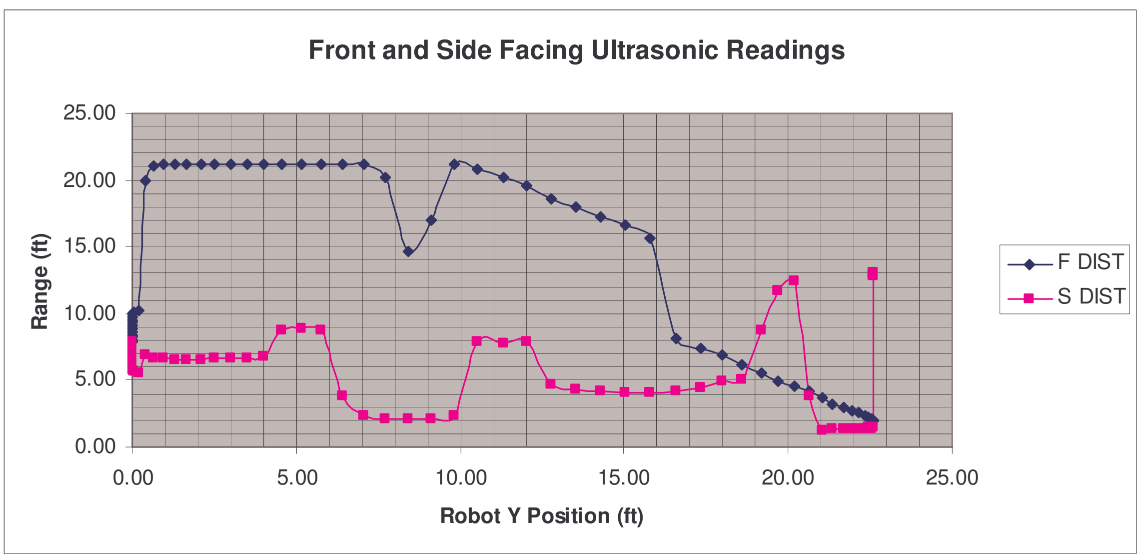


Linear movement "find box" setup

Ultrasonic beamwidth estimated to be approximately 52 degrees from experimental data. It would be a good idea to get some better data. The green, orange, and blue boxes represent the robot at different positions during the test. It should be noted that the robot followed a fairly straight path until the motors were shut off at the end of the run.



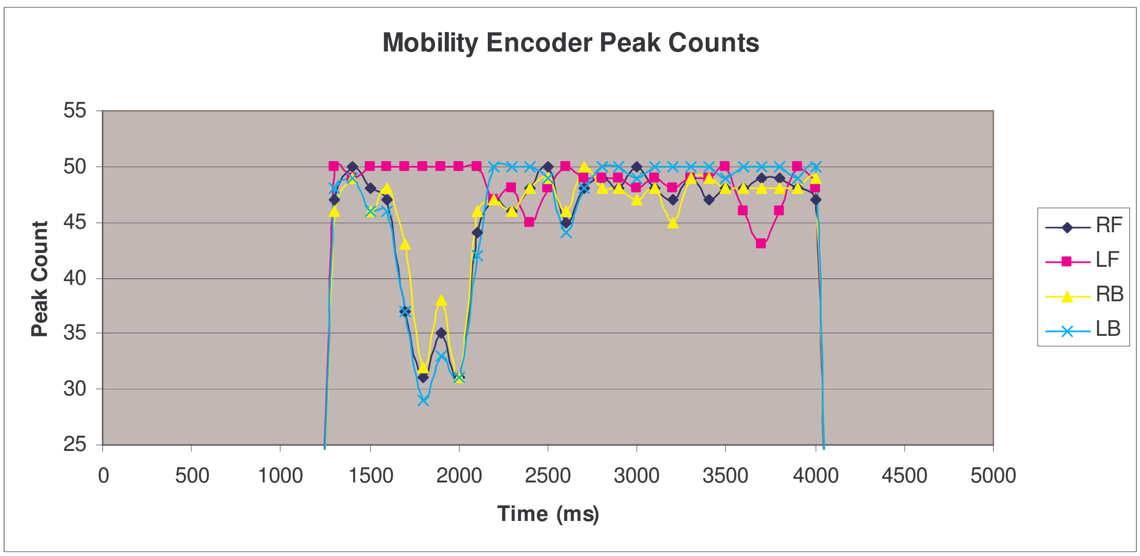
This is the result of the odometry wheels for the linear run. The measured distance for this run was 22'8" whereas the predicted Y distance from the Y odometry wheel was 22'7.44" – almost perfect. The measured X displacement however was 11.5" but the predicted X displacement from the odometry wheel was only 1.68" showing that the wheels do not provide accurate displacement information when the direction of motion is almost parallel with their axel. I think this makes sense given the roller pattern on the wheels. The final heading was about 7 degrees which may be close. The front of the robot was 17 inches from being on track. I forget how long the robot is but if it is 36" long the angle should have been 8.68 degrees. ATAN((17-11.5)/36). There is an interesting wheel speed dip for 3 out of the 4 wheels at 2 seconds corresponding with the angle change. Not sure what caused that.



Linear Ultrasonic Range Measurements

For this run the forward looking detector was pointed toward the outside wall of the drama room. I think what the blue line shows is that the range is maxed out at 21 feet

and begins to fall once the robot is within 21 feet of the wall. The dip at 8.5 feet is probably a box on the corner of the carpet. The range drop at 16.5 feet is the part of the carpet that is still rolled up. The robot stopped 2 feed from the roll. The side facing sensor was facing to the left (shop). The dip from 7 to 10 feet is an 18" box (the black boxes in the drama room) that is two feet from the robot. This shows that the beam width of the sensor is quite wide. The dip from 13 to 19 feet is the round gray trash can that was placed 4 feet from the robot's left side. I'm not sure what the sensor picked up 21 to 22.5 feet. I think that because the beam width is so wide that if the ultrasonic sensor is to be used to detect the end of the center wall in time to turn it needs mounted with a forward facing angle.



These are the peak counts for the find box case. See the encoder count explanation above. It would be a good idea to record the PWM values as well as the count information to see if the adjustment can be improved.

The following is an excerpt from the ultrasonic sensor data sheet. Our data seems to be pretty close to what is predicted here. The important thing to note is that these detectors find the closest thing in their beam width, even a ¼ inch dowel 4 feet away. Need to verify if we are using the EZ1.

Beam Characteristics

People detection requires high sensitivity, yet a narrow beam angle requires low sensitivity. The LV-MaxSonar®-EZ1™ balances the detection of people with a narrow beam width.

Sample results for measured beam patterns are shown below on a 12-inch grid. The detection pattern is shown for;

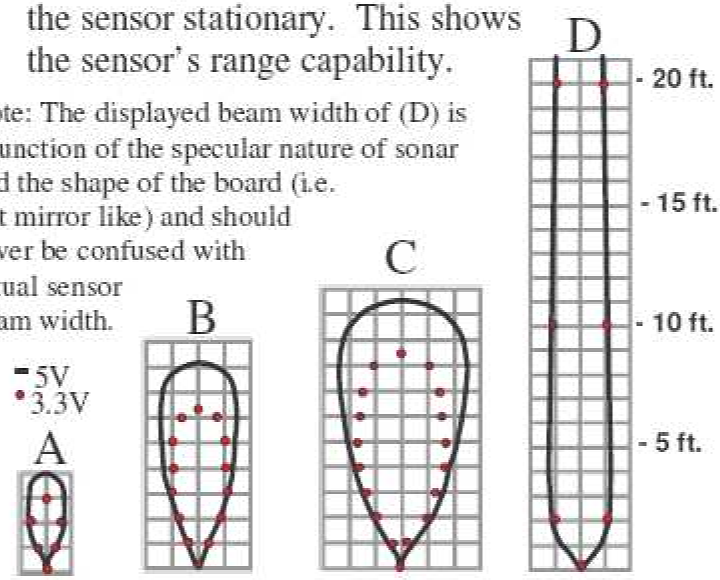
(A) 0.25-inch diameter dowel, note the narrow beam for close small objects,

(B) 1-inch diameter dowel, note the long narrow detection pattern,

(C) 3.25-inch diameter rod, note the long controlled detection pattern,

(D) 11-inch wide board moved left to right with the board parallel to the front sensor face and the sensor stationary. This shows the sensor's range capability.

Note: The displayed beam width of (D) is a function of the specular nature of sonar and the shape of the board (i.e. flat mirror like) and should never be confused with actual sensor beam width.



beam characteristics are approximate