

Self-intersecting meshes are a pervasive challenge in computer graphics, frequently resulting from limitations in modeling techniques, animation deformations, or physics-based simulations that are unable to prevent mesh intersections. These issues can lead to significant difficulties in achieving both computational efficiency and geometric accuracy, particularly when meshes become highly convoluted or experience complex distortions during deformation or interaction.

A promising strategy for addressing this problem is to compute the shortest internal path from a given point within the mesh to its boundary. This method proves effective even in the presence of self-intersections or inverted elements, which are often present in such meshes. A crucial aspect of this approach is the precise definition of what constitutes the "shortest path" in these complex scenarios, ensuring that the computed path remains fully contained within the mesh's geometry.

The method leverages the concept of element traversal, where the path is validated by navigating through connected mesh elements, either triangular in 2D or tetrahedral in 3D. To optimize this process, a bounding volume hierarchy (BVH) is employed, allowing for the efficient pruning of boundary points that are irrelevant to the shortest path search. This ensures that only the most pertinent boundary points are tested, effectively narrowing the search space and improving computational efficiency.

This approach becomes especially valuable in scenarios where simulations cannot guarantee perfect collision resolution. By handling self-intersections after they occur, it permits the use of more computationally efficient integration techniques. Furthermore, it is robust enough to handle complex simulations with numerous and deep self-intersections, thereby facilitating the simulation of highly intricate mesh scenarios where traditional methods might fail.

The topic of self-intersecting meshes is important because it addresses a fundamental challenge in computer graphics, physics simulations, and animation, where complex deformations can cause unrealistic or visually disturbing overlaps within 3D models. As models become more intricate, these self-intersections can hinder both visual realism and computational efficiency. Resolving these issues ensures more lifelike simulations, especially in real-time applications such as video games and virtual reality, where maintaining accurate geometry is crucial. Moreover, the ability to efficiently handle self-intersections allows for more accurate and computationally feasible simulations in fields like automotive, aerospace, and medical imaging. This approach also integrates well with existing techniques that can't guarantee intersection-free states, providing a reliable fallback and enabling faster, less expensive simulations without sacrificing accuracy. Ultimately, this research offers a solution that improves the handling of complex meshes, making it highly relevant across creative and industrial applications where 3D modeling and simulation play a vital role.

