ECE 3090
Junior Design
Homework #5
Calibration and Testing

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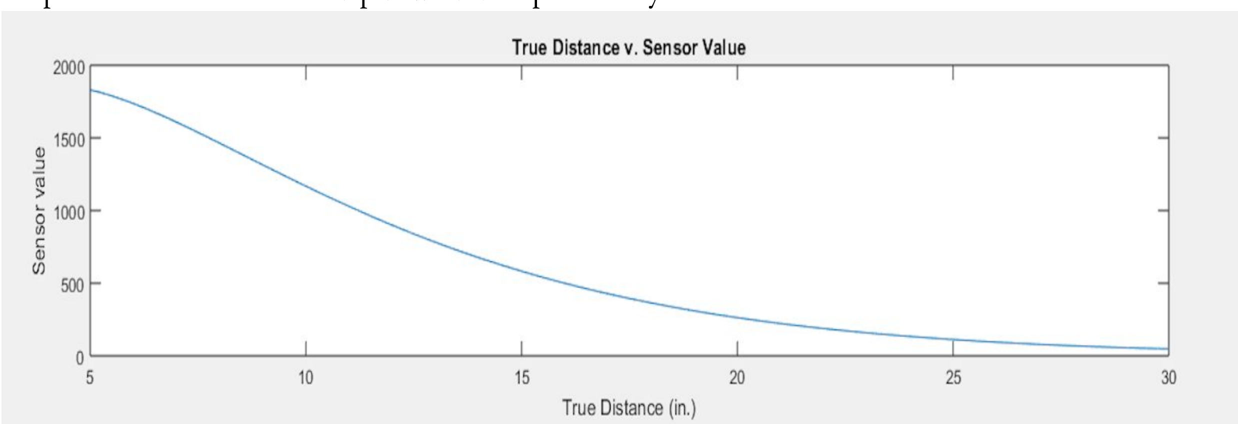
INTRODUCTION:

This assignment concerns the calibration and testing of sensors. Sensors are designed to provide values that do not inherently correspond to real world values. In other words, sensors provide values that can be converted to meaningful data through calibration functions. To properly calibrate a sensor, one must establish the range over which it can effectively measure, and quantify the uncertainty in the measured values. In this assignment, an IR ranging sensor is the subject of calibration. In MATLAB, a calibration function, IRdist.m, was created that receives a vector of raw sensor measurements and maps them to “real” distance values contained in another vector. Furthermore, a script, IRscript.m, that creates plots of both variance and accuracy was created.

RESULTS:

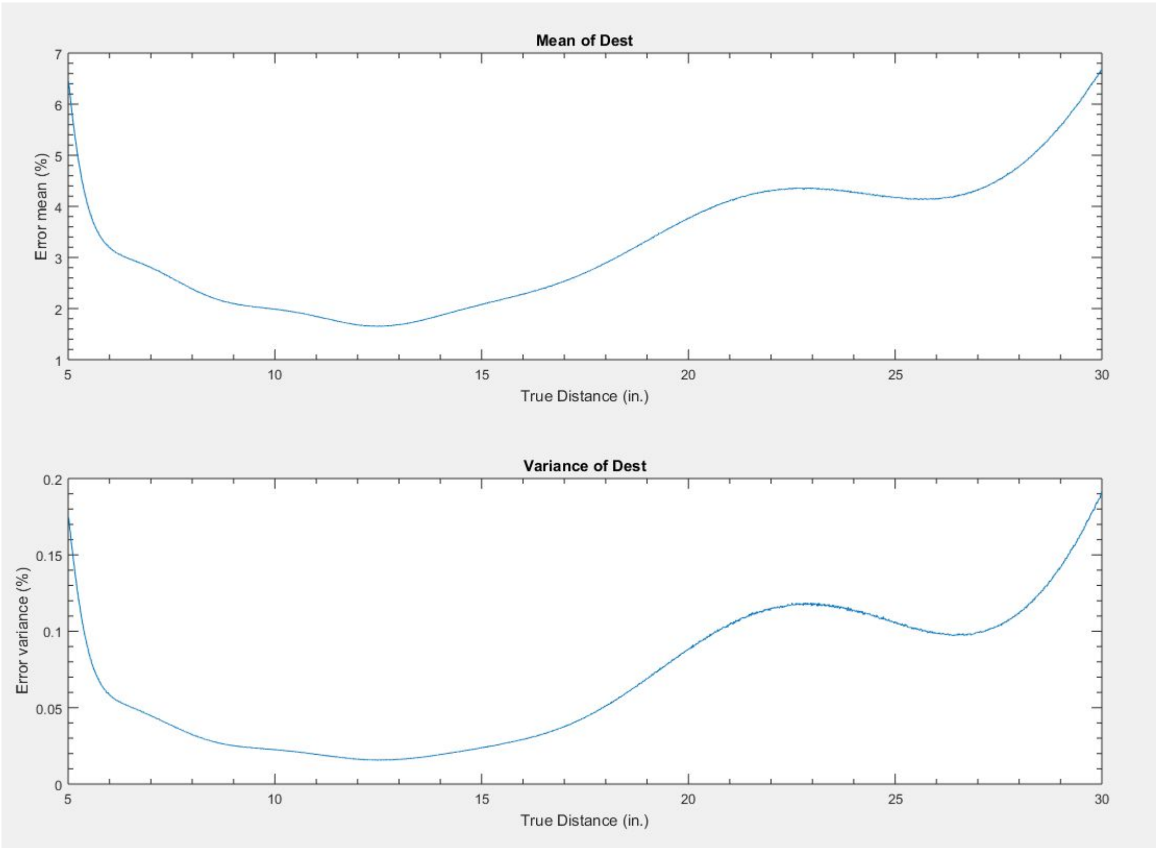
A.

In order to map the raw sensor data to a real distance value, we first generated sensor samples over a wide range of distance values (0-30 in.). We then used the built-in Matlab function polyfit to find a n-th degree polynomial that fit the curve. The generated samples were treated as the x axis and the true distance as the y axis in the polyfit function. This gave us a polynomial that mapped sensor value to distance. We used the polyval function to find values given a sensor value. We faced an issue when we attempted to invert the polynomial from mapping true distance to sensor value. At first we attempted to invert a given polynomial, but ended up discovering that it was possible to simply switch the parameters so that the output would map correctly.



B. Looking at the graphs of mean and variance of the percent error, we can see that the precision and accuracy of the distance are closely tied. Both are very low over the range of 6-17 in., but increase greatly outside of that range. We limited the graphs to 5-30 in. because outside of that range, the errors grew exponentially.

Based off the mean and variance curves graphed above, one could conclude that the optimal true distances to be estimated using this sensor would lie in the range of approximately 6 inches to 17 inches, corresponding to an S value range of approximately 1700 to 500 based upon the graph of S vs. True Distance in Part A. In this range the variance error lies below 0.1% and the mean error lies below 4%. In other words, for this range of true distance estimates the S values registered by the sensor were the most consistent.



CONCLUSION:

The most effective range of the distance sensor is the measurement of true distances from around 6 inches to 17 inches, based upon the curves that map the mean and variance of the distance estimates. One could also conclude that the calibration method does a reasonably good job of estimating true distance from the raw sensor measurements. This is evident in the fact that even far outside its most effective range, the error percentages in the mean hovered around only 6%, and the error in the variance did not climb above 0.2%. If the true distance is below 5 in., we know that the returned estimated distance will be wrong because those sensor values are also mapped to distances above 5 in. If the value is above 25 in., it is not possible to know that it will be wrong, as the values are simply very close together and a very small range of sensor values maps to a large distance range.