22. Epilog

Computer vision is a huge field, and this book could only touch upon a small section of it. First of all, the emphasis has been on the introduction of the notion of *observing* the physical phenomena, which makes the incorporation of scale unavoidable. Secondly, scale-space theory nicely starts from an axiomatic basis, and incorporates the full mathematical toolbox. It has become a mature branch in modern computer vision research.

A third major notion is the *regularization* property of multi-scale operators, in particular spatio-temporal differential operators. This enables the use of powerful differential geometric methods on the discrete data of computer vision, for the many fields where differential structure is part of the analysis, such as shape, texture, motion etc.

A next major emphasis has been the inspiration from the workings of the human visual system. Here too is still much to be learned, especially in the layers following the visual front-end, where perceptual grouping and recognition is performed. The intricate feedback loops and the local orientation column linking should be among the first to be studied in detail. Modern neuro-imaging technology is about to give many clues.

The theory covered in this book, focusing on *bio-mimicking* front-end vision, is primarily applied to the *local* analysis of image structure. The extraction of global, intelligently connected structure is a widely explored area, where model-based and statistical methods prevail to arrive to good perceptual grouping of local image structure. The study of the multi-scale relations in the deep structure in scale-space, and the use of hierarchical, more topological multi-scale methods, has just only started.

Finally, computer vision is solidly based on mathematics, in any applicable field. Image processing has become a *science.*

This book showed the use of *Mathematica*, as a powerful combination of a complete high-level mathematical programming language, from which through *pattern matching* the numerical implementation can be automatically generated, enabling rapid prototyping for virtually all the concepts discussed in this book. Many of the functions are intrinsically *n*-dimensional.

The role of and need for robust computer vision techniques is ever increasing. In diagnostic radiology, computer-aided diagnosis will see great successes in the next decade, and the availability of huge image databanks will stimulate the study to image guided retrieval and self-organization of analysis systems.

Much has been left untreated, the main reason is that the field is so huge. A possible sequel of this book might include multi-scale methods for shape from shading, texture analysis (locally orderless images), 3D differential geometry, wavelet based analysis, nonlinear and statistical methods, and deep structure analysis.

This book is meant to be a *interactive* tutorial in multi-scale image analysis, describing the basic functionality. It is my sincere wish that this book has invited you to actively explore this fascinating area.

Eindhoven, Summer 2002.

```
Import["https://www.romeny.info/FEV-CD/images/ScaleSpaceForest02.jpg"]
```

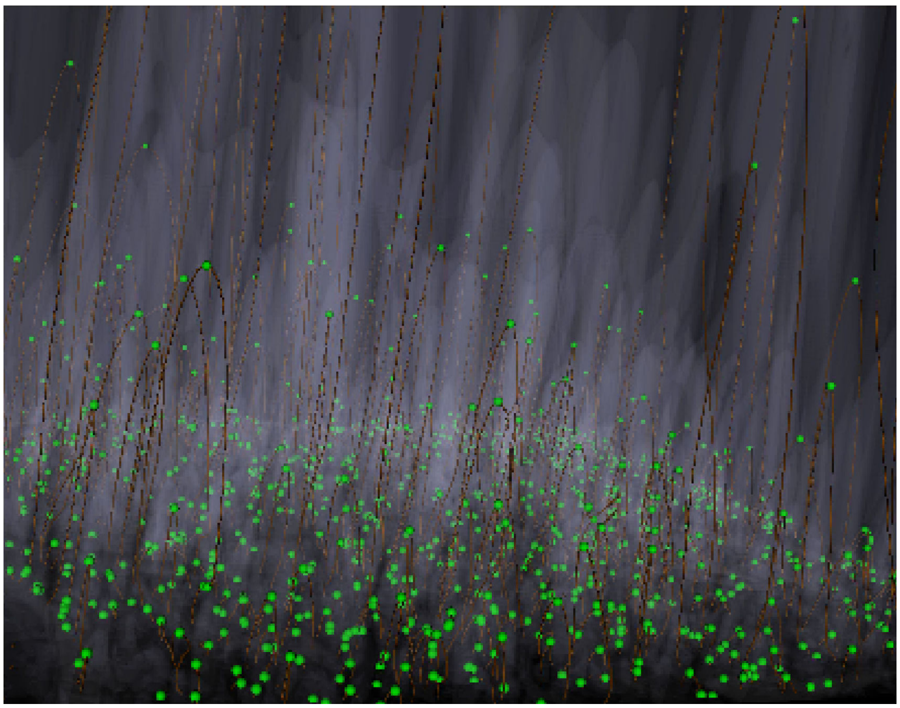

Figure 22.1 Artist's impression of a 'deep structure scale-space' forest, where the geodesic paths of the extrema and saddlepoints are shown as brown branches, and the points of annihilation of extrema and saddlepoints are depicted as green balls. Scale runs vertical. The mist is a partly transparent surface where the determinant of the Hessian vanishes. Artist: ir. Frans Kanters, University of Technology Eindhoven, Department of Biomedical Engineering, Biomedical Image Analysis Group, 2003.