

Supplementary Materials for Neural Deformable Models

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1. Detailed Quantitative Results of Bi-ventricular Shape Reconstruction

In Table 1, we show the detailed Chamfer distance (CD), earth mover’s distance (EMD) and point-to-surface distance (P2F) for geometric similarity evaluation of LV-endo, LV-epi and RV shape reconstructions. Our method outperforms all the baseline methods for LV-endo, LV-epi and RV shape reconstruction, respectively.

In Table 2, we show the detailed normal consistency (NC), easy non-manifold face (ENF) ratio and self-intersection (SI) ratio for reconstructed mesh quality evaluation of LV-endo, LV-epi and RV shapes. On average, our method can generate better cardiac meshes than all the baseline methods.

2. Detailed Quantitative Results of Bi-ventricular Shape Registration

In Table 3, we show the detailed CD, EMD, P2F for LV-endo, LV-epi and RV shape registration accuracy evaluations. Note that we register shapes from ED phase to ES phase. Our method outperforms all the baseline methods for LV-endo, LV-epi and RV shape registration, respectively.

Phase	Method	CD (mm) ↓				EMD (mm) ↓				P2F (mm) ↓			
		Endo	Epi	RV	avg	Endo	Epi	RV	avg	Endo	Epi	RV	avg
ED	MR-Net	2.56 ± 1.14	3.32 ± 1.10	3.39 ± 1.07	3.09 ± 1.06	6.04 ± 1.19	6.67 ± 1.71	5.44 ± 1.67	6.05 ± 1.17	1.26 ± 0.984	1.32 ± 0.817	1.82 ± 0.945	1.47 ± 0.877
	NMF	5.85 ± 4.43	5.67 ± 4.33	7.40 ± 8.96	6.31 ± 5.54	6.16 ± 1.37	6.61 ± 1.68	6.73 ± 2.27	6.50 ± 1.43	4.07 ± 3.70	3.45 ± 3.88	5.69 ± 8.03	4.40 ± 4.90
	Ours-un	2.72 ± 0.915	4.38 ± 0.978	8.38 ± 4.46	5.16 ± 1.70	5.93 ± 1.31	6.42 ± 1.60	6.24 ± 1.99	6.20 ± 1.26	1.37 ± 0.704	2.15 ± 0.682	5.81 ± 3.56	3.11 ± 1.30
	Ours	2.25 ± 1.03	2.91 ± 0.762	3.02 ± 0.892	2.73 ± 0.795	5.70 ± 1.14	6.38 ± 1.72	5.33 ± 1.69	5.80 ± 1.17	1.01 ± 0.850	1.06 ± 0.515	1.43 ± 0.712	1.17 ± 0.606
ES	MR-Net	2.11 ± 0.898	2.73 ± 0.755	2.28 ± 0.805	2.37 ± 0.729	2.59 ± 0.524	5.27 ± 1.53	5.64 ± 1.63	4.50 ± 0.666	1.18 ± 0.801	1.16 ± 0.539	1.35 ± 0.767	1.23 ± 0.641
	NMF	3.41 ± 3.10	3.74 ± 1.47	4.05 ± 2.83	3.74 ± 2.26	2.76 ± 0.870	5.29 ± 1.38	6.17 ± 1.72	4.74 ± 0.796	2.25 ± 2.35	2.04 ± 1.13	3.11 ± 2.59	2.46 ± 1.86
	Ours-un	1.97 ± 0.631	3.44 ± 0.663	3.27 ± 1.55	2.90 ± 0.732	2.93 ± 0.633	5.14 ± 1.27	5.37 ± 1.56	4.48 ± 0.656	1.15 ± 0.483	1.77 ± 0.433	1.95 ± 1.13	1.63 ± 0.516
	Ours	1.50 ± 0.542	2.32 ± 0.582	1.92 ± 0.823	1.91 ± 0.556	2.23 ± 0.481	4.92 ± 1.42	5.06 ± 1.49	4.07 ± 0.607	0.759 ± 0.397	0.914 ± 0.356	0.947 ± 0.605	0.873 ± 0.392

Table 1. Detailed Chamfer distance (CD), earth mover’s distance (EMD) and point-to-surface distance (P2F) for geometric similarity evaluation of LV-endo, LV-epi and RV shape reconstruction, respectively.

Phase	Method	NC ↑				ENF ↓				SI ↓			
		Endo	Epi	RV	avg	Endo	Epi	RV	avg	Endo	Epi	RV	avg
ED	MR-Net	0.713 ± 0.034	0.707 ± 0.033	0.866 ± 0.012	0.762 ± 0.024	1.48 ± 0.004	1.48 ± 0.002	1.47 ± 0.004	1.48 ± 0.003	0.035 ± 0.024	0.016 ± 0.012	0.055 ± 0.018	0.035 ± 0.013
	NMF	0.715 ± 0.031	0.707 ± 0.033	0.854 ± 0.024	0.759 ± 0.024	1.47 ± 0	1.47 ± 0	1.44 ± 0	1.46 ± 0	0.011 ± 0.027	0.016 ± 0.026	0.030 ± 0.046	0.019 ± 0.020
	Ours-un	0.717 ± 0.033	0.701 ± 0.032	0.835 ± 0.016	0.751 ± 0.022	1.47 ± 0	1.47 ± 0.002	1.42 ± 0.004	1.45 ± 0.002	0 ± 0	0 ± 0.001	0.007 ± 0.011	0.002 ± 0.004
	Ours	0.716 ± 0.032	0.709 ± 0.034	0.871 ± 0.011	0.765 ± 0.023	1.47 ± 0	1.47 ± 0	1.44 ± 0	1.46 ± 0	0 ± 0	0 ± 0.001	0 ± 0	0 ± 0
ES	MR-Net	0.708 ± 0.028	0.698 ± 0.033	0.843 ± 0.017	0.750 ± 0.022	1.46 ± 0.010	1.49 ± 0.003	1.46 ± 0.006	1.47 ± 0.005	0.113 ± 0.042	0.012 ± 0.014	0.078 ± 0.024	0.068 ± 0.018
	NMF	0.716 ± 0.030	0.699 ± 0.034	0.840 ± 0.021	0.752 ± 0.023	1.47 ± 0	1.47 ± 0	1.44 ± 0	1.46 ± 0	0.012 ± 0.025	0.018 ± 0.025	0.051 ± 0.082	0.027 ± 0.030
	Ours-un	0.719 ± 0.031	0.693 ± 0.033	0.830 ± 0.015	0.747 ± 0.022	1.47 ± 0	1.47 ± 0.001	1.43 ± 0.004	1.45 ± 0.001	0 ± 0	0 ± 0	0.004 ± 0.006	0.002 ± 0.002
	Ours	0.715 ± 0.032	0.701 ± 0.033	0.857 ± 0.013	0.758 ± 0.022	1.47 ± 0	1.47 ± 0	1.44 ± 0	1.46 ± 0	0 ± 0	0 ± 0.004	0 ± 0.002	0 ± 0.001

Table 2. Detailed normal consistency (NC), easy non-manifold face (ENF) ratio and self-intersection (SI) ratio for reconstructed mesh quality evaluation of LV-endo, LV-epi and RV shape, respectively.

Method	CD (mm) ↓				EMD (mm) ↓				P2F (mm) ↓			
	Endo	Epi	RV	avg	Endo	Epi	RV	avg	Endo	Epi	RV	avg
MR-Net	2.19 ± 0.754	2.82 ± 0.789	2.33 ± 0.737	2.44 ± 0.678	4.23 ± 1.09	5.37 ± 1.01	4.63 ± 1.11	4.74 ± 0.635	1.21 ± 0.560	1.44 ± 0.595	1.35 ± 0.627	1.33 ± 0.532
NMF	3.39 ± 2.48	3.85 ± 1.36	4.02 ± 2.34	3.76 ± 1.84	4.18 ± 1.08	5.94 ± 1.25	4.63 ± 1.28	4.92 ± 0.909	2.19 ± 1.91	2.26 ± 1.07	2.90 ± 2.19	2.45 ± 1.54
Ours-un	1.99 ± 0.635	3.58 ± 0.682	3.51 ± 1.58	3.03 ± 0.739	3.75 ± 0.715	5.37 ± 0.803	4.12 ± 1.05	4.41 ± 0.545	1.21 ± 0.484	2.15 ± 0.486	2.37 ± 1.42	1.91 ± 0.603
Ours	1.54 ± 0.535	2.36 ± 0.584	1.91 ± 0.714	1.94 ± 0.525	3.43 ± 0.653	5.18 ± 0.820	3.23 ± 0.872	3.95 ± 0.514	0.827 ± 0.389	1.15 ± 0.390	1.03 ± 0.621	1.00 ± 0.402

Table 3. Detailed Chamfer distance (CD), earth mover’s distance (EMD) and point-to-surface distance (P2F) for shape registration accuracy evaluation of LV-endo, LV-epi and RV, respectively. We register shapes from ED phase to ES phase.