Hyperspectral images neural network analysis of unstained micropreparations

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***Abstract* — The article presents the results of a study of hyperspectral imaging in microscopy to assess pathological changes in unstained medical micropreparations. Hyperspectral imaging was carried out using a system of synchronous shooting and movement of a movable table combined with a stepper motor. To improve the quality of the obtained images, software correction of the illumination of the spectral channels was used. The classification was carried out by a convolutional neural network. This method may be promising for assessing pathological changes in clinical practice. Experimental studies were carried out on histological preparations with different types of tissues without staining with contrasting medical dyes. To assess the reliability of the classification method, a comparison was made with the standard method using staining of the studied samples.**

Keywords — Hyperspectral images, convolutional neural networks, spectral-spatial classification of hyperspectral images, histology, histological slides.

I. Introduction

Hyperspectral Imaging (HSI) is a non-invasive imaging technique for quantitative and objective surface analysis that detects reflective light [1]. Hyperspectral imaging is used for satellite and geographic measurements [2–9], but in recent years, it has also been used for medical research [1, 10]. Unlike conventional RGB images, HSI uses more spectral channels (up to several hundred), with each channel having only a small amount of bandwidth. HSI generates a 3D from 2D image dataset at each wavelength called a hypercube. This paper presents the results of comparing the classification of tissues in stained and unstained biomedical preparations. The results show the possibility of using HSI instead of the staining procedure, while maintaining a high accuracy of tissue type recognition.

II. Hyperspectral data

The survey was carried out with a scanning hyperspectrometer adapted to work with a microscope.

Hyperspectral images of stained and unstained histological preparations were obtained.

The stained micropreparation was a vessel of a cat without pathologies and was obtained by standard histological “wiring” with staining with hematoxylin and eosin, followed by placement under a coverslip.

The unstained micropreparation was a human vessel in pathology, the process of obtaining it is identical to that described above, except for the staining stage. The preparations had a thickness of 5 and 8 μm, respectively.

Hyperspectral images were subjected to preprocessing to compensate for distortions, as in [11].

III. Neural network classification

For the most efficient feature extraction, three-dimensional convolutional layers assembled in cascades with convolution kernels of different sizes were used [12, 13].

To improve the quality of training, a batch normalization layer was added after each convolutional layer. Training was carried out on 20% HSI, validation was carried out on 10% of the training set and took 30 epochs.

IV. Results

Examples of neural network classification are shown in Fig. 1 and Fig. 2.

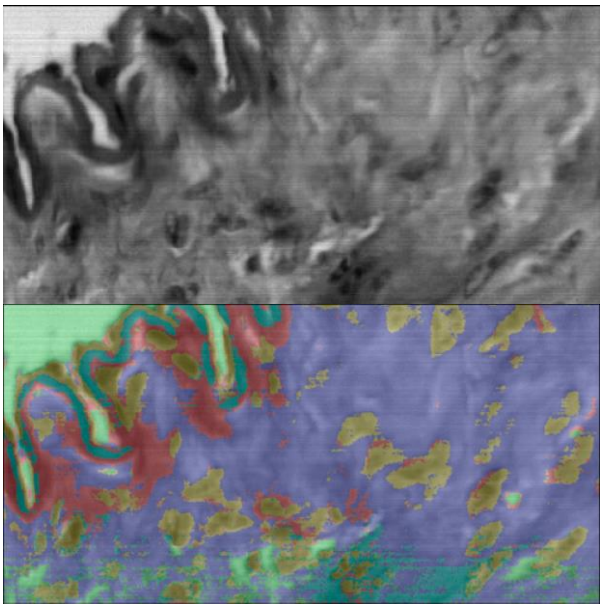

Fig. 1. Result of classification stained micropreparation

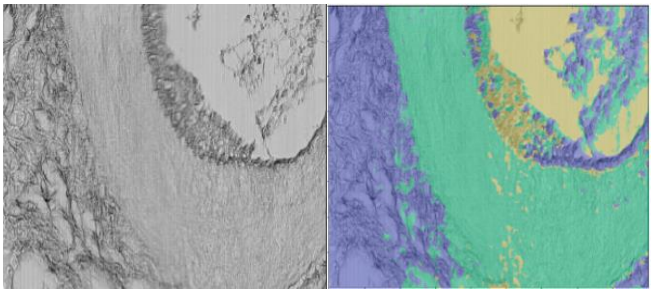

Fig. 2. Result of classification unstained micropreparation

The numerical representation of the results is given in Table 1.

TABLE I. CLASSIFICATION RESULTS

	precision	***recall***	***f-1***
painted	0.77	0.73	0.74
unpainted	0.79	0.76	0.77

As can be seen from the presented data, the classification of tissue type is possible without the staining procedure of the micropreparation with sufficient accuracy.

V. CONCLUSION

In this work, hyperspectral images of high spatial-spectral resolution of stained and unstained medical micropreparations were obtained. The possibility of classifying unstained micropreparations with high accuracy is shown, which makes it possible to reduce the time and money spent for analysis. A comparison was made between the classification of stained and unstained preparations to test the performance of the analysis method.

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