Segmentation numerical methods for area identification of Natura 2000 habitats in NaturaSat software

Michal Kollár[1], Martin Ambroz[1], Aneta A. Ožvat[1], Karol Mikula[1]
Lucia Čahojová[2], Ivan Jarolímek[2], Jozef Šibík[2], Mária Šibíková[2]

[1)] Department of Mathematics, Slovak University of Technology in Bratislava
michal.kollar@stuba.sk
[2)] Plant Science and Biodiversity Center, Slovak Academy of Sciences

The contribution presents an overview of numerical methods and mathematical models designed for the NaturaSat software. The application allows botanists, environmentalists and nature conservationists across Europe to explore protected areas of Natura 2000 habitats using the Sentinel-2 optical data. The presented methods are designed for accurate area identification - semi-automatic and automatic segmentation of European protected habitats and monitoring of their spatio-temporal distribution and quality.

Segmentation models are based on the evolving plane curve approach in the Lagrangian formulation. The first implemented segmentation tool is semi-automatic segmentation which allows a user to manually segment areas using a mouse cursor. By clicking, users create a nonlinear open curve, which is driven by constructed vector field towards the boundary of the segmented area. As the second segmentation tool, we use the automatic segmentation model, where we consider the time evolution of a closed planar segmentation curve driven by the movement defined as a combination of the movement in the normal direction and tangential direction. Movement in the normal direction represents a combination of three functions with different behaviour. The first function is an expanding term. This function drives the segmentation curve from its initial position through the segmented area to its border. The second function is the edge attracting term. This function attracts the evolving curve accurately to the boundary of the segmented area. The last function represents the curvature term which regularizes and smoothness the shape of the evolving curve. For the numerical solution, we use the flowing finite volume method discretizing the arising advection-diffusion intrinsic partial differential equation including the asymptotically uniform tangential redistribution of curve grid points.

These methods are verified by experts from Plant Science and Biodiversity Centre of the Slovak Academy of Sciences and State Nature Conservancy of the Slovak Republic and applied in different locations across Europe along the Danube river alluvium. At the end of the contribution, we also present examples of results from these locations.