Signed distance computation using the angle weighted pseudonormal

The normals of closed, smooth surfaces have long been used to determine whether a point is inside or outside such a surface. It is tempting to also use this method for polyhedra represented as triangle meshes. Unfortunately, this is not possible since, at the vertices and edges of a triangle mesh, the surface is not $C^1$ continuous, hence, the normal is undefined at these loci. In this paper, we undertake to show that the angle weighted pseudonormal (originally proposed by Thurmer and Wuthrich and independently by Sequin) has the important property that it allows us to discriminate between points that are inside and points that are outside a mesh, regardless of whether a mesh vertex, edge, or face is the closest feature. This inside-outside information is usually represented as the sign in the signed distance to the mesh. In effect, our result shows that this sign can be computed as an integral part of the distance computation. Moreover, it provides an additional argument in favor of the angle weighted pseudonormals being the natural extension of the face normals. Apart from the theoretical results, we also propose a simple and efficient algorithm for computing the signed distance to a closed $C^0$ mesh. Experiments indicate that the sign computation overhead when running this algorithm is almost negligible.