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Technique for processing imagery of plans and drawings obtained using digital camera

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Abstract

In practice, digital high-resolution cameras can be used to digitize plans, schemes, drawings and other similar documents. In this paper, we consider problems and limitations that arise in the processing of such documents, and propose a corresponding image processing technique. The proposed technique includes the assessment of a camera resolution, the correction of geometric distortions introduced by the camera's optical system, and the compensation of an uneven illumination.

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Keywords: estimation of resolution; slanted edge; geometric distortion; radial distortion; camera calibration; Gaussian filter; compensation of uneven illumination

1. Introduction

In recent years, the digitization of archival documents presented on solid carriers is an urgent task. A natural solution to this problem is the use of high-quality scanning equipment, which makes it possible to work with documents of a required size. Scanning of documents of a size up to A4 is usually not a problem, since flatbed scanners are ubiquitous and are inexpensive. A number of flatbed scanner models are also available for scanning documents of a size up to A3. Flatbed scanners for documents of A2 size and larger are quite rare and expensive. For these sizes, roll fed scanners are more often used.

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Unfortunately, even in the presence of such a scanner, it is not always possible to solve the task of digitizing documents of the required size. Firstly, the thickness of the scanned document is limited to several centimeters, even if the roll-fed scanner with lifted cover is used. Secondly, the transmission of old and valuable documents through the pull mechanism of the scanner can be unacceptable. Thirdly, the scanning of a document by the roll-fed scanner can be impossible due to the physical deformation of the document presented on a hard surface. Jamming, slipping, and skewing of such documents may occur in the pull mechanism of the scanner due to deformations of documents. The scanned document can also be heavily contaminated, including substances with abrasive properties, which causes premature wear out of the scanner parts. First of all, the expensive cover glasses of the scanner suffer from scratches, which cause artifacts (stripes) on the scanned images that cannot be eliminated by the calibration of the scanner. Due to the above reasons, it is better to use contactless ways of digitizing images for the entire set or part of documents that cannot be digitized in other ways.

Such a problem could be solved by scanners of projection type, large-format scanning stations, but such equipment may not be available, and this task has to be solved by other methods. For example, one of such methods is the scanning of documents in parts, followed by gluing parts into single image or using photo equipment. This paper is devoted to the development of a technique for creating digital copies of documents (including documents presented on hard surface) using high-quality high-resolution photographic equipment.

It is assumed that the developed technique can be applied to the processing of snapshots of plans, schemes, drawings and other documents, when it is essential to preserve the geometric properties of the depicted objects, and other characteristics, such as the color rendering quality, are not important.

The paper is structured as follows. The second section examines the problems and limitations that arise in processing the captured images, and presents the image processing technique. The third section is devoted to the question of estimating the resolution of the captured images. The fourth section describes the problem of eliminating the geometric distortion introduced by the optics of a camera. The fifth section considers the problem of compensating for the evenness of illumination. The sixth section presents the results of experiments. The last section gives conclusions and lists the issues that remain beyond the scope of this paper.

2. Processing of captured images

Compared to an image scanner, an image taken with a digital camera has a number of distortions (geometric, brightness, color, etc.) that can make it difficult or impossible to solve particular applied problems using captured image. The quality of the captured image can be determined by different parameters:

- correctness (cropping, orientation, etc.);
- artifacts (defects, dust, etc.);
- resolution;
- geometric distortions;
- evenness of illumination;
- color accuracy;
- noise, etc.

Some parameters, such as the cropping, orientation, the presence or absence of artifacts, the presence of exposures can be completely controlled by the operator who performs the digitizing. Other parameters, such as color accuracy, may not play a significant role in digitizing of plans, drawings, schemes and other similar documents. But there are critical parameters such as resolution, geometric and significant brightness distortions, which cannot be ignored, since the possibility of using the resultant images depends on them directly.

The first of these parameters is resolution that is determined by the equipment used for digitizing. If equipment does not meet the requirements to resultant images, the only solution is to replace it, since it is very difficult, if at all possible to compensate for the lack of resolution in the post-processing stage. In connection with this, the first important step of the considered technique is to check the equipment to ensure compliance with the requirements to