

Project #3: Gesture Recognition

ESE 650: Learning in Robotics

Submitted By

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MSE in Robotics

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Date: 2/25/2012

Implementation Details:

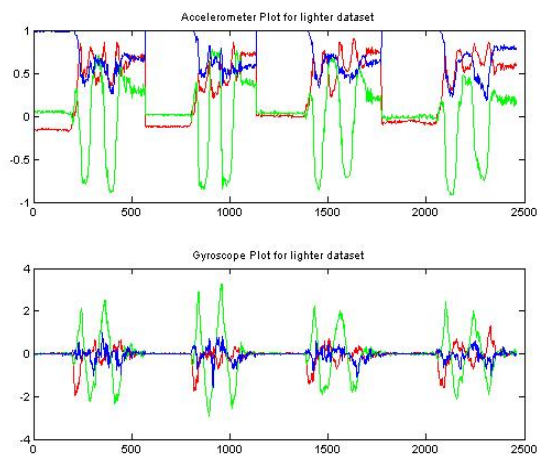
Processing Data:

The raw IMU data is processed by first estimating the bias and converting to respective accelerometer and gyroscope vectors. Also the 5% of the data is pruned at the end as it stays constant in the same state for a long time for the last trial alone.

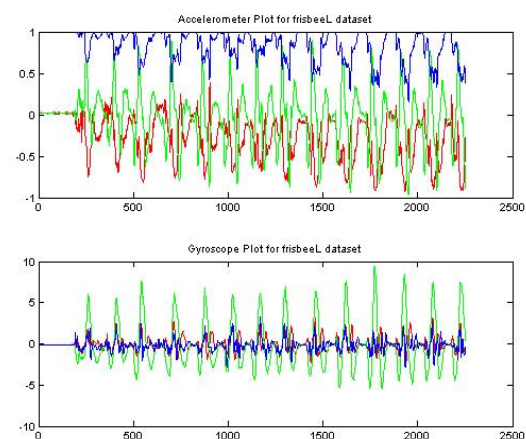
Vector Quantization:

- The input data -IMU measurements is first converted to discrete set of codes by using K-means on the data.
- The starting points for the K-means is selected randomly from the dataset points itself so that none of the cluster becomes invalid.
- The K-means is repeated N times and the best output i.e., the one with the minimum objective function is selected.
- The final means in the K-means is arranged in the increasing order of the norm. This is done so that all trials get the same output code even if the random initialization of mean was different.

Breaking data into trials:



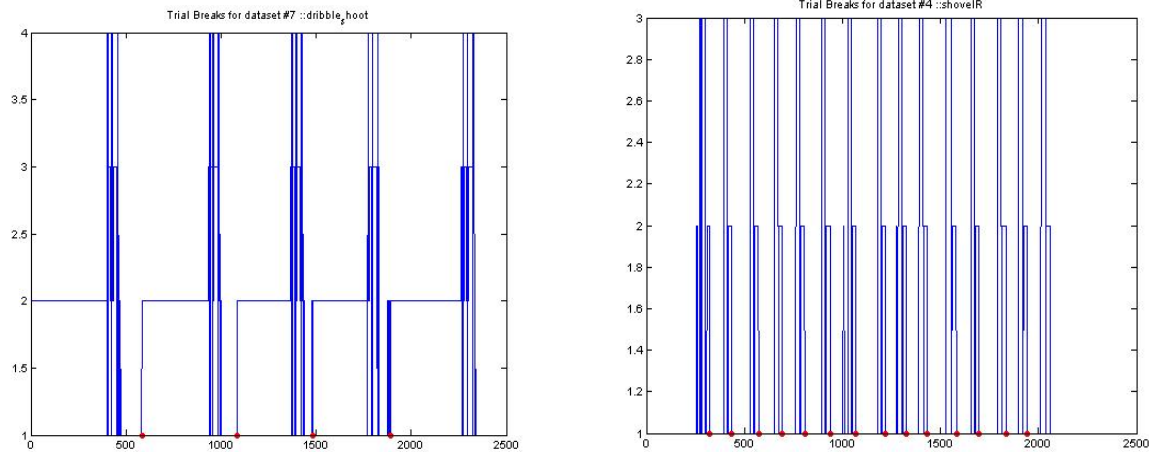
Lighter Dataset



FrisbeeL Dataset

The input data which is a continuous sequence of trials is broken down into segments by first finding the local maxima or peaks in the data. Then the

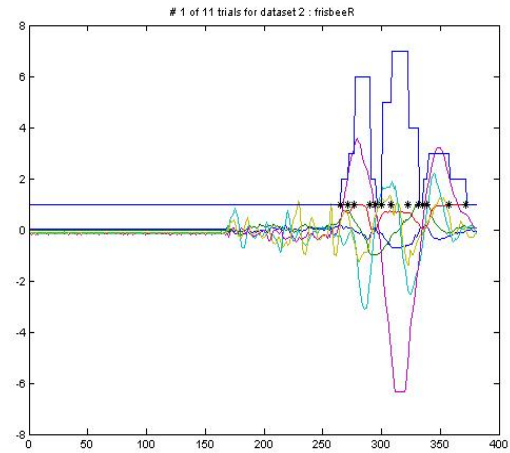
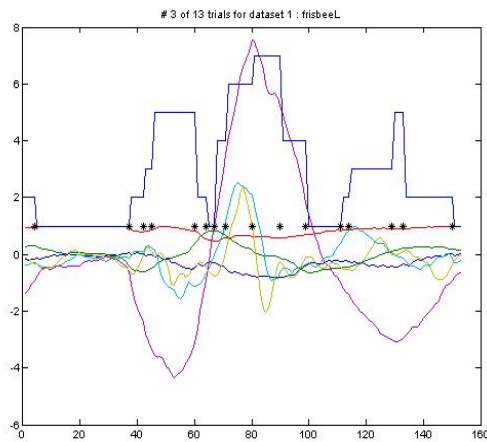
successive peaks are compared and if beyond a specific threshold it is considered as separate trial. It is also ensured that the trials start at correct starting point and not in the middle.



Break Points for trials for dribble shoot and shovelR dataset. The break points are shown as red dots.

Finding States:

- After the break points for the trials are estimated, each trial is further split into states by following the same method but with different thresholds.
- Each dataset is allowed to have different number of states. Within a dataset the number states is held constant by first finding the most commonly occurring length of state.
- Then states with length greater than the mode length are converted to the specified length by collapsing state intervals which are smaller. The trials with state intervals less than mode are ignored.
- A left to right HMM was used and hence the states were numbered directly from the partitions as 1->N



The states boundaries are marked by black dots in the above figure.

Calculation of A,B and π

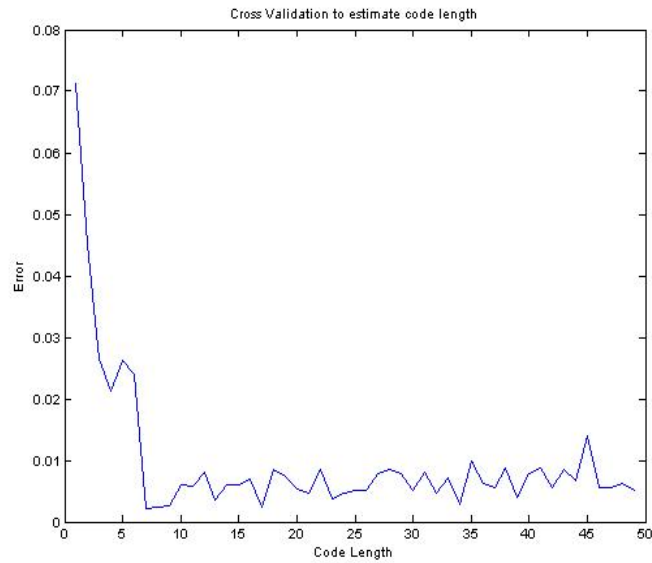
The transition probability matrix A and emission probability matrix are initialized by expected number of transitions given a particular state. Since a left to right HMM model was used A was limited to a band diagonal matrix. π is 1 for state 1 and 0 for everything else.

EM for re-estimation of λ

Baum Welsh method of expectation maximization for learning the A and B was tried.

Cross Validation:

The number of codes for vector quantization was selected using Leave one out Cross Validation (LOOCV). From the graph it was calculated that 7 was the optimum code length for vector quantization.



Results and Analysis:

Parameters	Stats
K-means convergence	17-20 iterations
	K=7 is selected based on cross-validation
Average time taken for classification	0.6 seconds for each dataset
Cross-validation results	Percentage error=1.18% for K=7