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Increasing the effectiveness of intelligent information technology for producing digital graphic documents with weakly formalized description of objects

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Abstract

In this paper, we present models, methods and algorithms designed and developed with the aim of increasing the efficiency of information technology for producing digital graphic documents. The hierarchical model of structured description of raster images of graphic documents, 3D контроль ошибо1the two-criteria recognition algorithm with self-learning, algorithms for automatic assembling of composite linear and discrete objects, methods for increasing the automated component of interactive editing procedures and assigning classification types to automatically generated templates, 3D modeling and visualization methods at the stages of interactive control and editing that have been implemented in the framework of the proposed technology contribute to a significant increase in time efficiency. The results obtained are demonstrated using the example of digitizing some typical images of real-world documents.

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Keywords: intelligent IT; efficiency; vectorization; description models; recognition

1. Introduction

Currently, the problem of producing electronic archives of large-format graphic documents (topographic and nautical charts, design documentation, technical drawings, circuit diagrams, etc.) remains important and relevant.

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The source materials for such archives are usually graphic images on paper, and it is necessary to produce vectorized digital documents in the terms of the relevant problem areas. This process is extremely time-consuming. In order to automate the input technology for graphic documents, various information technologies based on heuristic procedural methods and also on the recognition methods with the teacher have been proposed in recent years. Such technologies are effective for only a limited set of objects with strict limitations concerning their size and orientation [1-10]. However, there is a significant class of large-format graphic documents that are made by hand. Such documents feature weakly formalized graphic representation of objects, arbitrary orientation, arbitrary sizes of symbols, the presence of a large number of inter-object overlaps, junctions and intersections. All this significantly reduces the performance of existing information technology for vectorization of this type of graphic documents and necessitates the development of new models, methods and software for intelligent IT.

2. Problem statement

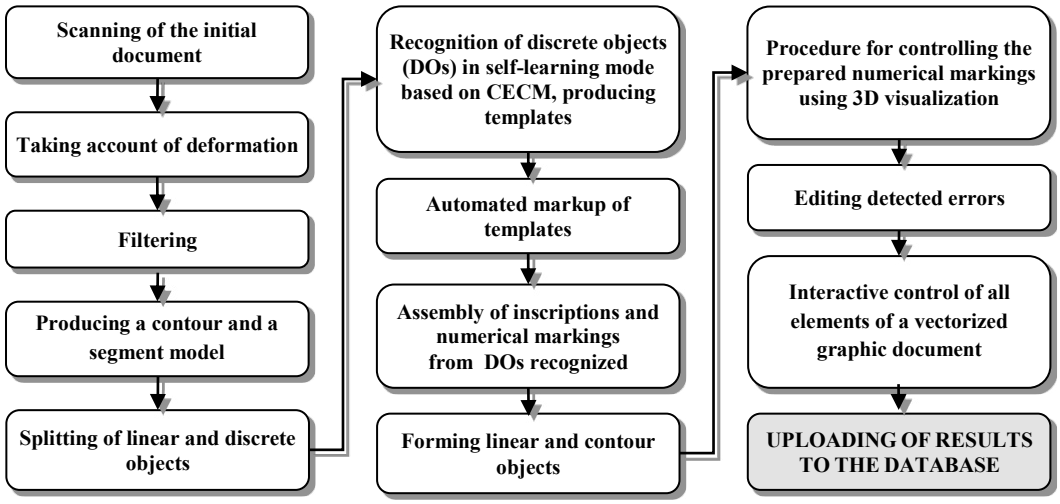

Fig. 1. The technology for automated input of large format graphic documents.

We consider the problem of increasing the efficiency of various stages of the information technology for creating digital graphic documents with weakly formalized description of objects.

Some ways for solving this problem are proposed that involve the use of hierarchical models for structured description of raster images of graphic documents, a two-criteria algorithm for recognition with self-learning, algorithms for automatic assembly of composite linear and discrete objects, increasing the automated component of interactive procedures for editing and assigning classification types to automatically generated templates, as well as applying 3D modeling and visualization at the stages of interactive control and editing.

3. Effective models for structured description of raster graphic documents

The task of automated input is achieved within the framework of the technology that involves the construction of a hierarchy of image models. The lower level of the hierarchy contains information obtained directly from the scanning input device, and the upper level matches the storage format in the database, with the account of the domain's knowledge base.

The mathematical model of the image M^v of rank v is considered to mean the triple $M^v = (E^v, R^v, C^v)$, where $E^v = (e_1^v, e_2^v,.., e_s^v)$ is a set of non-derivative elements of the model, $R^v = (r_1^v, r_2^v,.., r_t^v)$ is a set of permissible relations between non-derivative elements, $C^v = (c_1^v, c_2^v,.., c_k^v)$ is a set of characteristics of non-derivative elements.