Continuous Visibility Feature*
#supplementary material#

Guilin Liu, Yotam Gingold, Jyh-Ming Lien

In this supplementary document, we provide additional evaluations between the proposed CVF and other methods. These evaluations are obtained using the Princeton Segmentation Benchmark [1] and results are shown in Section 1. We provide an algorithm that details idea of filtering-based approach for speeding up CVF computation in Section 2. We will also show more results from CVF variants, namely the strong CVF and weak CVF in Section 4. Finally, we will show weak CVF with different values of τ.

1 Evaluate Shape Segmentation

In this section, we provide results in addition to Fig. 5 and Table 1 in the main paper. In addition to the Rand Index values, in Fig 1 we show that other metrics such as consistency error, cut discrepancy, Hamming distance all show similar trend as RI.

2 Algorithm Details for Filtering Based Approach

In Section 4 of the main paper, we provide a description on how the computation CVF can be sped up. Here we show the pseudo code for this filtering-based approach in Algorithm 1.

3 Different tolerance for computing weak CVF

In the implementation of CVF, to reduce the effects of noise on visibility testing, for each vertex, we push the vertex into the mesh a bit in its anti-normal direction to generate a proxy for this vertex. However, if the thickness in this area is too thin, the vertex may be pushed outside the mesh. The pushing step size is $min(\tau, intersection\ ray\ length/2)$. In Fig 2 we show some results of using different tolerances in CVF. For all the following images, from left to right, are the results of: $\tau = 0.05$, $\tau = 0.10$ and $\tau = 0.25$ (times of the model radius).

4 Comparisons of CVF, Strong CVF, Weak CVF, and SDF

In this section, we show the differences of CVF, Strong CVF, Weak CVF, and SDF [**?**]. Recall that strong CVF of two points p and q requires mutual continuous visibility so that both CV(p,q) and CV(q,p) are **TRUE**. We say that two points p and q have *strong continuous visibility* if both CV(p,q) and CV(q,p). A weak CVF, on the other hand, is more tolerable of small amount of invisibility between p and q, where τ is a user

*More information can be found at http://masc.cs.gmu.edu/wiki/CVF

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Table 1: Comapre CVF and its variants with SDF. The CVF$_{avg}$ means the the feature values for a vertex are are achieved by averaging the CVF values between original CVF values and the the facet that is hit by the ray sent out from that vertex in its anti-normal direction (counter-normal direction.) The CVF$_{weak}$ is the weak CVF and the CVF$_{strong}$ is the strong CVF.

	RI				
Category	SDF	CVF	CVF$_{avg}$	CVF$_{weak}$	CVF$_{strong}$
Human	0.18	0.16	**0.14**	0.17	0.16
Cup	0.36	0.45	**0.23**	0.42	0.42
Glasses	0.2	0.21	**0.19**	0.20	0.22
Airplane	**0.09**	0.17	0.2	0.15	0.16
Ant	**0.02**	0.04	0.04	0.05	0.05
Chair	0.11	0.1	**0.07**	0.10	0.10
Octopus	0.05	0.04	**0.03**	0.03	0.04
Table	0.18	0.12	0.09	**0.08**	0.10
Teddy	**0.06**	0.08	0.07	**0.06**	0.07
Hand	0.2	0.17	**0.13**	0.17	0.16
Plier	0.38	**0.21**	0.22	0.31	0.22
Fish	0.25	0.18	0.18	0.19	**0.17**
Bird	**0.12**	0.25	0.18	0.18	0.26
Armadillo	**0.09**	0.11	0.1	0.11	0.11
Bust	**0.30**	0.31	**0.30**	0.31	**0.30**
Mech	0.24	0.21	**0.14**	0.16	0.15
Bearing	0.12	0.14	0.13	0.07	**0.10**
Vase	0.24	0.18	0.18	0.17	**0.15**
Fourleg	**0.16**	**0.16**	0.17	**0.16**	0.17
Average	0.18	0.17	**0.15**	0.16	0.16

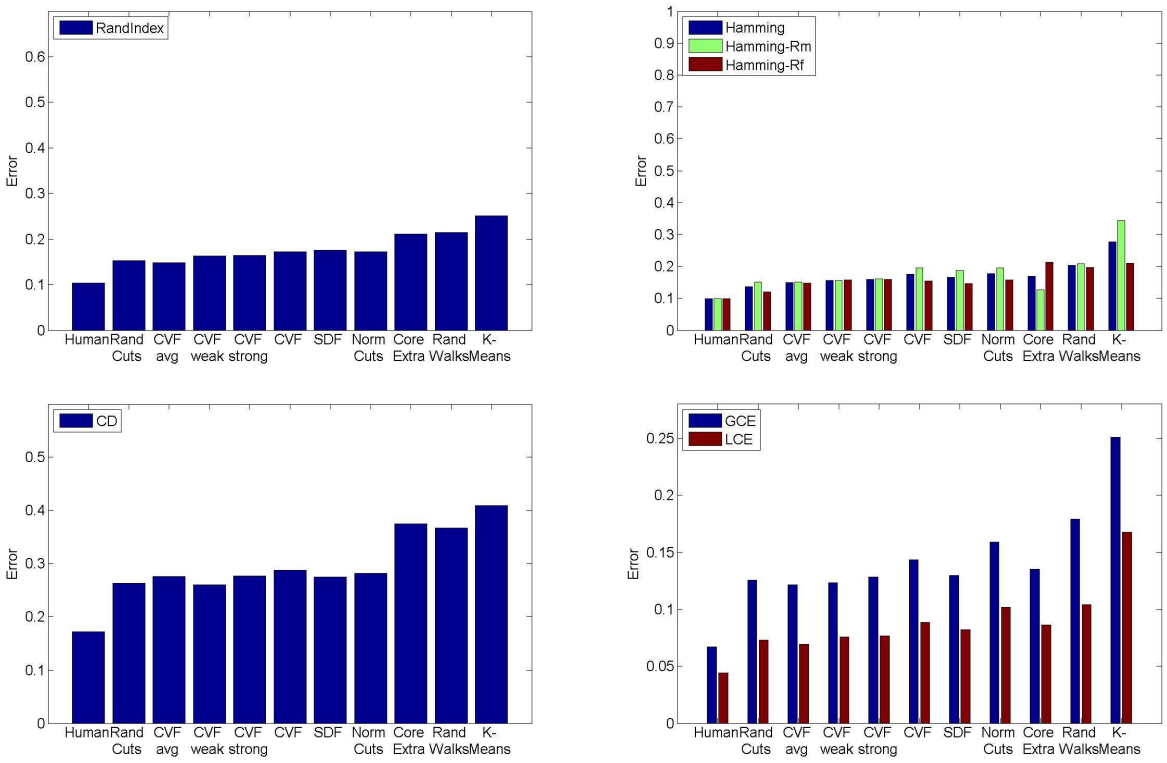


Figure 1: Comparison using RI, HD, CD and RI on Princeton Segmentation Benchmark

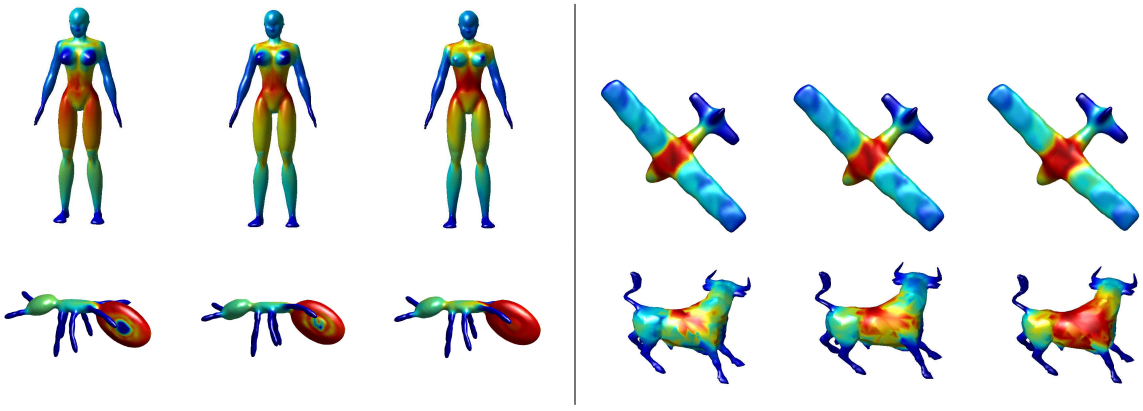


Figure 2: CVF results using different τ. For each model, from left to right, $\tau = 0.05, 0.10$ and 0.25.

Data: a vertex v and its positive continuous region T_v
Result: the continuous visible region of v
while $\exists f \in \partial T_v$ *whose visibility to* v *is undetermined* **do**
    Let $u \notin T_v$ be a vertex incident to f ;
    Find a path π connecting v and u ;
    Starting from v, let $e = \{w', w\}$ be the first edge such that w' is invisible and w is visible ;
    Let $L = \{e\}$;
    while L *is not a closed loop* **do**
        Let f be a face incident to e that is not visited ;
        Let w'' be the vertex of f that is not in e ;
        if w'' *is invisible from* v **then**
            $e = \{w', w''\}$
        else
            $e = \{w'', w'\}$
        end
        $L = L \cup e$
    end
    Mark all vertices connected to u without crossing L be continuously invisible from v
end

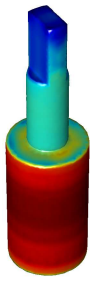
Algorithm 1: Filter-based CVR computation

parameter. More specifically, given two points p and q, $\text{WCV}(p, q) = \textbf{TRUE}\}$ if p and q are visible to each other but the length of the invisible part of the shortest geodesic path connecting p and q is smaller than a user defined value τ. All images in this section are created with $\tau = 0.09$. For the visualization of the following images, generally if a potential part/component has more consistent color, it means the feature is better in terms of the encoding of part-aware information. Color map is used so that warmer colors indicate larger feature values in the following images. Our criterion for evaluating these color maps is based on the observation that a good feature provides more consistent values (thus colors) within a meaningful part. We show the comparison in Fig 3.

References

[1] X. Chen, A. Golovinskiy, and T. Funkhouser. A benchmark for 3d mesh segmentation. *ACM Transactions on Graphics (TOG)*, 28(3):73, 2009.

[2] L. Shapira, A. Shamir, and D. Cohen-Or. Consistent mesh partitioning and skeletonisation using the shape diameter function. *The Visual Computer*, 24(4):249–259, 2008.



(3.1) SDF

(3.2) CVF

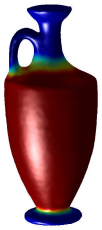
(3.3) Strong CVF

(3.4) Weak CVF

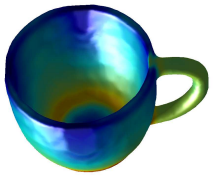
(3.5) SDF

(3.6) CVF

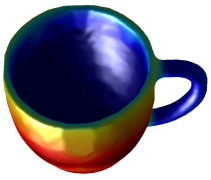
(3.7) Strong CVF



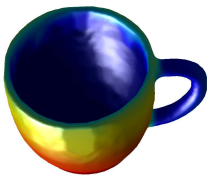
(3.8) Weak CVF



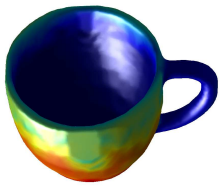
(3.9) SDF



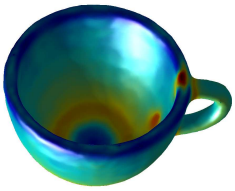
(3.10) CVF



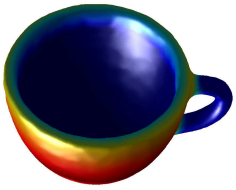
(3.11) Strong CVF



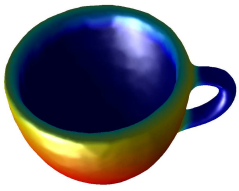
(3.12) Weak CVF



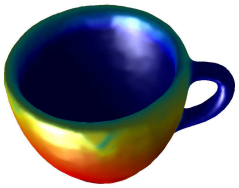
(3.13) SDF



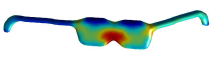
(3.14) CVF



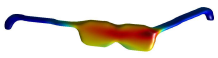
(3.15) Strong CVF



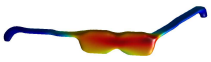
(3.16) Weak CVF



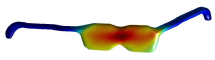
(3.17) SDF



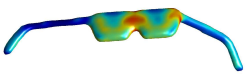
(3.18) CVF



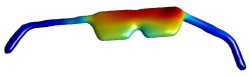
(3.19) Strong CVF



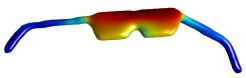
(3.20) Weak CVF



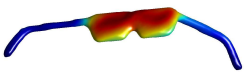
(3.21) SDF



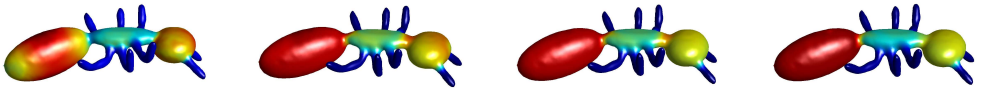
(3.22) CVF



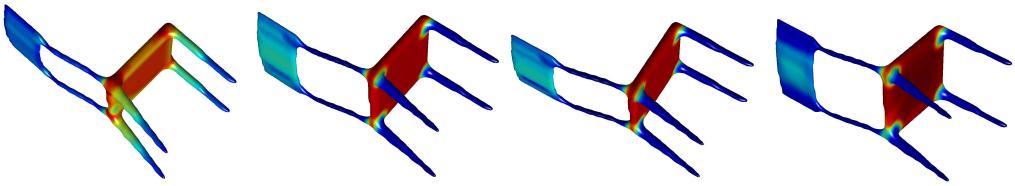
(3.23) Strong CVF



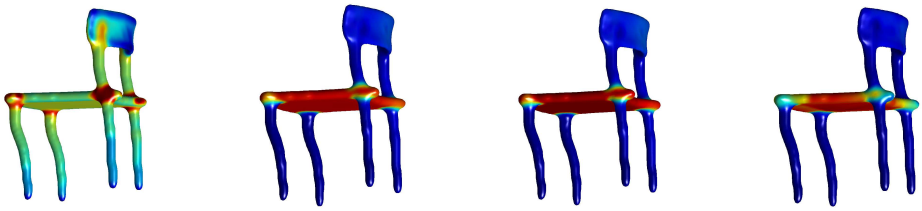
(3.24) Weak CVF



(3.25) SDF (3.26) CVF (3.27) Strong CVF (3.28) Weak CVF



(3.29) SDF (3.30) CVF (3.31) Strong CVF (3.32) Weak CVF



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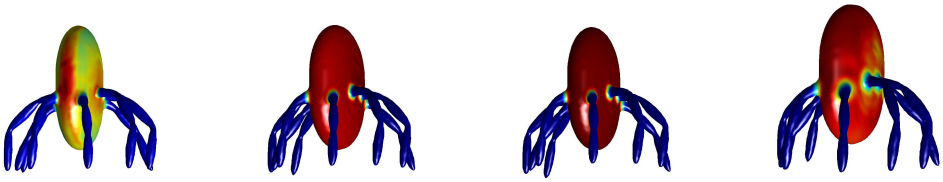

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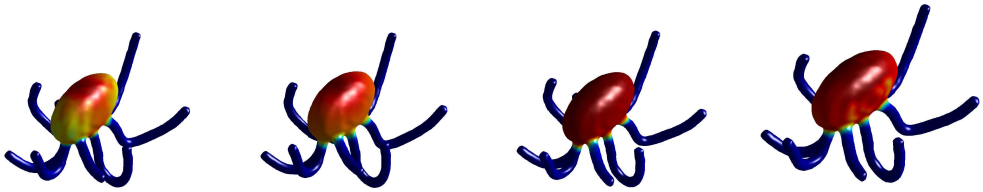

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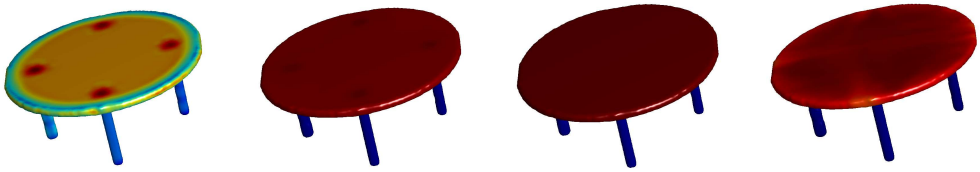

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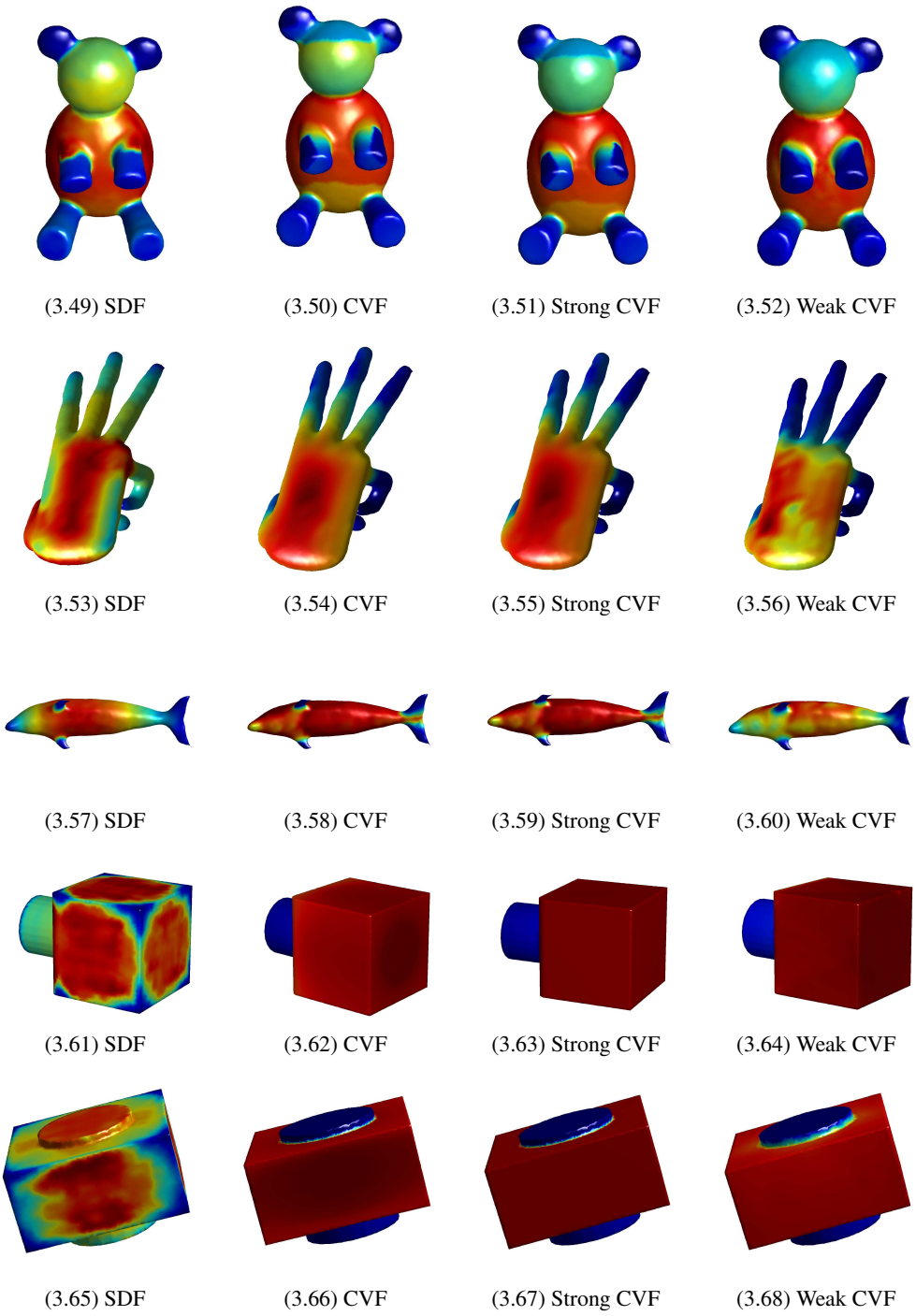

(3.49) SDF (3.50) CVF (3.51) Strong CVF (3.52) Weak CVF

(3.53) SDF (3.54) CVF (3.55) Strong CVF (3.56) Weak CVF

(3.57) SDF (3.58) CVF (3.59) Strong CVF (3.60) Weak CVF

(3.61) SDF (3.62) CVF (3.63) Strong CVF (3.64) Weak CVF

(3.65) SDF (3.66) CVF (3.67) Strong CVF (3.68) Weak CVF

Figure 3: SDF, CVF, Strong CVF and Weak CVF