Supplementary Material: Algorithm Parameter Settings and Additional Results

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1 Implementation Details

1.1 Spatial Parameters for Interface

We fixed the pot to be 0.6 units in length with radius in the range $[0.1875, 0.3125]$. Further, we fixed the resolution of the pot to 314 circular sections with each section containing 100 points. Thus, the difference in height between each section is set to 6×10^{-4} units. The SoftKinetic sensor provides a spatial resolution of $0.9\ mm$ in the $x-y$ (frontal) plane and $0.01\ mm$ along z (depth). After spatial mapping and PCL scaling, the average distance between two neighboring points in the PCL were observed to be 2×10^{-3}, 4×10^{-4} and 1.5×10^{-3} units along x, y and z directions respectively. The proximity and convergence thresholds were set as $\varepsilon_P = 0.1$ and $\varepsilon_C = 10^{-8}$ respectively.

1.2 Algorithm Parameters

Proximal Attraction: We conducted an informal pilot study where participants used our system with a set of parameter combinations. The goal was to study the effect of parameters (α, β, and γ) on the intuitiveness and responsiveness of the pot deformation process. We note that effect of these parameters are not independent. Thus, an exhaustive study of all combinations is prohibitively difficult. Here, the ranges of parameters were:

- $0.1 \leq \alpha \leq 0.4$
- $0.1 \leq \beta \leq 0.4$
- $\gamma \in \{0.5, 1.0, 1.5, 2.0, 2.5\}$

The general trend we observed is that $\beta > \alpha$ and $\gamma < 2.0$ resulted in uncontrollable pulls. Our final parameters provided by user's feedback were $\alpha = 0.3$, $\beta = 0.1$, and $\gamma = 1.5$.

Grasp+Motion: For the KDE based approach, we have three parameters given by: the rate of attractions (α), the KDE bandwidth (a), and shift threshold to classify smoothing (S). Here, we used $S = 3$ and $a = 500$.

2 Additional Evaluation Results

2.1 Trials Per Target Shape (T1)

As a part of our qualitative analysis, we recorded the number of trials per user per target shape (Figure 1). The global maximum number of trials was recorded to be 5 for the thin-concave feature. Most users required only one trial for fat-convex, central-flat, and top-bottom-flat features. On the other hand, thin-concave and thin-cvex features required more iterations.

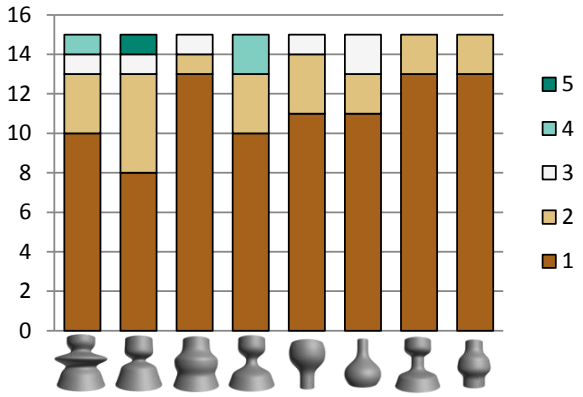

Figure 1: Number of trials per target shape are shown. Each column is color coded with respect to the number of trials for a given target shape in task **T1**. For example, the first column shows that 10, 3, 1, and 1 users to create a thin-concave feature in 1, 2, 3 and 4 trials respectively.

2.2 Response Quality

In addition to curvature cross-correlation, we analyzed the response quality in task **T1** (*Quiz*) using three other measures of curve dissimilarity (Figure 2). The first is the Procustes distance, which is simply computed by taking the euclidean norm between the user created and target profiles of the pot. The second is the Frechet distance to measure similarity between profiles, taking into account the location and ordering of the points along the profiles. The third is dynamic time-warping (DTW), a well known method for comparing time-series data.

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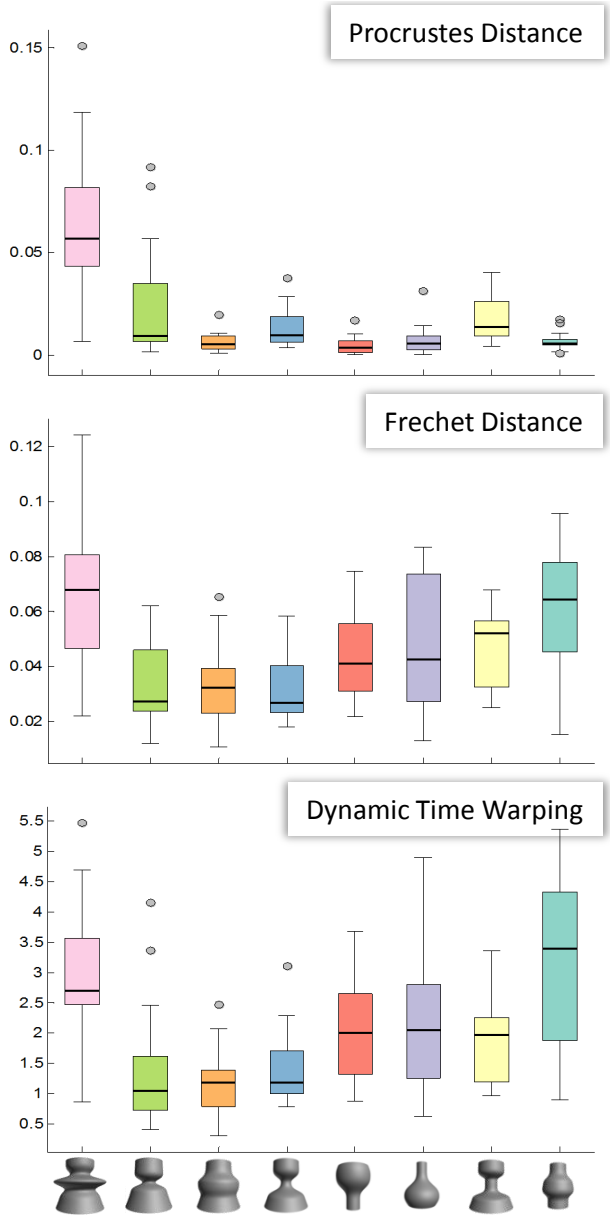

Figure 2: User performance is shown using three dissimilarity measures. While the top two are measures for computing similarity, DTW (last row) computes the dissimilarity between the user's response and target profiles (i.e. lower values correspond to better response).