Magnet Localization for the Tongue Drive System

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Tongue Drive System

- The Tongue Drive System (TDS) is a brain-tongue-computer interface system that enables severely disabled people to control an actuator such as a wheelchair or a computer input device using their tongue.
- The TDS uses magnetic sensors to locate the magnet on the tongue in order to track tongue movements and translate that to commands controlling a wheel chare or mouse cursor.

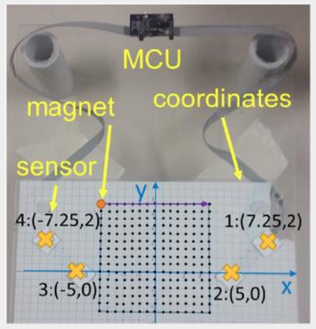


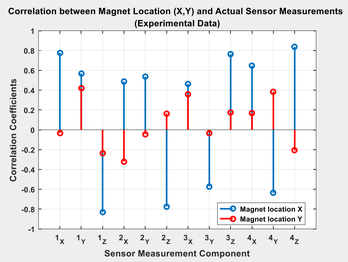
Figure 1. Experimental model emulating the tongue-attached magnet.

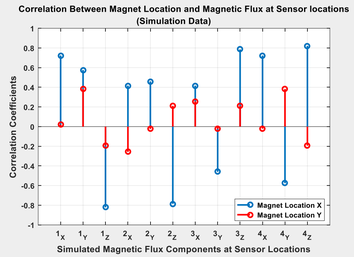
Figure 2. The Tongue Drive System

Project Purpose

- A previous group tested three machine learning algorithms on the data collected in Figure 1 using high resolution on training and testing.
- Our goal is to derive ML algorithms that can be trained on low resolution but perform well at higher resolution (i.e., training on 1cm resolution and test on 0.5 cm resolution)

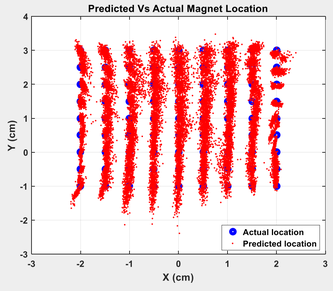
Correlation Analysis of Training Data Set



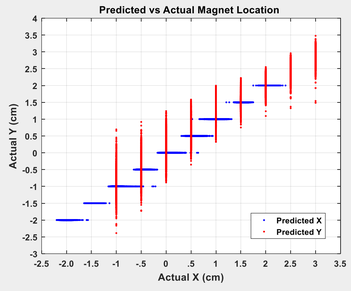


Key Observation:

- Sensor measurements are a lot less sensitive to magnet movement along the Y axis than movement along the X axis. Most likely due to sensors locations.
- Y prediction error is increasing the overall magnet location prediction error

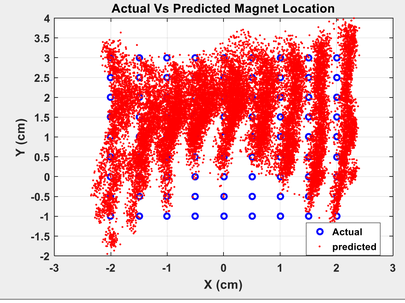


RMSE = 0.19 cm



RMSE(X) = 0.07 cm, RMSE(Y)=0.28 cm

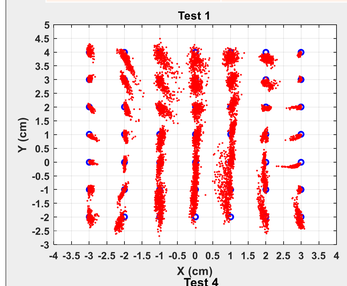
- **Sol. #1** : Drop least correlated components. Drop lowest 4 for predicting Y

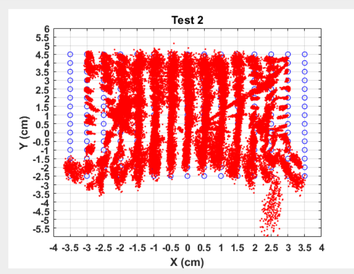


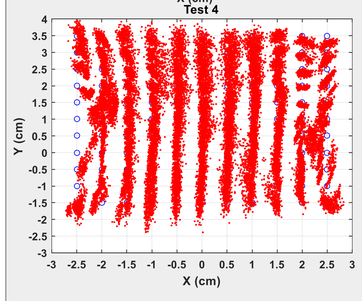
RMSE = 0.59 cm

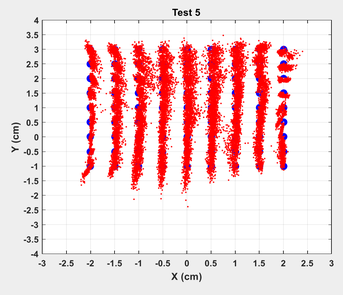
Sol. #2: Train and Predict X and Y Separately

Prediction Error - RMSE (cm)			
Regression Method:	Kernelized Ridge Regression (RBF) X: α =0.001, γ =0.01 Y: α =0.01 , γ =0.1	SVR (RBF) X: C=10000,γ=0.0001 Y: C=100, γ=0.1	Neural Networks 250 Hidden Layers
Test 1	0.21	0.32	0.076
Test 2	0.74	0.81	0.500
Test 3	0.27	0.32	0.348
Test 4	0.25	0.29	0.563
Test 5	0.19	0.25	0.792









Conclusion:

When X and Y are predicted independently, kernelized linear regression results are 50% better than all previous results. SVR results are almost the same. Neural Network performs extremely well on some test, poorly on other tests.

Recommendation for future work:

- Install sensors along the Y axis of the grid (lateral to X) or use better sensors with sensitivity to changing in magnet location along Y axis.