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SEAT INFLUENCE AREA EXTRACTION FROM MAGNETOPTICS IMAGES

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In this paper we describe an image-processing pipeline for seat influence area extraction from magnetoptics images. The extracted areas are used for analysis of magnetic structures. Due to proposed approach a number of features can be obtained such as seed coordinates, seat influence area, magnetization front, velocity of magnetic field propagation, etc. These features provide physicists with vital additional information about magnetic materials and help to describe the complex nature of magnetization.

Introduction

Many physical experimental setups rely on digital image processing. The introduction of new generation of digital magnetoptics and scanning probe microscopy (SPM) enables new experiments. However the acquired images are often processed in manual time-consuming mode. And it is clear that complete system for processing and interpretation of magnetoptics images can not be constructed. Nevertheless the system which should extremely reduce the amount of routine work is in a high need.

The macroscopic properties of a magnetic material are determined by its magnetic microstructure. Therefore domain observation is essential for the development of magnetic materials and understanding of magnetization processes. We use magnetooptical microscopy for domain observation[1].

At the most basic level magneto-optic imaging is simply based on the rotation of the polarization plane of linearly polarized light upon reflection from a magnetic surface. The domain contrast in the image is directly sensitive to the magnitude and direction of magnetization. Arbitrary magnetic fields can be applied during observation so domain nucleation and magnetization processes can be observed easily. Possibly the utmost advantage over other domain observation methods is the speed and time-resolution in which images can be acquired.

An image-processing pipeline that assures correct determination of the magnetic field distribution of magneto-optical images is presented [1, 2]. The method remedies image faults resulting from sources that are proportional to the incident light intensity, such as different types of defects in the indicator film and light unevenness, as well as additive signals from detector bias, external light sources, etc. When properly corrected a better measurement of the local magnetic field can be made, even in the case of heavily damaged films.

The physical experiment allows to grab image for every value of magnetic field. This result to grabbing of images sequence. For these images seats of magnetization grow in depending on evolution magnetic fields.

The seats of magnetization, their influence and contribution in overall picture of magnetization are important and challenging problem in applied physics. Hence the approach which allows to estimate the seat influence area is proposed which consist of the following stages: noise reduction for image enhancement, image segmentation for magnetization seats extraction, accumulation image construction to take into account image changes and watershed operation for seat influence area extraction.

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1. The proposed approach

Image capturing by digital magnetoptics microscopy is a complex process which result to image distortion and noise appearance (Fig. 1). Thus the first step of our approach is noise reduction. There are several techniques for noise reduction and elimination [3]. For solving this task, it is possible use any methods of noise reduction. We recommend median filtration as more simplest and popular method.

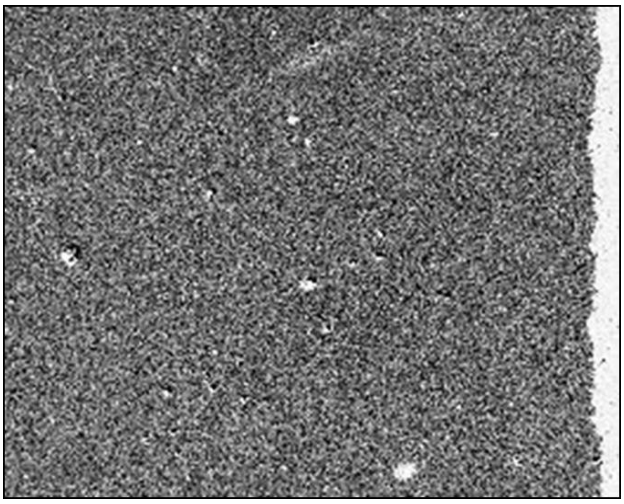

Fig. 1 Magnetoptic image

The segmentation step is required to extract the objects of interest. In our case the areas of magnetization are under investigation and should be correctly classified. We used the tresholding technique [4] for segmentation step (Fig. 2). On segmented image there are small particles which are treated as a noise to be filtered. The resulting binary image is constructed by seats regions. But often these regions are connected. Therefore, it is necessary to separate its.

Fig. 2 The sequence of binary images after segmentation

In addition the investigated scene is not static but dynamic and magnetization areas are changed in time. There are two types of magnetization areas: seats and front of magnetization. The seats correspond to stand alone white particles in images and the front is the largest white area in images.

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Depend on experimental condition the new seats can arise and the old one can be absorbed by the magnetization front. The changes of images are taken into consideration in accumulation multiphase image which is product of segmented binary images (Fig. 3).

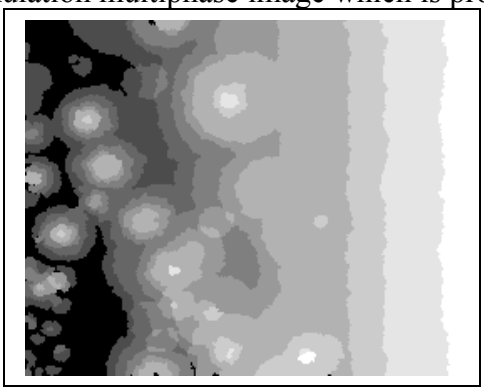

Fig. 3 Multiphase image after accumulation of binary images

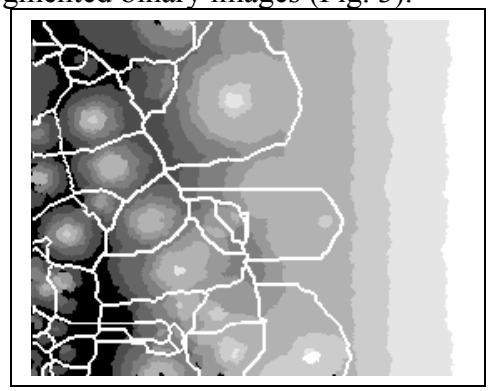

Fig. 4 Seats influence area extraction

The watershed operation is a popular image segmentation algorithm which simulates a flooding process [5, 6, 7]. Multiphase accumulative image is identified with a topological surface, in which the attitude of every point is equal to the phase level of the corresponding pixel. Once the relief is completely covered by water, the set of obstacles depicts the watershed image. In our case watershed image allows to evaluate the degree of seats influence in magnetization front formation (Fig.4).

In result the proposed pipeline for extraction of seats regions are represented by two phase (fig. 5): processing every image from sequence and processing accumulated image from sequence.

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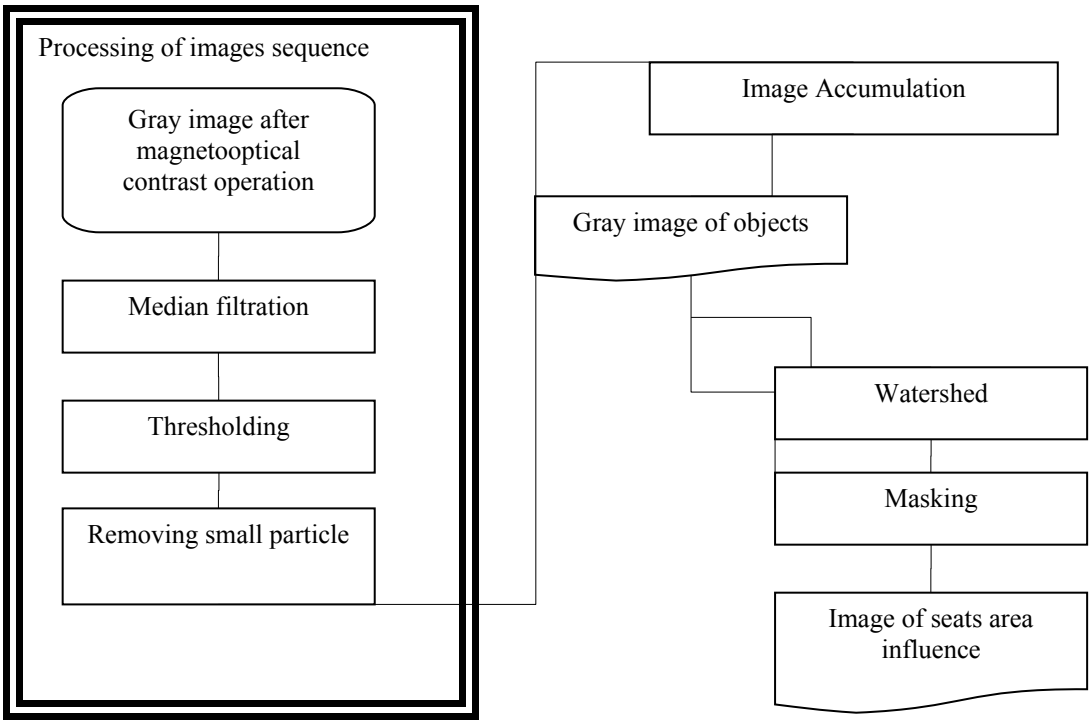

Fig. 5 Pipeline for seat influence area extraction

Conclusion

The described image processing pipeline allows to extract seats area influence from magetoptic images. The result of this processing is multiphase image. which includes information about seats evolution against changing of magnetic field. The proposed approach allow physicists to focus on result interpretation rather than image processing. That is why it is more convenient for analysis of magnetic properties of samples and serving results of analysis.

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