RJMCMC Optimization of marble thin section image segmentations

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The project GrainAutLine [1] addresses the issue of easing the analysis procedure of marble thin section images which usually involves time consuming manual work. The traditional and the actually widespread method to extract valuable information about the images starts by drawing the borders of the grains by hand. These are then used to produce grain size histograms and further statistics about the grains and their neighborhood. Experts use these results to draw conclusions about the provenance of the sample, the quality, and a lot of other properties. The project is about creating a software especially for geologists which enables them to access the required information in an automatic way (further endeavor) or at least semi–automatic way (closer purpose). The automation involves the following features: identifying the grains using image segmentation methods, and extracting statistic related information. The full automation is difficult due to the fact that marble grains are not artificial formations and they can show anomalies even an expert may be confused about. To eliminate uncertainty caused by the difficult cases the program lets the user make some interventions and correct mistakes. In this work a sub–project of GrainAutLine is shown which deals with only the image segmentation.

The proposed algorithm presented in this paper is for the segmentation of the grains in a special situation when a lot of twin crystals pose a challenge for the traditional algorithms like adaptive thresholding. A twin crystal is the result of more small crystals when they melt into a bigger one under special circumstances, as this leads to very characteristic patterns inside the grains which need to be distinguished from the true grain boundary lines. The basic idea is the over–segmentation of the image with another algorithm which is already available in the software. The over–segmented picture contains many little segments called blobs and the algorithm structures the blobs into bigger groups called superblobs. The concrete superblobs give a possible configuration of the system. The goal is to change this configuration until the superblobs match the real grains. The change occurs according to an energy function which depends on the configuration. The better the configuration, the smaller the total energy. [2] The capability of the algorithm revolves around the good choice of the energy function. Finally, the remaining task is the minimization of the energy function.

The energy function is the sum of four energy terms. Each term grabs a concrete characteristic of the shape of the grains: (1) the fact that grains tend to be convex, that (2) the straight parallel lines indicate twin crystals. (3) The actual technique relies on the user's intervention in some extent because the user is required to mark every grain in the input picture, and that (4) grains do not entirely surround other grains. The proposed algorithm uses the Reversible-jump Markov Chain Monte Carlo (RJMCMC) optimization method [3] in order to change the configuration of the superblobs until the energy function reaches its minimum point. The algorithm was tested on both artificial and real images and the profile of its performance in terms of processing time, accuracy and convergence speed. The results have proven that the concept of this algorithm can solve the segmentation of marble thin sections even in the presence of twin crystals.

Acknowledgements

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References

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