Non-manifold Level Sets:
Review of changes from prior SIGGRAPH 2015 submission

An earlier version of this work had previously been submitted to SIGGRAPH 2015. For the convenience of any reviewers we may retain via continuity, we provide a brief summary of changes since the last submission.

1. Additional references have been added to relevant prior work in the field. In particular, we include citations to research by [Bloomenthal and Ferguson 1995; Yuan et al. 2012] on constructing multivalued implicit surface data structures from non-manifold input geometries, [Faure et al. 2008; Wang et al. 2012] on image-based techniques for collision processing, and [Zheng et al. 2006] on regional level sets for bubble simulations.
2. Since the term "level set" can be used in different contexts to refer to (a) a data structure, (b) the zero isosurface, (c) an implicit surface representation or (d) a signed distance field, we take care to properly convey the semantics of such instances in our exposition. We also qualify the term "non-manifold" by associating it with the non-manifold connectivity of the explicit mesh used to store signed distance values.
3. We understand that the basic principle of using a non-manifold embedding may not be quite as familiar outside the context of elastic simulation. Since our approach is conceptually motivated by such approaches, we expressly review a stock non-manifold embedding pipeline [Molino et al. 2004; Teran et al. 2005a; Sifakis et al. 2007] to place our modifications in context.
4. We simplified both our exposition and the algorithm itself, by making it non-iterative and handling the reconnection of the mesh and the introduction of transition faces simultaneously (as opposed to an add-on to the output of a basic embedding scheme). Functionally, our new formulation is identical to the earlier submission (although, we hope, much easier to comprehend) on all demonstrated examples. In certain (exotic) cases, our present formulation would actually produce a more topologically rich result than as described in the earlier submission (the earlier algorithm might take the more conservative approach of merging certain regions that the new algorithm could keep separate using transition faces).
5. We have generalized the concept of a transition face by representing it as a bipartite graph. This allows for arbitrary connectivity across faces. We have elaborated on the description as well as the intuition behind this concept in a separate subsection.
6. Our paper and submission video have been enhanced with more concrete examples to motivate the intuition behind our changes to the stock non-manifold embedding algorithm.
7. We have completely revised the exposition describing our algorithm. It now uses significantly less notation, and makes use of more verbal and intuitive descriptions of the individual steps.
8. For clarity, we have included pseudocode for our algorithm, which is used as reference in the text and gives a high-level summary of the overall procedure.
9. We have revised the section on distance computation by more clearly explaining the process of computing signed distance values on the nodes of the non-manifold level set mesh. We have also commented on alternative approaches, such as storing a normal field [Kobbelt et al. 2001].
10. We have revised the section on normal backtracing (for surface projection) by shortening the text and reducing notation. We have also included a new, more informative, figure which illustrates the different scenarios that may be encountered.
11. We have provided detailed timing information to highlight the overall performance of our system. The cost of constructing the non-manifold level set is a one-time cost prior to starting the simulation. During simulation, the cost of detection and surface projection is evidenced to require only a fraction of the cost of elastic simulation.