Inferring Informative Grasp Parameters from Trained Tactile Data Models

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Abstract

When choosing parameters for a tactile action, it is useful to be able to choose parameters that will optimize the discriminating power of the tactile data acquired during the action. We propose a way to extract this information about informative grasp parameters from a deep network trained to perform a classification task on the tactile data. We do this by defining a new cost function on the network that quantifies the certainty of the result, and optimizing the input on that cost function. Though our work on this technique is still in progress, we present some early experiments using this approach on the BiGS tactile grasping dataset, and propose experiments for further investigation of the technique.

BiGS Dataset

We have performed initial experiments with our system using the Biotac Grasp Stability dataset [1]. The part of the data we used consists of 1000 labeled (success or failure) grasp attempts on a cylindrical object with a randomly varied initial hand pose. Available data items include:

- Biotac electrode values
- Biotac AC and DC pressure values
- Robot pose and joint angles
- Grasp phase (grasp and lift)

For our system we retain the Biotac electrode and AC pressure values, as well as the hand pose at the start of the lift phase. We retain this data for the 200ms following the start of the lift phase.

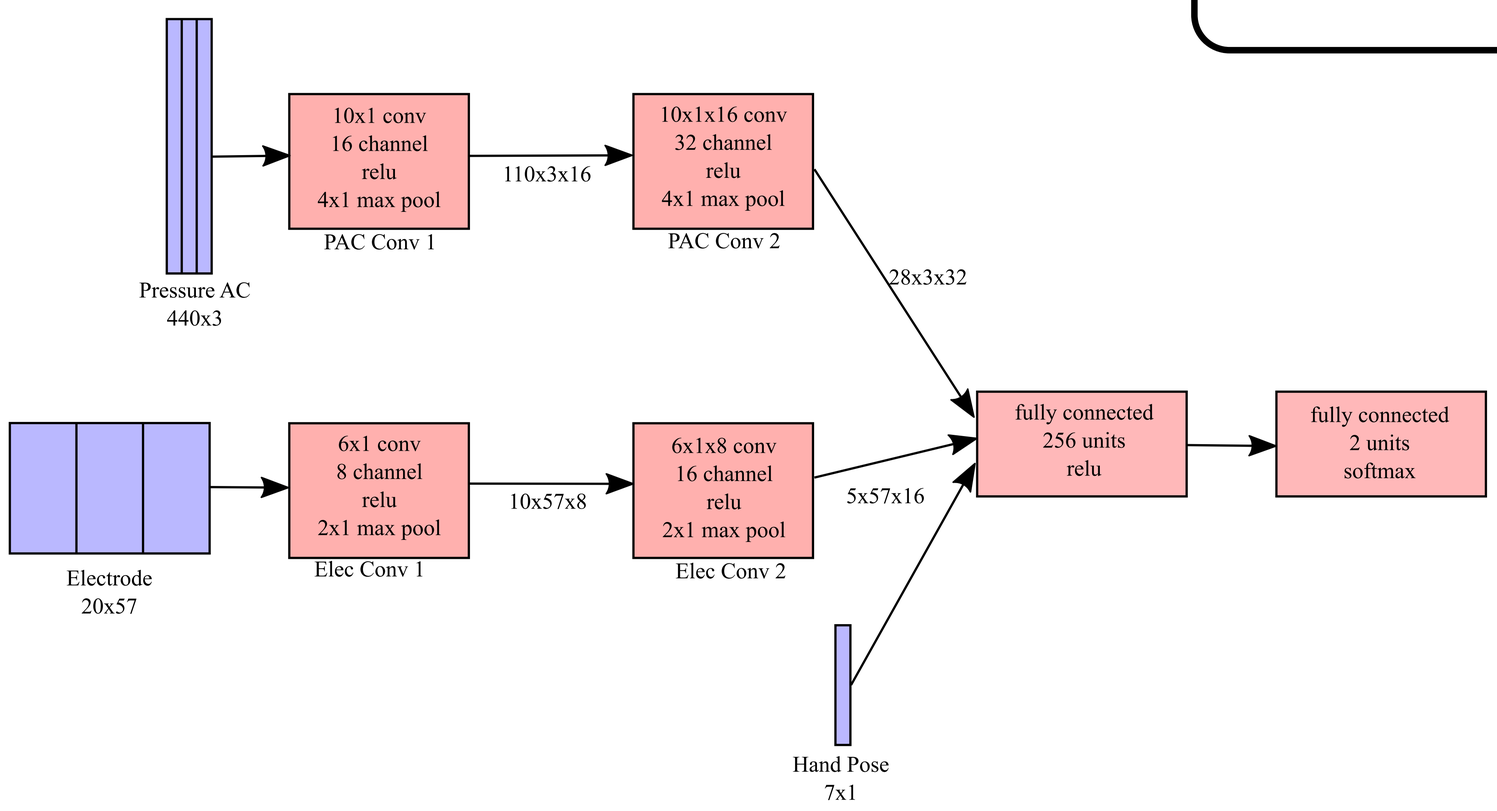

Figure 1: Diagram of our network model showing convolutional and fully connected layers. Blue boxes show input data, while red boxes show a complete layer operation. Arrows are labeled with the dimension of the data tensor passed to the next layer of the network.

Figure 2: A typical grasping example from the BiGS dataset

Methodology

In order to find informative grasp parameters, we assume that we start with a network that has already been trained for a particular task, such as a classification or regression objective. We then start with initial grasp parameters and sensor data, and define an optimization objective on the certainty of the result. For a discrete classification task we use an entropy loss function:

$$\text{loss} = \sum_i y_i \log(y_i)$$

where y_i is the predicted probability of category i. Now, we can do a gradient descent on the grasp parameters to minimize the expected entropy of the classificaiton result.

Training the Model

- Network is implemented using the TensorFlow framework
- Dataset split 90/10 train/test
- Adam optimizer over 20,000 random batch iterations
- Final test accuracy of 90%

BiGS Grasp Updates

- Evaluated by updating input in test examples
- Most test cases started at high certainty and saw little or no update
- Currently working on visualizations and other techniques to evaluate updates of uncertain examples

References

[1] Y. Chebotar, K. Hausman, Z. Su, A. Molchanov, O. Kroe- mer, G.S. Sukhatme, and S. Schaal. Bigs: Biotac grasp stability dataset. In *ICRA 2016 Workshop on Grasping and Manipulation Datasets*, Stockholm, Sweden, May 2016.