

ACUTE LEUKEMIA CLASSIFICATION USING CONVOLUTION NEURAL NETWORK IN CLINICAL DECISION SUPPORT SYSTEM

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ABSTRACT

Leukemia induced death has been listed in the top ten most dangerous mortality basis for human being. Some of the reason is due to slow decision-making process which caused suitable medical treatment cannot be applied on time. Therefore, good clinical decision support for acute leukemia type classification has become a necessity. In this paper, the author proposed a novel approach to perform acute leukemia type classification using convolution neural network (CNN) classifier. Our experimental result only covers the first classification process which shows an excellent performance in differentiating normal and abnormal cells. Further development is needed to prove the effectiveness of second neural network classifier.

KEYWORDS

Acute Leukemia Classification, Convolution neural network, Clinical decision support system

1. INTRODUCTION

Leukemia is a group of cancers that begin in the bone marrow and result in high numbers of abnormal white blood cells. It attacks white blood cells which responsible for immune system and disease prevention in the human body. There are four main types of Leukemia which are classified based on severity level and infected cells type - acute lymphoblastic leukemia (ALL), acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML). In this paper, we would like to propose a novel approach to perform acute leukemia classification based on Convolution Neural Network (CNN). This method provides an excellent performance in classification process that reaches 96.43% of accuracy to discriminate normal and abnormal cell images from given database.

2. RELATED WORK

2.1. OVERVIEW OF LEUKEMIA

A. Acute Lymphocytic Leukemia (ALL)

Acute Lymphocytic Leukemia (ALL) is one between two classes of acute leukemia which develop from early (immature) forms of lymphocytes cells in bone marrow. ALL is recorded as the most common of the 4 major types among children but the least common types in adults, but most deaths occur in adults which are understandable because children's bodies can often handle aggressive treatment better than adult's. Most leukemia infected white blood cells has average

size about two times the red blood cells that surround them, while normal white blood cells have an average size that similar with the surrounding red blood cells. In most of ALL infected cells, the nucleus area occupies almost 80-90% of the whole cell and left about 20-30% of cell area for the cytoplasm. The surface of ALL cell is smooth.

B. Acute Myeloid Leukemia (AML)

Acute Myeloid Leukemia is developed from early (immature) forms of myeloid cells in bone marrow. AML cases generally occur in older people and uncommon before the age of 45. AML cases hold the most number of deaths among the 4 types of leukemia. The nucleus area is about 50-60% of the whole cell area and about 40-50% cell area is cytoplasm. Sometimes short purple stripes which called “Auer rods” can be found in the cytoplasm area and it makes AML identification become easier.

C. Chronic Lymphocytic Leukemia (CLL)

Chronic Lymphocytic Leukemia is a type of leukemia that attacks the lymphocytes, different from ALL which attack the immature form of lymphocytes. CLL cell has a similar characteristic with ALL with a small area of cytoplasm and almost 80-90% of the cell area is occupied by nucleus area. The difference between ALL and CLL is the existence of nucleoli inside the nucleus area. Because CLL is basically mature cells which development has been completed, there should not be any nucleolus detected inside CLL cells.

D. Chronic Myeloid Leukemia (CML)

Chronic Myeloid Leukemia is another type of chronic leukemia that attacks the myeloid cells and has a similar behavior like CLL, especially in the development state. The average age at diagnosis of CML is around 64 years old. CML cell has a similar characteristic with AML in terms of cytoplasm area ratio, CML also show a big portion of cytoplasm in the cell and most of CML cells are fully developed into mature white blood cells which make it as the most differentiable cells among the four leukemia types. CML nucleus has developed into differentiable shape and texture unlike AML which in most cases the shape is round and under developed.

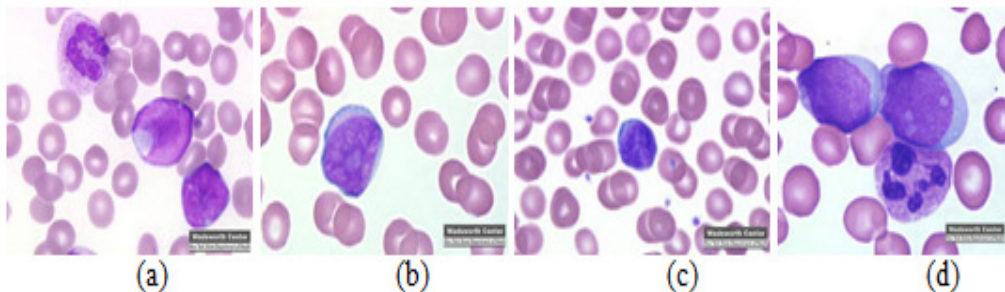


Figure 1. (a) Sample images of Acute Lymphocytic Leukemia, (b) Acute Myeloid Leukemia, (c) Chronic Lymphocytic Leukemia, and (d) Chronic Myeloid Leukemia.

2.2 RECENT LEUKEMIA DETECTION AND CLASSIFICATION METHODS

The researches about leukemia classification in recent years based on computer vision. The most common algorithm in this approach consists of several rigid steps: image pre-processing, clustering, morphological filtering, segmentation, feature selection or extraction, classification, and evaluation [1] [2]. Almost authors have used machine learning techniques to detect blood cell

in images and to classify cells in images. They extract features representing points, regions, or objects of interest and then use those features to train a model to classify or learn patterns in the image data. Feature extraction usually involves processing each image with some image-processing operations, such as calculating gradient to extract the discriminative information from each image. In this paper, we used the method of deep learning to learn characteristics of leukemia shape to classify normal and abnormal cell images.

3. PROPOSED METHOD

In this paper, we will use a Convolution Neural Network (CNN) to perform classification and extract features from raw images.

3.1. ARCHITECTURE OF CNN

In this work, we proposed a network contains 4 layers. The first 3 layers for detecting features and the other two layers (Fully connected and Softmax) are for classifying the features. The input image has the size $[50 \times 50 \times 3]$. The receptive field (or the filter size) is 5×5 . The stride is 1 then we move the filters one pixel at a time. The zero-padding is 2. It will allow us to control the spatial size of the output image (we will use it to exactly preserve the spatial size of the input volume so the input and output width and height are the same). During the experiment, we found that in our case, altering the size of original image during the convolution lead to decrease the accuracy about 40%. Thus the output image after convolution layer 1 has the same size with the input image.

The convolution layer 2 has the same structure with the convolution layer 1. The filter size is 5×5 , the stride is 1 and the zero-padding is 2. The number of feature maps (the channel or the depth) in our case is 30. If the number of feature maps is lower or higher than 30, the accuracy will decrease 50%. By experiment, we found the accuracy also decrease 50% if we remove Convolution layer 2.

The Max-Pooling layer 25×25 has Filter size is 2 and stride is 2. The fully connected layer has 2 neural. Finally, we use the Softmax layer for the classification.

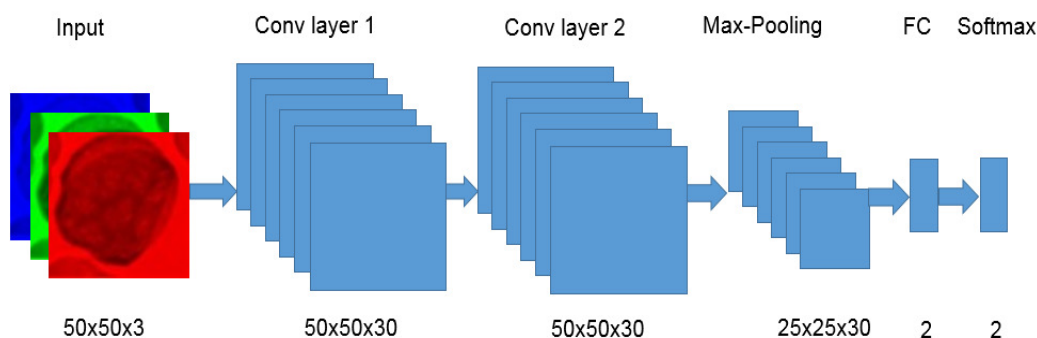


Figure 2. The architecture of network.

4. EXPERIMENT AND RESULT

In this experiment, the original ALL-IDB1 image database which consists of 108 cell image [3] (59 normal cell images and 49 abnormal cell images) was used. The number of labelled training data and unlabelled testing data are shown in Table 1.

The experiment conducts on Matlab and the accuracy rate of the recognition of leukemia by our proposed CNN model achieved 96.43%.

Table 1. The number of training and test data.

	Training Set	Test Set
Normal cell	40	19
Abnormal cell	40	9
Total	80	28

5. CONCLUSION

Leukemia is one of the most fatal diseases for the human being. This paper proposed a novel acute leukemia type classification method using CNN as one of the constructing modules for the acute leukemia type clinical decision support system. In the future study, we will consider how to improve our architecture to obtain a better result and try to classify four types of Leukemia.

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