UDC 004.8 (045)

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IMAGE PROCESSING OF CT WITH HELP OF A CONVOLUTIONAL NEURAL NETWORK

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Abstract*—*The methods of learning Artificial Neural Network to analyze computed tomography images and identify them on the disease.

Index terms—Deep learning; image processing; medicine; artificial neural network; computer tomography.

I. INTRODUCTION

Computed tomography (CT) (Fig. 1) at this stage of the medical engineering is one of the most effective methods of informing diagnosing diseases of internal organs, including the liver. Computed tomography liver is a detailed study of the internal organ ray technique that allows at an early stage to determine the presence of the pathological process of unexpressed symptoms. Due to the fact that all protocols perform carefully verified CT scan does not depend on the individual doctor, as there is a standardized method of diagnosis. Methods of diagnosis involves X-ray radiation in small doses, so that is displayed on the monitor and layered three-dimensional image slices of the body, which can determine the size, state, structure, tumors and other data.

Fig. 1. The device CT

Appointed CT liver in the presence of formations surround character to determine the etymology of tumors (benign or malignant), signs of primary research oncology metastases cysts, hemangioma and other tumors, the value of which exceed a diameter of 1 cm. Using CT determined complications after injuries or operations – abscesses, billoma, hematomas, circulatory disorders. This research will help identify the presence of blood clots in the portal vein, arterial anatomy of the body, its precise dimensions and indicators tumors, hemosiderosis (the amount of iron in the liver). This technique allows for diagnostics of overweight and obesity in excess areas of research. And this is not all the clinical picture that can detect computed tomography of the liver. Early diagnosis gives hope for a positive clinical outcome and patient recovery through successful conservative treatment without the presence of surgery.

The process of diagnosis

The scanner has the shape of a cube with smooth corners. There is a round hole into which enters the patient lying on his mobile diagnostic table in the center of the cube. Then the process of X-rays begins, in which special sensors record the radiation absorption by various tissues. Based on these data layers generated three-dimensional image. Typically, to improve contrast, before the study physician enters the patient intravenously special agent based on iodine.

II. RESEARCH PROBLEMS

Liver tissue density exceeds tissues surrounding organs such as the spleen or pancreas. Normally it is homogeneous, so the lower density areas generally correspond to the location of major blood vessels of the liver (Fig. 2). With the visualization of the hepatic artery often have problems, because in such cases, a contrast agent. To scan small inside in the liver ducts are practically invisible. Quite distinct visualization comes from the common bile duct and common hepatic. Due to the lower density is easily visible and the gallbladder, which has to scan an elliptical shape [4]. Even the smallest tumors can be diagnosed using quick personnel scan. To ensure the doctor-diagnostician can add a contrast agent. In some cases, tumors tissue density coincide with the tissues of parenchyma, in which case you can guess

the presence of this pathology by distorted contours of the liver.

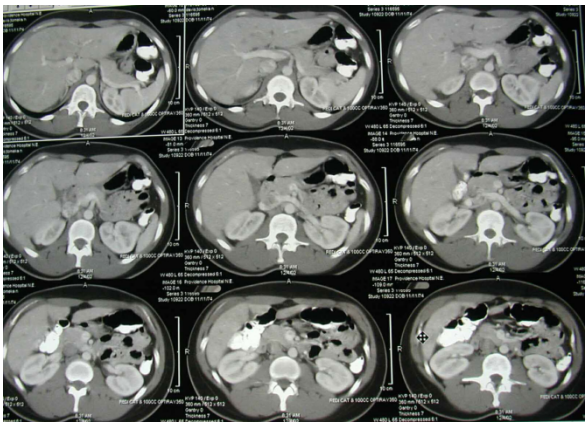

Fig. 2. Photos stages of liver CT

Density cancer tumors may depend on the stage of development. Similarly, the density may vary clots in major blood vessels of the liver. For example, a blood clot that forms inferior density tissues of liver parenchyma, the density of fresh clot is higher. These features allow the identification of blood clots during a CT scan (Fig. 3). Differences in density also allow for CT determine the cause blockage of the bile ducts.

Fig. 3. Image defects liver CT image

The reasons may be different. For example, calculus have a different density, so easily visualized. The cause obstruction can also be tumor formation at the head of the pancreas. As for the differential diagnosis of different types of jaundice, there is first of all pay attention to the state of the same duct. For example, if the bile ducts dilated, with high probability we can speak of obstructive jaundice. Computed tomography liver – visualizes the affected body on the screen, showing him in a few sections. These projections allow to collect three-dimensional image space, which will provide detailed information not only about the shape and size of the liver, but also all the structural anomalies investigated organ.

If this is the tumor, we can study it as accurate localization, determine the size and potential threat to the liver and surrounding organs. In addition, there is a possibility as accurately recognize its nature, such as malignant and benign [5]. So the photographs obtained during the test, you can find:

– structural features of the liver;
– primary tumors and metastases;
– cirrhosis;
– bleeding places;
– parasitic cysts;

Computed tomography – features and benefits:

– X-rays used in CT scans, have no side effects. After examination of traces of radiation in the patient's body remains;

– computed tomography is designed for the diagnosis of changes in organs and tissues that are impossible to detect at other methods;

– no imposition of organs and tissues – no closed areas;

– it allows to estimate the ratio of the size of the study area;

– highly accurate visual picture;

– computed tomography does not require removal / disposal of all metal objects (implants) in the patient's body.

Analysis of images obtained by CT, is quite complex and lengthy process. Explanation images of the liver involves identifying the pictures of pathological changes of liver tissue. Usually it takes 30 to 60 minutes. So better to use intelligent image processing. That ceiling is convolutional neural network.

III. PROBLEMS SOLUTION

Artificial Neural Network (ANN) – nonlinear system that allows much better categorize data than using conventional linear techniques. In addition to medical diagnostics, ANN makes it possible to significantly increase the effectiveness of methods of diagnosis and assign adequate treatment [1], [2]. Problems are solved using neural networks:

– classification of images;
– clustering, categorization;
– the prediction, forecast;
– management.

The main problem is the classification of images. Convolutional neural network solves this problem, because the image processing is not full, and parts. While studying online image goes through a number of layers rolls, with reduced image size to speed processing. At the end of training the neural network generates map features characteristic of this type of images.

Research images

To search for disease neural network to analyze the site and identify characteristic features. Under the structure of the liver feature meant its size (that is the lot, where the size of the liver is considered normal). During the transition beyond this area is considered that the liver and be allocated deformed part that went beyond the norm [4]. Primary tumors, cysts and metastasis determined by the following criteria, certain areas of abrupt change its color or gradation, and the form is close to the range where the color has changed. (Figs 4 and 5).

Fig. 4. Computed tomography with contrast. Multiple simple cysts of the liver

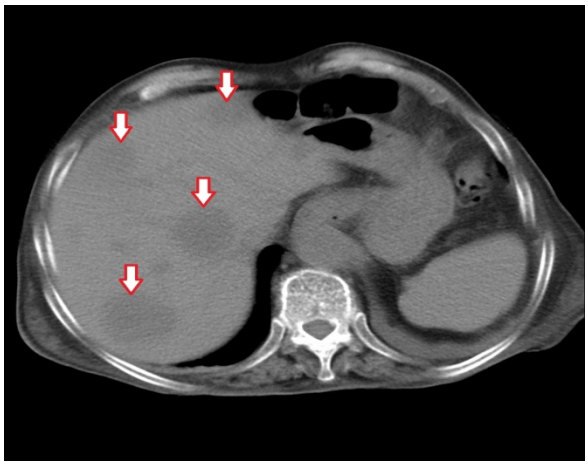

Fig. 5. A typical type of metastasis

Hemangioma has the characteristics of the image – low density, round shape created with a homogeneous structure and a clear outline [5]. In cirrhosis of the liver – the body nodular structure, rough, hilly edge of the liver, liver increased in size, but in the end stage of the disease is becoming less the norm.

Pictures show cirrhosis and ascites (Fig. 6). Size outlined strilkamy.Sama liver liver has no larger than the spleen. Liquid on both flanks abdomen marked with an asterisk "*". Places are bleeding bruise on uneven torn areas in the liver. If space formed by cirrhosis bleeding then be shown the recess of frozen blood inside, that little black pit throughout the liver.

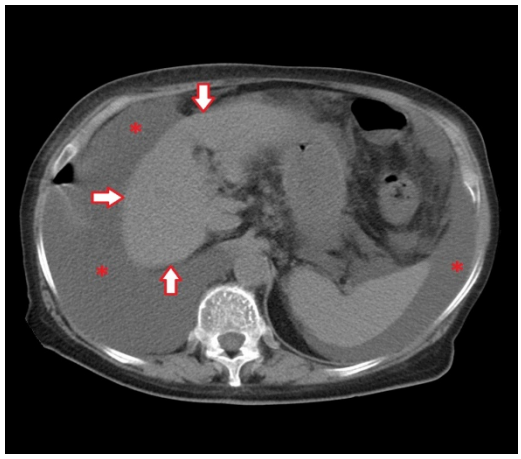

Fig. 6. Cirrhosis and ascites

Hepatic steatosis – defined marked reduction in the density of the liver parenchyma. Her background is clearly visible nekontrastirovani vein of the liver (Fig. 7).

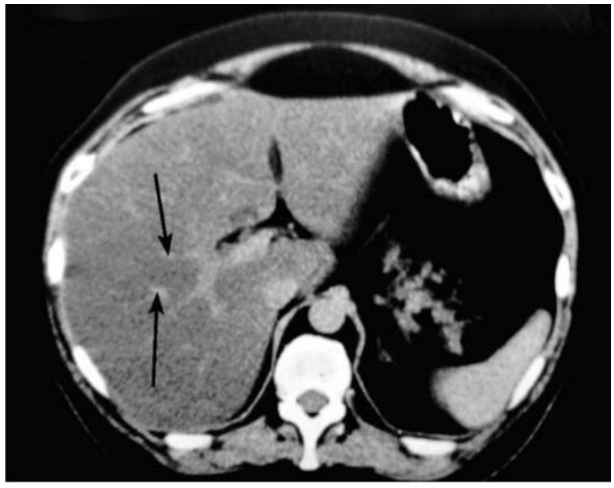

Fig. 7. Hepatic steatosis

Test DataSet

We use images taken physician during the examination of the patient to CT.

As the amount of data is limited, it requires analysis of its adequacy to the task. In any case, educational data should be greater than the parameters of the neural network. If the results of the experiment were not enough, then add the training set using a generalized model. This method can increase the number of training pairs without increasing the number of experiments. Since the true value of error is not available in practice used its evaluation. To obtain it, an analysis of the examples of existing databases, which are known feedback system,

but some were not used during the training. This example is called sample test. In the study sample will be allocated zones liver defects detected on CT. The test sample, as well as educational, consist of images of the liver, but no marked zones (Fig. 8).

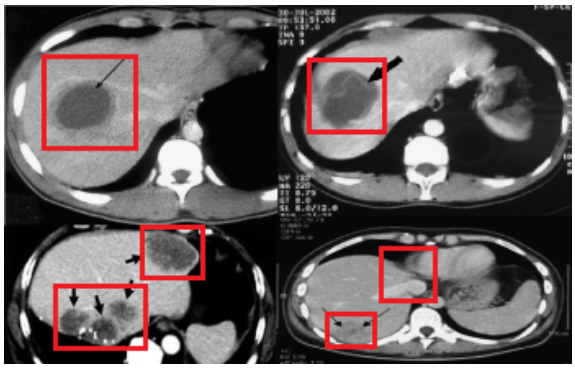

Fig. 8. Image abnormalities in the structure of liver CT images without processing neural network

The pictures will be allocated parts, which show some defects which will be used as prototypes diseases (Fig. 9). Teaching Process neural network built on the said sample, and will be for several tens of periods, then the neural network can detect defects in the liver in the test sample.

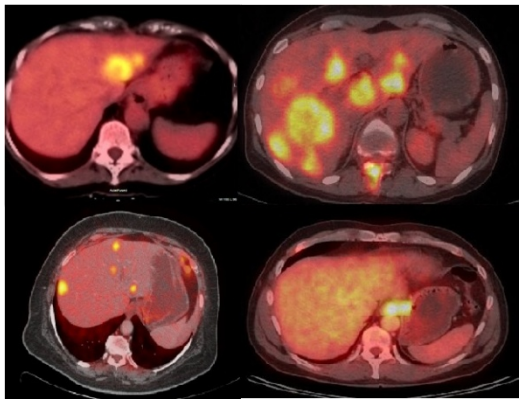

Fig. 9. Image abnormalities in the structure of the liver by neural network

IV. Conclusion

Thus, the possibility of a neural network are dependent on the size of the sample images and limited computing power system. It should be emphasized that the benefits of the neural network lies not only in its accuracy, short processing time, but also opportunities to improve their database to improve performance.

So, at this stage, this intelligent system can greatly speed up diagnosis and, consequently, the treatment of liver diseases. The development of high-precision computer diagnostics and application of convolutional neural networks eventually will allow to completely replace a doctor.

References

[1] Y. Lecun and Y. Bengio, *Convolutional Networks for Images, Speech, and Time-series, in Arbib*, M. A. (Eds), The Handbook of Brain Theory and Neural Networks. MIT Press, 1995.

[2] Y. LeCun, L. Bottou, Y. Bengio and P. Haffner, "Gradient-Based Learning Applied to Document Recognition." *Proceedings of the IEEE*, 1998.

[3] Y. Tay, P. Lallican, M. Khalid, C. Viard-Gaudin, and S. Knerr, "An Offline Cursive Handwriting Word Recognition System", *Proc. IEEE Region 10 Conf.*, 2001.

[4] *Springhouse corporation. illustrated guide to diagnostic tests*. Springhouse, pa: springhouse corporation, 1998.

[5] Kenji Suzuki, Feng Li, Shusuke Sone, and Kunio Doi, "Computer-Aided Diagnostic Scheme For Distinction Between Benign And Malignant Nodules In Thoracic Low-Dose Ct By Use Of Massive Training Artificial Neural Network", *IEEE Transactions On Medical Imaging*, 2005.

Received September 24, 2016.

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В. М. Синєглазов, М. О. Омельченко. Оброблення зображень КТ печінки за допомогою згорткової нейронної мережі
Розглянуто методи навчання нейронної мережі для аналізу зображень комп'ютерної томографії печінки та виявлення на них захворювання пацієнта на цироз печінки.
Ключові слова: глибоке навчання; обробка зображень; медицина; штучна нейронна мережа.

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В. М. Синеглазов, М.О. Омельченко. Обработка изображений КТ с помощью сверточной нейронной сети
Рассмотрены методы обучения модели машинного обучения для анализа изображений компьютерной томографии и выявления на них заболевания пациента с циррозом печени.
Ключевые слова: искусственная нейронная сеть, глубокое обучение, обработка изображений, медицина.

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