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# IMAGE PROCESSING WITH LIVER MRI CONVOLUTIONAL NEURAL NETWORK

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***Abstract*—*The methods of learning machine learning models to analyze magnetic resonance imaging images and identify them on the disease.***

**Index Terms**—Automation deep learning; image processing; medicine.

## I. INTRODUCTION

The number of patients with chronic hepatitis in the world increases over the past decade, which inevitably leads to an increase in the number of patients with liver cirrhosis (LC).

According to WHO, liver cirrhosis (LC) is the cause of 1.8% of all deaths in Europe. 0.1% of the European population suffers from securities corresponding to 14-26 new cases per 100 thousand population / year, or 170 thousand deaths / year.

According to the State Statistics Service of Ukraine in 2015 registered 47,857 cases of securities (131.8 per 100 000 population), including 8254 with the diagnosis set for the first time in my life (22.7 per 100 000 population). Moreover, among the working age population registered 27,797 cases of securities (111.6 per 100 000 population). In the male population (18 and older), this figure was 29,154 cases (183.7 per 100 000 population) among women – equal to 18,703 cases (97 per 100 000 population).

The death rate from cirrhosis in 10 years increased from 7.4 to 22.7 per 100 thousand population in Ukraine. A significant cause of mortality indicators are securities and late treatment of patients to doctors. Because of this, according to statistics, 25% of patients on the CPU die two months after the diagnosis of disease and only 25% can live more than a year, in Ukraine.

The most of patients on securities younger than 60 years, increasing their numbers are significant social and economic problem for society as general and requires prompt treatment and prevention given the fact.

Therefore, you should pay attention to the early stages of cirrhosis – liver fibrosis. Since the reversibility of liver fibrosis in patients has been proven. Fibrosis of the liver is mainly the result of inflammation, especially chronic, but can occur for a number of reasons. The chronic inflammation, various injuries liver radiation exposure or radiation, allergies or infectious and allergic diseases, immunological factors, elevated levels of collagen are the most common causes.

To improve the treatment of fibrosis requires diagnosis and regular monitoring of its stages in natural disease or against therapy.

Liver fibrosis has 5 stages (stages): F0, F1, F2, F3, F4 (cirrhosis). Interpretation of the results is carried out by the method Metavir or index Claudel. On average, from stage to stage time is about 5 years. However, progression rate higher in the later stages of fibrosis. Diagnosis is based on laboratory and instrumental methods of research in liver fibrosis. One of these methods is magnetic resonance imaging (MRI).

## II. PROBLEM ANALYSIS

Magnetic resonance imaging is effective and modern method of diagnosing liver disease. Safety procedures and high accuracy have made this method popular and widespread.

Using MRI can identify the following features.

1) Changes in the structure of the liver. Under the structure of the liver means the internal structure of the connective tissue parenchyma. The liver of a healthy person consists of hundreds of thousands of tiny particles, each of which resembles a hexagonal prism. The bumps of different sizes may be in inhomogeneous structure of the organ, reduce or increase the connective tissue infiltration or degeneration of liver cells (Fig. 1)

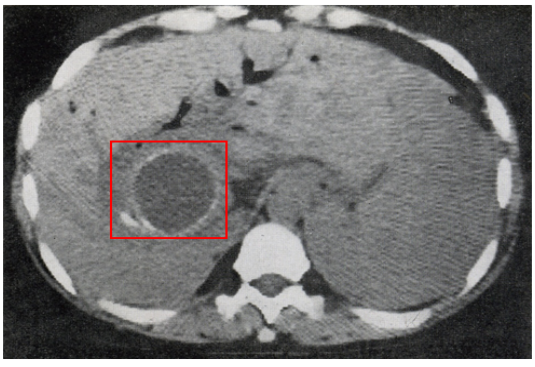

Fig. 1. The variable structure of the liver

To find changes in the structure of the liver system should analyze the image and find areas of grayscale that are on it and select them.

2) Reduction in size of the right lobe of the liver, her wrinkled as a result of atrophy. (Fig. 2).

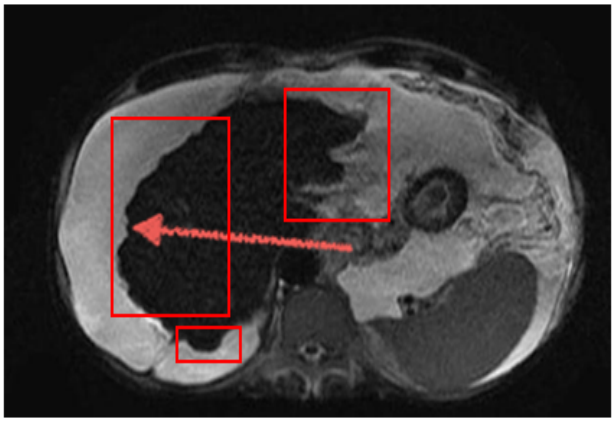

Fig. 2. Cirrhosis. Liver wrinkled, atrophic

To find signs of liver shriveled and its system atrophy should analyze MRI images and find the image ragged uneven areas on the contour of the liver, for this study a sample network must make a selection of images of features of these areas. Also required variable contrast ratio of the input image to detect these signs.

3) Increasing the tail lobe and lateral segment of the liver (Fig. 3).

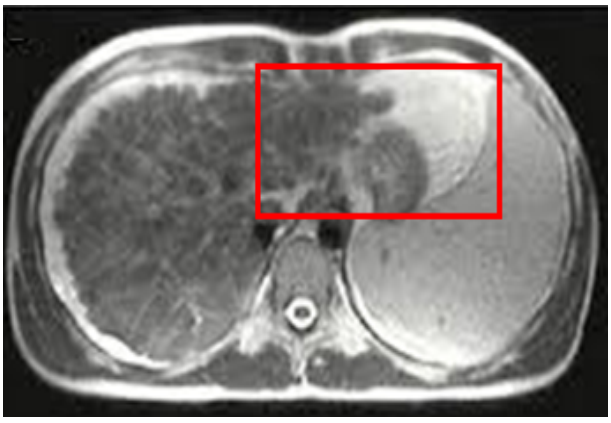

Fig. 3. Increase in the tail lobe and lateral segment of the liver

To find evidence of a growing tail lobe and lateral segment of the liver system should analyze MRI images of the right answer and whether it is on the zone with enlarged liver or not. For this study sample will hover examples of these signs.

4) Liver cirrhosis affects the portal vein. Portal vein it is very important anatomical part of the abdomen. In cirrhosis, the blood flow through it violated and suffer as other bodies as in the portal vein is formed stagnation and high blood pressure that threatens to rupture often veins of the lower third of the esophagus, and then, as a consequence of the slow death of the patient (Figs 4 and 5).

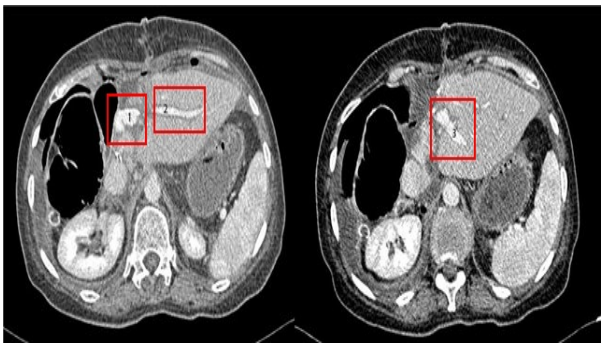

Fig. 4. The picture shows the portal vein

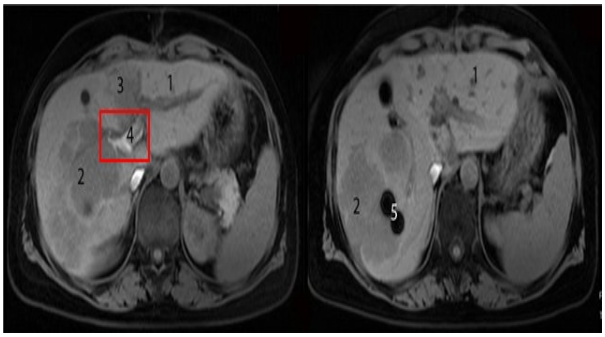

Fig. 5. The picture shows the portal vein

To find increasing hepatic portal vein system should increase the contrast and analyze all MRI images and find areas increase portal vein. For this study sample will hover examples of these signs.

All of pathological conditions can be seen in the performance of MRI of the liver [1].

Thus, using MRI in diagnosing fibrosis we can see:

– restructuring of the liver (mounds of various sizes, decrease or increase of connective tissue) (Fig.1);

– modifies the liver (increased tail lobe and lateral segment of the liver, liver atrophy) (Figs 2 and 3);

– increased portal vein (Figs 4 and 5).

Analysis of MRI is often long, because the data to work out in detail, remove image artifacts, and include different ways of smoothing the image. All processing can take several hours, which is problematic because these studies are sometimes needed within minutes. This paper proposes a solution for diagnostic use intelligent imaging MRI.

## III. Problems Solution

Block diagram of intelligent system imaging MRI is presented in Fig. 6.

The input system serves MRI image pixels. The intelligent system is a nonlinear system that will better categorize data than commonly used linear

methods. Also, it should give the opportunity to significantly improve the specificity of the method, without reducing its sensitivity.

Such a system is linear neural network, because it can make decisions based on the data found in the hidden patterns. A distinctive feature of neural networks is that they do not use any inference rules for diagnosis and learn to do it by examples. The output of the system provides images which highlight suspicious areas.

The outputs of the system are:

– exit 1: changing forms of liver;

– exit 2: restructuring of liver;

– exit 3: increased portal vein.

Diagnosis is a special case of classification of events, with the greatest value is the classification of those events that are not in the training set. It appears advantage of neural networks – they are capable of such a classification, summarizing the previous experience and applying it to new situations.

We use is quite logical neural network of direct distribution in the right system. It is able to perform complex tasks with image recognition.

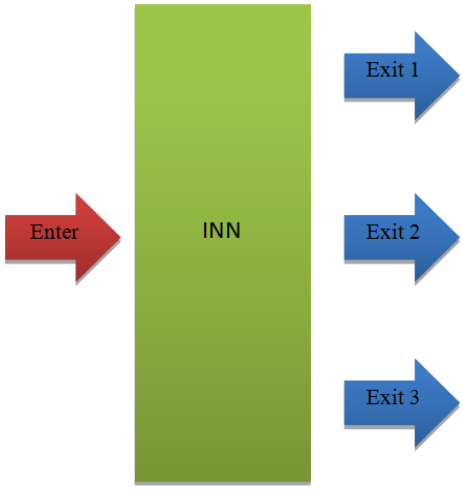


Fig. 6. Block diagram of intelligent system imaging MRI

However, this type of neural network architecture has some limitations. In situations where the desired object appears along with other objects in the picture, direct distribution network may be overloaded and unable to make correct recognition. Therefore, you should pay attention to the convolution neural network.

Rolls neural network process image is not full and separate "chunks", consistently reducing its size or highlighting the most important characteristic signs, going to a new level of abstraction. These networks are formed so-called card signs that an outside observer seem blurred, distorted copies of the original image, but the neural network are fundamentally different meaning, because they contain the characteristic features of the desired areas [2].

The basic idea convolution neural network is subsampling alternating layers, layers of rolls and output layers. So combined together architectural ideas that achieve invariance to distortion (Fig. 7).

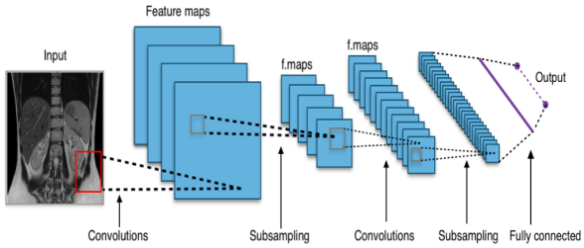


Fig. 7. Block diagram of the convolution neural network

Alternating layers allows card features make the cards the previous layer that promotes recognition of complex hierarchies of attributes. The model provides for the allocation of a large number of areas of the original image, and therefore, in this case, the rational use of computing power, able to quickly process large amounts of data.

That is, we face the following problems: we are given a set of medical images obtained by MRI. Our goal is to develop an automatic algorithm that displays images and notes thereon us the required information [3].

Our network at the entrance will take a set of images. On the way out, she will highlight suspicious area. Before the development of the network should form a study sample. For this we consider liver MRI images that are available. The quality of these images is highly dependent on patients, it is an image with different size, different brightness, contrast and aspect ratio.

That is to use these images in the study sample need to solve the following problems:

– different image sizes;

– different spacing of pixels in images;

– different brightness image;

– images that are repeated to remove;

– some images have several places of identification that is necessary to specify.

Then, to create our system we need to create a training sample. You need to identify areas for training set of several hundred images, which were performed procedures were describing earlier. This is a laborious process that takes a lot of time. But this should be done to machine learning algorithm was able to find the right answers.

At the same time we can turn up the problem with the number of images for the educational model because it should increase by volume of change, such as display and rotation.

Then it is necessary to determine the structure of our coagulation neural network. You need to clearly analyze the images with which we work and conduct tests of learning and results. In the end, the following structure was chosen network. (Fig 8). Of course, there are some small errors in the results, but they are not significant.

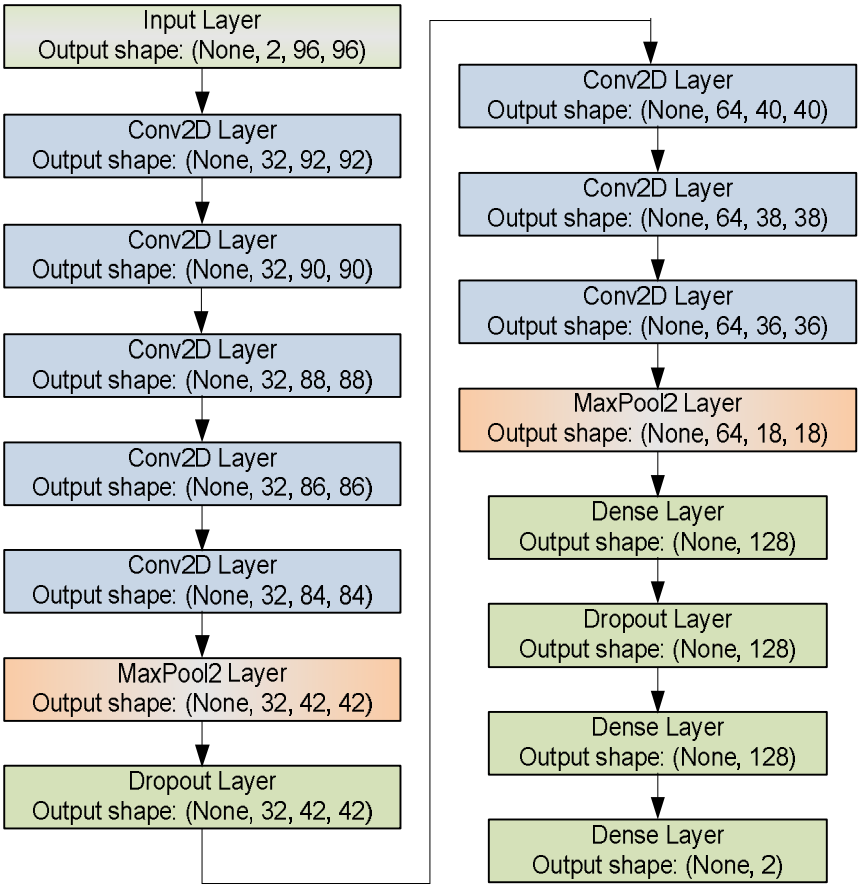


Fig 8. Structure of convolution neural networks, MRI imaging

## IV. Conclusion

The main problem of image analysis MRI is a problem processing speed and information from these images. This is due primarily to the fact that these data should be detailed to work, remove artifacts images include different ways of smoothing that takes time.

Since the results of these studies may be required for a few minutes, there is a need for intelligent system imaging MRI. In this paper, the methods of teaching machine learning models to accelerate liver MRI image analysis and detection of suspicious areas on them.

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**В. М. Синєглазов, В. П. Хоцянівський. Оброблення зображень МРТ печінки за допомогою згорткової нейронної мережі**

Розглянуто методи навчання моделі машинного навчання для аналізу зображень магнітно-резонансної томографії печінки та виявлення на них захворювання пацієнта на цироз печінки.
**Ключові слова:**автоматизація; глибоке навчання; обробка зображень;медицина.

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**В. М. Синеглазов, В. П. Хоцяновский. Обработка изображений МРТ с помощью сверточной нейронной сети**

Рассмотрены методы обучения модели машинного обучения для анализа изображений магнитно-резонансной томографии и выявления на них заболевания пациента с циррозом печени.
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