Dimensionality Reduction in Hand Gesture Classification

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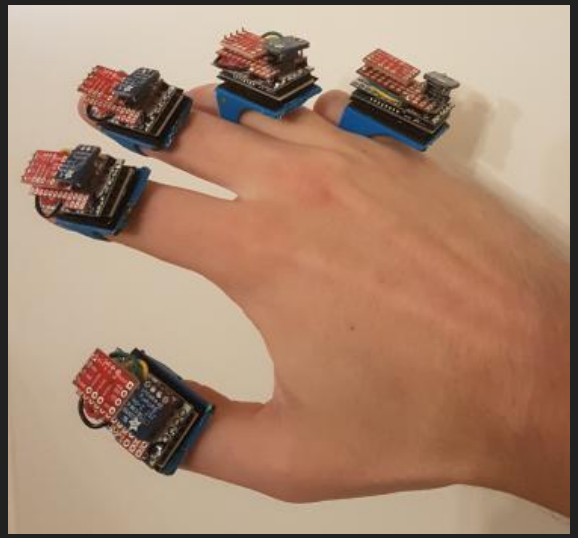
Background

The device



Existing research

- Ambar, Radzi & Kar Fai, Chan & Abd Wahab, Mohd Helmy & Mahadi Abdul Jamil, Muhammad & Alabqari Ma'radzi, Ahmad. (2018). Development of a Wearable Device for Sign Language Recognition.
- Mehdi, Syed Atif & Khan, Yasir Niaz. (2002). Sign language recognition using sensor gloves

Research Question

Can dimensional reduction be used on time-position data corresponding to sign language gestures without causing a statistically significant change in accuracy?

Method: The Data

- Every word is one gesture, but the gesture happens over time, your hand is moving. So one sample contains several snapshots over time of finger positions, which are 10 times 3 dimensional
- Some gestures are completed quickly, others are slower. Thus the dimensions of each class won’t be the same.
- We need to find the sample with the highest number of dimensions, and apply imputation on the other samples, to make them have the same number of dimensions
- A dimensionality reduction method needs to be applied due to the large number of components

Method: Metrics

The time-position data will be used to train a k-NN algorithm. At least 3 different k values will be attempted.

The data set will be divided using N-fold cross validation, where N = 10.

The Brier Score will be compared for three groups:

Control: No Dimensionality Reduction

Trial 1: PCA (Principal Component Analysis)

Trial 2: PLS (Partial Least Squares)

Related Research(different methods of dimension reduction)

1) Fusion of Dimensionality Reduction Methods: a Case Study in Microarray Classification
   https://www.diva-portal.org/smash/get/diva2:283116/FULLTEXT01.pdf
2) Unsupervised Dimensionality Reduction for High-Dimensional Data Classification
   http://article.sciencepublishinggroup.com/pdf/10.11648.j.mlr.20170204.13.pdf
3) Dimensionality Reduction and Classification through PCA and LDA
   https://pdfs.semanticscholar.org/4147/22ddd809b460d5b397eaf454fbb697cfb881.pdf
4) Classification of Microarrays with kNN: Comparison of Dimensionality Reduction Methods
   http://dl.ifip.org/db/conf/ideal/ideal2007/DeegallaB07.pdf

Related Research(different methods of dimension reduction)

1) FF - Feature Fusion (1)*
2) CF - Classifier Fusion (1)*
3) PLS - Partial Least Squares (2)
4) PCA - Principal Component Analysis (4)
5) LDA - Linear Discriminant Analysis (1)
6) IG - Information Gain (2) - but this is better with categorical data
7) RP - Random Projection (1)

*FF and CF is in addition to one of the other dimension reductions.

Caution: There is no “best” algorithm and these studies were testing algorithms for image processing. Two were classifying cancers. One was doing face / object recognition. And the final one was doing alpha-numeric character recognition.

Related Research(kNN with different voting methods)

1) A Novel Weighted Voting for K-Nearest Neighbor Rule
   https://pdfs.semanticscholar.org/c624/cbec68fe6940bd4477f3cefe29b767a8d33a.pdf
2) Weighted k-Nearest-Neighbor Techniques and Ordinal Classification
   https://epub.ub.uni-muenchen.de/1769/1/paper_399.pdf
3) KNN Model-Based Approach in Classification
   https://pdfs.semanticscholar.org/a7e2/814ec5db800d2f8c4313fd436e9cf8273821.pdf
4) An Improved k-Nearest Neighbor Classification Algorithm Using Shared Nearest Neighbor Similarity
   https://pdfs.semanticscholar.org/87f0/e0e4bf0332f0c81adf5b8379f9cc00c10d8e.pdf

In one of the dimensionality studies from earlier, it showed that using k=1 resulted in best accuracy in k-NN algorithms if dimensional reduction had taken place.

Hypothesis

When analysing time-position data for hand-gesture classification, both PLS and PCA dimensionality reduction will result in an increase in the Brier score when compared to the control group. PLS will result in greater gain compared to PCA.