We have developed a new, more accurate version of Merriman, Bence, and Osher’s threshold dynamics algorithm for evolving interfaces under geometric motions. The new version also alternates two computationally efficient operations -- construction of the signed distance function, and convolution with a kernel -- to generate a variety of geometric motions accurately on uniform grids.

For example, the affine invariant curvature motion of a planar curve $\Gamma_0$ moves the curve with normal speed $\kappa^{1/3}$ where $\kappa$ is its curvature. This motion is of fundamental importance in many computer vision tasks. With our approach, it can be approximated as follows: Given the signed distance function $d_{n-1}$ to the solution $\Gamma_{n-1}$ at time $(n-1)(\delta t)$, construct the signed distance function $d_n$ to the solution $\Gamma_n$ at the next time step by the following prescription:

1. Form the convolution $u(x)=G_{\delta t} * d_{n-1}$
2. Let $d_n(x)$ be the signed distance function to $\{ x : d_{n-1}(x)+ (u(x)-d_{n-1}(x))^{1/3} (\delta t)^{2/3} = 0 \}$.

where $G_t(x)=(4\pi t)^{-1} \exp(-|x|^2/4t)$ is the Gaussian kernel in 2D.