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Markers detection on facies of human biological fluids

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Abstract

The precise diagnostics of different diseases is very important for its treatment. It is particularly important to differentiate the disease on the early stages when the pathological alterations have not yet caused great harm to the whole organism, since this allows using greater number of therapies and increase the recovery probability. One of the methods of early diagnostics is based on examination of human biological liquids (blood, tears, cervical mucus, urine, etc,). A small drop of liquid is drawn on an object-plate and dried out slowly, thus a thin dry film (facies) remains. In the process of fluid crystallization there appear characteristic patterns (markers) in the facies. Each marker is a highly definite sign of some pathology even at an early stage of a disease development. When mass population health examination is carried out, it is necessary to analyze a large number of images This is the reason the problem of algorithm and software development for automated processing of images is rather urgent nowadays. In this paper, the algorithms for detecting several markers on images of facies are presented. First, the characteristic features (location, geometry, brightness, variation, spectrum, etc.) were revealed by means of their visual analysis of markers. Then, the methods of algorithmic detection of these features were developed. The decision about the presence of the marker was made provided a set of its necessary characteristics. Tests of algorithms showed that correctly identified images with different markers was 92-98% with 10-14% of false alarms.

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Keywords: medical diagnostic; biological fluid; facies; marker; detection; recognition

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1. Introduction

The mathematical analysis of medical images is a very important tool for medical diagnostic systems that allow to significantly improve the diagnosis quality. So there is an important problem to develop efficient methods and algorithms for early diagnostics of various diseases. The last years have been characterized by significant achievements in the algorithmic image analysis in vascular structure [1,2], ophthalmology [3], mammary glands [4], skeleton [5-7] and other areas of medicine.

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The method of studying biological fluids by means of their dehydration and analysis of the crystallization of contained substances has a long history. The theoretical description of the process of evaporation of a drop was made by D.K. Maxwell [8]. Bohlen investigated the facies of capillary blood and noticed a connection between markers and gastrointestinal tumors [9]. A systematic study of facies markers were carried out by V.N. Shabalin and S.N. Shatokhina [10]. The majority of obtained methods involve visual image analysis with a variety of techniques, which increase the quality of visual perception: special microscopes, chemical additives in biological fluid, etc. When mass health examination is carried out, it is necessary to analyze a large number of images. The eyes get tired rather quickly that's why the analysis becomes rather inefficient. Small and ill-defined markers can be missed, which leads to errors in diagnosis and omission of a diseases with all the consequences that come with this. One of the promising way of getting qualitative and efficient image analysis is the automated computer processing. This is the reason, the problem of algorithm and software development for automated image processing is rather urgent nowadays. However, there are much less such papers. Nowadays, researches in this direction are actively conducted. Several algorithms and automated systems where developed (for example, [11,12]). Algorithms presented in [13-15] are elaborated to detect several peculiar markers with high probability while the probability of false alarms is low. The comprehensive review and bibliography are given in [16].

The markers on facies of the biological fluids are very diverse in shape, size, orientation, etc., which is the main difficulty in their algorithmic recognition. In the present work, the following approach to the development of recognition algorithms is used. First, a visual analysis of the markers is carried out to reveal their characteristic features. Then the methods of algorithmic detection of these features are developed. The decision about the presence of the marker is made if a combination of its necessary characteristic was found in the image section.

Note that only a medical worker can make the final diagnosis to the patient. Computer analysis of the facies is only auxiliary. Its destination is to identify images on which specific set of markers is present. Therefore, it is not necessary to find all markers of this type on the image. It is enough to find at least one of them and inform about it. Then the operator will perform a more thorough analysis of this image. In fact, it is required to select images which contain at least one of considered markers. This is an indicator of the effectiveness of algorithms for detecting and recognizing markers.

2. The examples of images of biological liquids facies

Let us consider some examples of images of the blood serum facies. There are two images of the whole drop in Fig. 1. In the normal state of the body, the image has a regular radial-ring structure (physiological morphotype). In the presence of pathologies, the regularity of the structure is disturbed (pathological morphotype) and pathological markers appear. Some of them are shown in Fig. 2 and 3.

3. The image preprocessing

Each marker has a number of features, among which: the location on the image field relative to the cracks that make up the skeleton, the local brightness and uniformity. Therefore, preprocessing is first performed to find the separation of these common features.