In-Hand Object Recognition in Human-Robot Collaboration Using a Wearable Force-Myography Device

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Applicable human-robot collaboration requires intuitive recognition of human intention during shared work. A grasped object such as a tool held by the human provides vital information to the robot about the upcoming task. In this work, we explore the use of a wearable device to non-visually recognize objects within the human hand in various possible grasps. The device is based on Force-Myography (FMG) where simple and affordable force sensors measure perturbations of forearm muscles. We propose a novel Deep Neural-Network architecture termed Flip-U-Net inspired by the familiar U-Net architecture used for image segmentation. The Flip-U-Net (Figure 1) is trained over data collected from several human participants and with multiple objects of each class. Data is collected while manipulating the objects between different grasps and arm postures. The data is also pre-processed with data augmentation and used to train a Variational Autoencoder for dimensionality reduction mapping. While prior work did not provide a transferable FMG-based model, we show that the proposed network can classify objects grasped by multiple new users without additional training efforts. Experiment with 12 test participants show classification accuracy of approximately 95% over multiple grasps and objects. Correlations between accuracy and various anthropometric measures are also presented. Furthermore, we show that the model can be fine-tuned to a particular user based on an anthropometric measure.

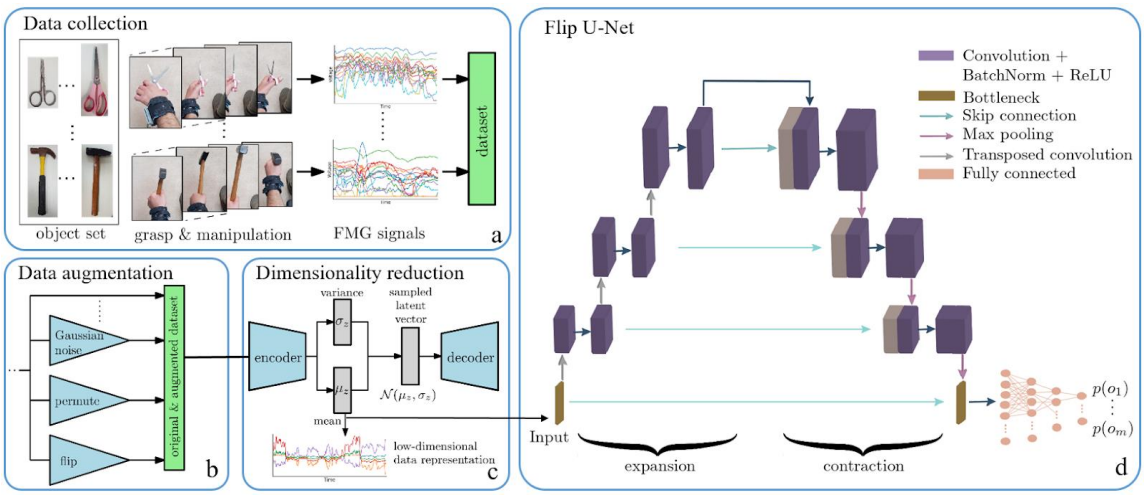

Figure 1. The proposed method for data treatment and Flip-U-Net architecture to classify processed FMG signals to grasped objects.