Conference Paper

System Approach to the Development of Intelligent Complexes of Oncological Diagnostics

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Abstract

The system approach to the development of intellectual complexes in cancer diagnosis are discussed in the article. Distinctive features of this approach: the participation of pathologist at the stage of description of recognizable images (the description is based on traditional assessments of quality informative features of tumors); the set of the most similar probabilistic diagnoses is forming on the classification stage of recognition; final histological diagnosis is made by pathologist. The proposed approach has been successfully tested in clinical practice.

Keywords: image processing, image description, image classification, pattern recognition, qualitative attributes of tumor images, interactive recognition, cancer diagnosis, decision support system

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1. Introduction

Medical diagnostics from the position of smart metering systems is one of the most promising areas of pattern recognition. A large class of medical diagnostic systems is associated with image processing.

The procedure of image recognition in histological diagnosis intelligent systems is in the stages of macroscopic and microscopic analysis. Microscopic analysis is the final and most sophisticated diagnostic stage. Diagnostic conclusion is generated at this stage by using expert systems. In this context main attention in this work will be paid to the detection of tumors at the stage of microanalysis, and it is illustrated by practical examples.

Number of papers are dedicated to research and development of key provisions of the methodology of high-tech information-measuring cancer diagnosis complexes [1-12].

The purpose of this article is to develop an approach to the recognition of images in clinical intelligent systems of histological diagnostics of cancer diseases on the basis of light microscopy.

2. Materials and methods

Next provisions are the basis of a system approach to the development of intellectual complexes in cancer diagnosis.

1. The principles of recognition of microscopic images of tumors must conform to the schema of classical training of the pathologist and correspond to the logic of the diagnostic search of pathologist on all stages of recognition. It is base for the construction of intellectual systems of cancer diagnostics.

   First of all, it concerns the fundamental recognition stage - describing of the images of the histological microscopic preparations and as well as making diagnostic decisions at the stage of image classification. Description is used for creation of a parametric space [1-5]. The implementation of intelligent systems of medical and technical diagnostics on the basis of light microscopy with such approach to the recognition showed the trust of users to the system. It is special psychological importance.

2. On selecting the recognition mode from automatic (without participation of pathologist) or automated (interactive with participation of pathologist) it should be applied an automated mode for working option of clinical application. The reason is that for the present time work on creation of automatic recognition systems of microscopic histological images have not yielded positive results in general. The main reason is complexity and weak formalization of recognition objects [1-5]. Conducting of procedures of informative quality features measurement (by scaling) of the diagnostic images on their stage descriptions should be included in interactive recognition mode.

3. The interactive features of micropreparations images in histological diagnosis clinical intelligent systems should be based on the classical (traditional) for the pathologist's qualitative descriptions that reflect morphological features of structural and cellular structure of tumors. So, the description of histological variants

of tumors of the thyroid gland contains 15 groups of traits with their details on each group. For example – the structure type (12 types), form follicles (2 signs), cell shape (9 signs), the shape of the nuclei (9 signs), and others [4].

4. Reference database of microscopic images of the tumors for the recognition tasks decision is formed on the basis of the adopted histological classification of tumors. Knowledge base for 9 organs (thyroid gland, esophagus, pancreas, kidney, mammary gland, esophagus, stomach, large intestine, lymph nodes) was created according to this principle by experts of the N. N. Blokhin Russian Cancer Scientific Center and the National research nuclear University "MEPhI". It contains 7988 images (2615 cases). For example, the thyroid gland includes 813 images (324 cases)[5, 9, 11].

5. The diagnostic solutions making at the final stage of recognition – classification of tumors in histological diagnosis intelligent systems should take into account the ambiguity of the diagnosis. This means that the result of recognition in these systems needs to be not the only diagnosis but a set of diagnoses that are most relevant to the studied case. Moreover, it makes probabilistic assessment in the classifier of the diagnostic options on the rating system [4, 10]. The standard comparison method corresponds to pathologists diagnostic search. For the same reason a measure of the closeness of recognized and reference images is advisable to choose on the basis of frequency of occurrence of characteristic combinations of the detected object among the signs of the reference objects. Affiliation of histological image of the tumor to one or another diagnostic variant is defined on the maximum of occurrence frequency.

6. Discussed in this paragraph the position is shared. It concerns the role of histological diagnosis intellectual systems (on the basis of pattern recognition) and the role of the pathologist in the diagnostic process. In the formation of the specified role it should be aware that legal responsibility for diagnosis are the responsibility of the pathologist. Therefore, the results of recognition of tumors in clinical intelligent systems must be recommendations for pathologist. The pathologist can take them and if necessary to appoint additional diagnostic tests or to discuss with colleagues – in person or remotely (with the use of network technologies). The purpose of these procedures is making a final diagnostic conclusion.

3. Results and discussion

In this context, the histological diagnosis intellectual system (based on recognition) should be qualified as a decision support system (DSS) [4]. From this point of view, DSS should be considered as a tool for the pathologist. And accordingly, it is an essential point to consider development methods and construction means for histological diagnostics intelligent systems of cancer diseases for their use in clinical practice.

Analysis of the effectiveness of the proposed approach for the young (working experience up to 5 years) pathologists of the N. N. Blokhin Russian Cancer Scientific Center showed that the use of the interactive recognition approach allowed to reduce the recognition error of 3.5 times.

Along with the above application of histological diagnosis intelligent system it can be used both in research and in teaching of medical students, and training of pathologist. In addition, such systems can be used independently and in integration with hospital information system that ensures prompt analysis of the clinical data for the analyzed case.

4. Conclusions

We obtain the following main results.

Approach of interactive recognition of histological preparations microscopic images was proposed. It is based on our experience of research of images with complex spatial-luminance elements.

The approach is intended for use in histological diagnosis intelligent systems of cancer diseases.

The interactive recognition approach is based on procedures corresponded to the classical scheme of training of pathologist, which is important for its application in clinical practice at the present stage. The method involves the participation of pathologist to describe the images in traditional morphological qualitative characteristics of images of tumors.

The result of the decision at the final stage of recognition - classification of histological images of tumors is the set of most probable diagnoses that meet the examined (diagnosed) case.

The set of diagnostic variants is carried out by means of rating in the classification for the frequency of occurrence of combinations of informative features of images of the studied case in the reference base.

The results of image recognition of tumors in histological diagnostics intelligent systems of cancer diseases are recommended. Pathologist gives final diagnostic conclusion.

It is advisable to create histological diagnosis intelligent systems on a single hardware and software platform for research and clinical information systems to improve the efficiency of their use.

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