Vol. 03, No. 02, pp. 35 –38 (2022)
ISSN: 2708-0757

JOURNAL OF APPLIED SCIENCE AND TECHNOLOGY TRENDS

www.jastt.org

Diagnosing the Leukemia using Faster Region based Convolutional Neural Network

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Abstract

It is difficult to building deep learning algorithms for identifying chronic diseases. One of the must difficulties facing the system of diagnosing leukemia is the irregular shape and twisted nucleus in white blood cells (WBCs) without cleaning and segmentation of cells by Appling filters. Moreover, it is challenge to identify and classify the WBC at once time which is considered the essential step of leukemia diagnosing. This paper proposed system only based on deep learning algorithms. The modified Faster R-CNN (Faster Region based-Convolutional Neural Networks) algorithm is used to detect and classify WBCs. The system is achieved a high accuracy training on the database tacked directly from microscope which used in [4].

Keywords: *Faster Region CNN, White Blood Cells, Deep Learning, Classification, Detection.*

Received: September 24, 2022 / Accepted: November 29, 2022 / Online: December 19, 2022

I. INTRODUCTION

The main constituents of the blood are Red blood cells (RBC), white blood cells (WBC), and platelets. The microscopic examination of blood smears is crucial in the diagnosis of many blood disorders [1]. The human immune system depends heavily on white blood cells. According to Figure 1, there are four primary kinds of white blood cells: lymphocytes, monocytes, neutrophils, and eosinophils. We can learn a lot about the state of human health by looking at the total number of white blood cells as well as the numbers of each type of white blood cell. Additionally, it makes the identification of numerous blood illnesses, including leukemia, easier [2]. The accuracy of diagnosing of leukemia is very important. A cytological diagnosis strategy for breast implant-associated anaplastic is large cell lymphoma. However, the diagnosing of leukemia obtains a better prognosis and risk classification for treatment and planning to determine the type of leukemia [3]. However, due to a lack of data, noise in resolution, irregular form and color as they come from many sources, and pre-processing by deep learning, the identification and categorization of white blood cells from microscope pictures is a difficulty [4]. In the past, researchers employed a machine to aid in the analysis of medical photographs. The systems were composed of two key steps: learning algorithms and feature extraction. However, to achieve high performance of detection and classification, several researches employed image pre-processing as a key step for segmentation, feature engineering, and manually object extraction [5]. On the other hand, some researchers combine conventional methods with deep learning to analyze medical pictures and diagnose various disorders. Preprocessing, which entails performing operations on the data such segmentation and filtration, is the first step the researchers take to get the dataset suitable for learning algorithms [6]. The second phase involves feeding data into deep learning algorithms like convolutional neural network (CNN), which is utilized for detection, identification, and classification tasks [7]. This review utilizes quick faster R-CNN (Faster Region based on Convolutional Neural Network) to identification order of WBCs in variety pictures. First and foremost, get ready and construct dataset leukemia for the preparation [8], [9]. Our dataset incorporates four sorts of leukemia. A portion of the pictures just hold back one WBC for each picture, and different pictures which contained more than one WBCs every picture. In opposite side, the WBCs are not typical. This Convolutional Neural Network (CNN) is to show the veracity and power [10]–[12]. This information utilized for preparing the proposed framework.

doi: 10.38094/jastt302134

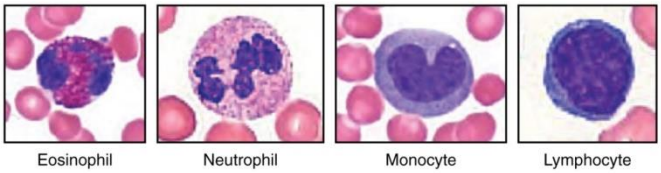

Fig. 1. Type of White Blood Cells.

II. Related Work

There are many studies used to classification and detection of blood cells [13]. The shape and the number of WBCs indicate that human has disease related to the blood such as Leukemia. One of the must importance studies is using deep learning algorithms to localize and classify blood cells [14]. However, the fast RCNN is used to object detection and classification. This algorithm is very high accuracy to detect and classify the WBCs. This algorithm is the second version of RCNN which depend on the mechanism called selective search [15]. The RCNN used selective search to extract the feature map which represented by box as rectangle. This box area passes through CNN to produce output features and then classify by other algorithm such as SVM (support vector machine) [16], [17].

The faster R-CNN is depended on ROI pooling instead of performing maximum pooling. This procedure covert all the regions into single feature map which used max pooling the figure 2 show the structure of fast R-CNN [18].

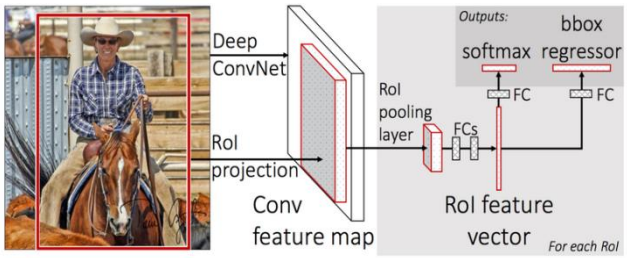

Fig. 2. Structure of Fast R-CNN.

the Faster R-CNN algorithm is used th Edge Boxes to generate region proposals of entire image instead of interest region [19].

The study [20] used Faster Region-based Convolutional Neural Network to detect and clasify red blood cells (RBCs) and white blood cells (WBCs). the aims of this reseach was create fast system to helpe the medical field in the classification of RBCs and WBCs. The result was diffirence between the RBCs and WBCs which represented 66 to 98 accuracy.

This research [21] proposed system based on deep neural network to detect and count blood cells trianed on public BCCD (Blood Cell Count and Detection) dataset. The Faster R-CNN used for detection the blood cells. The result of detection accuracyr was 90 for RBCs and 80 for WBCs.

This research [22] applied Faster Region-based Convolutional Neural Network (Faster R-CNN) using pre-trained on ImageNet. The system trianed on natural images to deatect and classify RBCs in malaria. However, the The accuracy of detect and classify was 72%.

The study [23] used system to detect and classify WBCs in Leukemia by appling modified you only look once (YOLO v2) algorithm which one of simplest object detection algorithm. In addition, the study also used costume CNN to classification. The dataset that used to training and evaluating the system was create and take directly from microscopic images. The accurasy of detection was 96% and the accuracy of classification was 94.3%.

This research [24] used system to count Red and white blood cells automatily by applying mask R-CNN and convolutional neural network (CNN). Inaddition, this study used many filter and other techniques to count the blood cells. The dataset used in this study was take form microscope which taked from Isfahan medical image and signal processing (MISP) datase. Moreover, the restult was 92% of the RBCs detection and 96% of the WBCs detection.

III. THE PROPOSED SYSTEM

The proposed system consist of two part: the first par is the costum CNN which trained indivisually. The second part is Fast R-CNN function which connect to costum CNN and also trained indivisually. Howover, as it knowen the Faster R-CNN is need to pre-trained CNN to extract feature map of interesting region.

The CNN that used consist of four main convolutional layers, four max pooling laysers and three connected layers. The first layer is input layer which receive image with size 256×256. In oderside, The first convolution layer used 32 kernel size (3×3) and stride 1 to extract features map.The second convolution layer used 64 kernel size (3×3) and stride 1. The third and fourth convolution layers sed 128 kernel size (3×3) and stride 1. Inaddtion, four max pooling layer used fillter with size (2x2) with stride 2 to reducale the diamansion of the featur map. Howover, the convolutional layers that used all them followed by ReLu nonlinear activation function and Batchnornaliztion [25].

Finally, the last three fully connected layer used to flatt and classify the WBCs. The first layer cosist of 150 neurons, the second layer cosist of 60 neurons and the last one cosist of 2 nuerons. The table 1 show the pre-trained CNN architecture.

TABLE I. Pre-trained CNN Structure for Faster R-CNN

Layer name	Layer size input	Kernal Number	Kernal size	stride
Convolution	256 x 256	32	3x3	1
Max Pooling	256 x 256	-	2x2	2
Convolution	128x128	64	3x3	1
Max Pooling	128x128	-	2x2	2
Convolution	64x64	128	3x3	1
Max Pooling	64x64	-	2x2	2
Convolution	32x32	128	3x3	1
Max Pooling	32x32	-	2x2	2

Fully Connected	150	-	-	-
Fully Connected	60	-	-	-
Fully Connected	2	-	-	-

IV. DATA ACQUISITION AND AUGMENTATION

One of the fundamental components of every deep learning system is the dataset. Dataset access concerns resulting from data confidentiality, a lack of data, or other problems are the key challenge. The dataset that used in our serearch was acquired from a private hospital and processed that used in [4]. This dataset consist of 1870 color Image with size 256×256. The dataset used to train fast R-CNN that consist 1500 images for training and 370 images for testing the faster R-CNN which represent about 80% training dataset and 20% test dataset. Each image contain at least one or more cells of WBCs. The figure 3 show the sample of the dataset.

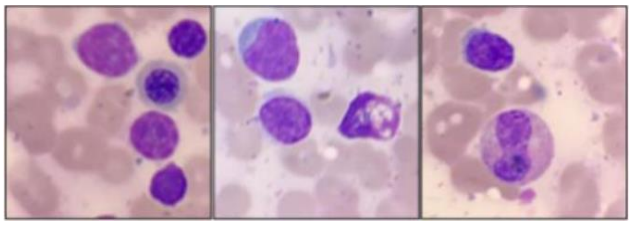

Fig. 3. Sample of images used for training.

As it known the deep learing algorithm need to heuge dataset. Due to lack of dataset the images in training dataset of WBC detection and classification are augmented. However, The augmentation of data means to duplicate the images into many variation by keeping the main features key of the images. In addition, we used augmentatation approach by using color jitter with random values, randomly reflecting in horizontal and vertical axis and randomly rotation (0-90).

V. RESULTS AND DISCUSSION

We use MATLAB R2020a enviroment for training the Faster R-CNN with other some toolboxes. Moreover, the training is processed on DELL laptop with single central processing unit (CPU) Core i7, 8 Giga byte random access memory (RAM) and internal graphic GPU.

However, the 'Adam' optimization algorithm is used to trained the faster R-CNN during 50 epochs with a minimum batch size of 8 and 0.01 initial learning. Moreover, the accuracy that achieved (average precision (AP)) was 97% as shown in the figure 4. The result that the faster R-CNN achieved is prove the ability of the system to detect and classify WBCs in leukemia. On the other side, the the proposed system able to helpe the doctor to diagnosing the Leukemia.

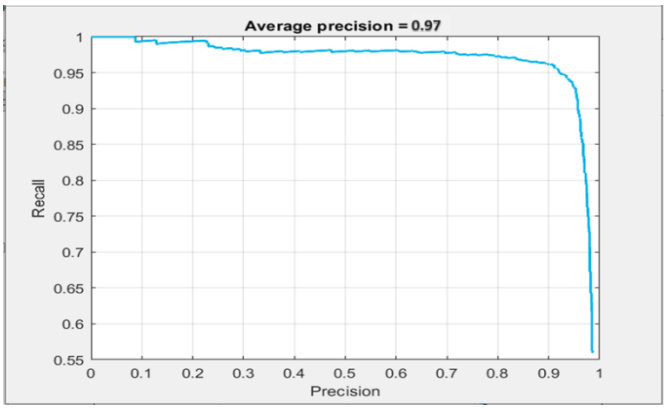

Fig. 4. The average precision (AP) of Proposed system.

VI. CONCLUSION

The proposed system used costum pre-trained CNN and faster R-CNN algorithm. The proposed system able to achieved high accuracy of WBCs detection and classification which given important information. The result that achieved the study is perfect to treatment effective on state of leukemia patient in earlly states. In other side, the proposed system used simple CNN which affecte to the speed on training compared with public pre-trained CNN such as ResNet, VGG16 and etc. Morover, the proposed system useing dataset taked directly from microscope. The result compared with other systems is very good.

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