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Biography

I am an undergraduate student at New York University and a research assistant in NYU Multimedia and Visual Computing Lab, advised by Professor Yi Fang. I am broadly interested in 3D Computer Vision, Pattern Recognition and Deep Learning.

Research Project: Meta Deformation Network: Meta Functionals for Shape Correspondence

1 Description

We present a new technique named Meta Deformation Network for 3D shape matching via deformation, in which a deep neural network maps a reference shape onto the parameters of a second neural network whose task is to give the correspondence between a learned template and query shape via deformation. We categorize the second neural network as a meta-function, or a function generated by another function, as its parameters are dynamically given by the first network on a per-input basis. This leads to a straightforward overall architecture and faster execution speeds, without loss in the quality of the deformation of the template. We show in our experiments that Meta Deformation Network leads to improvements on the MPI-FAUST Inter Challenge over designs that utilized a conventional decoder design that has non-dynamic parameters.

2 Method

In this project, we investigate the possibility of an alternative decoder structure and compare it against LVC on the task of computing correspondence for human 3-D scans. Specifically, we evaluate an alternative decoder design scheme that uses only the template point cloud as input but has dynamic parameters that are predicted by a neural network from E and also outputs the deformed template points. We call this architecture Meta Deformation Network because the deformation process is carried out by a neural network whose parameters are not independent but generated by another neural network. The decoder could be thought of as a second-order function that is defined or generated by another function. Figure.1 shows the architecture Overview of the Meta Deformation Network. Blue rounded rectangles represent multi-layer perceptrons (MLPs) with numbers in parentheses specifying the number of neurons for all layers, yellow rounded rectangles represent dynamic MLPs, and white rectangles indicate feature sizes at different stages in the pipeline.

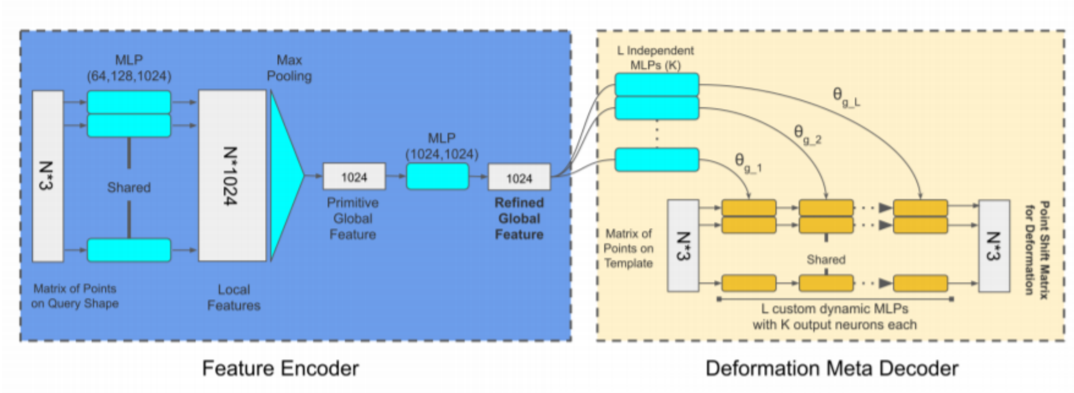

Figure 1: Architecture Overview of the Meta Deformation Network.

3 Results

In this section, we conduct experiments to demonstrate the effectiveness of the proposed Meta Deformation Network. We test the Meta Deformation Network on the MPI-FAUST Inter and Intra Subject Challenges. The "inter" challenge contains 40 pairs of 3D scans of real people with each pair consisting of two different people at different poses. We show the deformation of the template into the query shapes before the optimization of E, and compare Meta Deformation Network against the non-meta deformation network developed by T. Deprelle et al. The figures are included in Figure.2 which shows the comparison of Meta Deformation Network and 3D-CODED with Learned templates in unoptimized deformation quality. Left: Query Shape, middle: Meta Deformation Networks, right: 3D-CODED with Learned Template. Though the Meta Deformation Network did not surpass the state-of-the-art performance, it showed an improvement over 3D-CODED w/. Learned 3D Translation Template, an approach that is comparable to ours in that it shares the same simplified PointNet encoder design and also applies a learnable translation matrix to the points of the base template, with the difference being that it its LVC decoder has fixed parameters. This shows quantitatively that having the meta decoder produces more

Method	FAUST-Inter Mean Error (cm)
Deep functional maps [13]	4.82
Stitched Puppet [21]	3.12
3D-CODED w/. Learned 3D Translation Template [5]	3.05
3D-CODED w/. Learned 3D Deformed Template [5]	2.76
Meta Deformation Network (Ours)	2.97

Table 1: Comparison of Meta Deformation Network to Network Architectures with Conventional Methods.

accurate correspondences on FAUST-Inter than does a static-parameter decoder (while also having speedier execution). We report results from training under a low-resolution template and hotswapping in a different high-resolution template in inferencing. See the accuracy numbers are shown in Table 1.

Figure 2: Comparison of Meta Deformation Network and 3D-CODED with Learned templates in unoptimized deformation quality.