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AUTOMATIC DETECTION OF WHITE BLOOD CANCER FROM BONE MARROW MICROSCOPIC IMAGES

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ABSTRACT - One of the important medical test to evaluate overall human health condition is the Complete Blood Cell Count (CBC). Traditionally these blood cells were counted manually by visual inspection or by using the haemocytometer along with some chemical compounds and other scientific equipment's which is a tedious and more time consuming task. To avoid this problem, the proposed work here is the machine learning approach of automatic identification and counting of blood cells (RBC's, WBC's and Platelets) using 'You Only Look Once' in short YOLO object detection and classification algorithm to automatically identify and count the blood cells from the blood smear images. This YOLO framework will be trained the modified Blood Cell Count Data set (BCCD) of blood smear images to automatically identify and count the RBS's, WBC's and Platelets from the blood smear images. Thus overall the computer aided system of counting and detection enables to count the blood cells just in less than a second and this can be useful in the practical applications.

Key Words: Blood Smear images, BCCD Set, YOLO, Tiny YOLO, VGG-16 Architecture, Bounding Boxes, Automatic identification and counting.

1.INTRODUCTION Complete Blood Cell Count (CBC) is one the important medical test often requested by the medical professionals to evaluate overall human health conditions. Human blood composed of three important cells. Those are Red Blood Cells (RBC's), White Blood Cells (WBC's) and Platelets. RBCs are also called as the Erythrocytes constitute 40-45% of blood and the main function of these cells is they carry oxygen to our body tissues. Normal range of RBC is between 4.7 to 6.1 million cells per microliter of blood. WBCs are also called as Leukocytes constitutes 1% of blood and they fight against infections. Normal range of WBC is 4500 to 11000 cells per microliter of blood. Platelets are also called as Thrombocytes constitutes remaining part of blood and its function is it helps in clotting of blood. As these cells are huge in number traditional method of manually counting of blood cells using haemocytometer and other equipment's is time consuming and erroneous task and is completely depends on the skill of a laboratory analyst. With the development of machine learning techniques, image processing, object detection and classification becoming more accurate and robust. Generally, deep learning methods are being applied in different medical applications like detection of diabetic retinopathy in retinal fundus images, automatic segmentation of left ventricle in cardiac MRI, femoral neck fracture recovery. This model deploys a deep learning based object detection method to detect and count different blood cells from the blood smear images automatically. Among different object detection algorithms such as Region-based fully convolutional network (R-FCN), Region-based convolutional networks (R-CNN), Single Shot Detector (SSD) and You Only Look Once (YOLO) this model will be deployed with YOLO algorithm with VGG-16 architecture, which is three times faster than other algorithm. The YOLO framework will be retrain to automatically identify and count RBC's, WBC's and Platelets from the blood smear images. Verification method has also deployed in order to improve the counting accuracy in order to improve the counting accuracy and to avoid the double count by the framework.

2. RELATED WORK Generally there are two different methods for automated counting of blood cells those are the image processing and the machine learning techniques. Acharjee et al. [3] The Hough transform is applied with specified diameter to detect the biconcave and oval shape of RBC. Cruz et al. [1] has designed the raspberry-pi based image analysis system for detection and counting of blood components from the microscopic blood images using Hue saturation and value (HSV) thresholding method. Zhao et al. [13] a system for automatic identification and classification system for WBCs using the convolutional neural network (CNN) has been proposed. They detected WBCs from the microscopic images first then CNN was used to detect different types of WBCs. Image processing technique for counting of RBCs along with the identification of normal and abnormal cells has been proposed by Acharya and kumar [10] where they used k-medoids for WBCs extraction and separating RBCs from WBCs using granulometric analysis and counting it using labelling algorithm and CHT transform. Circlet transform for counting of RBCs from grey scale images has been proposed by Sarrafzadeh et al. [11] where they have used the soft thresholding iterative method for identification and counting. Patch size normalization has been applied on the pre-processed images, and then the RBCs shapes are classified by applying CNN from the microscopic images of sickle cell disease proposed by Xu et al. [15]. A system for classifying five different types of the WBCs using three different classifiers (two SVMs and one CNN) has been proposed by Habibzadeh et al. [2]. A complete different framework has been proposed here which deploys the YOLO for the identification and counting of all three different blood cells. This model does not requires the binary conversation of image and is fully automated, accurate and fast process.

3. MATERIALS AND METHOD The goal is to use the YOLO algorithm which is an object detection and classification algorithm to detect and count the blood cells directly from blood smear images. The YOLO framework will be trained with the modified configuration and annotated blood cells training images.

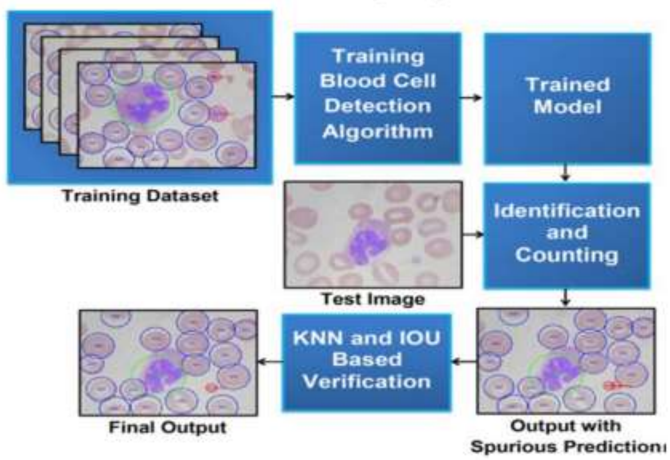

Fig -1: Automatic Blood Cell Detection and Counting System

3.1 Dataset: The dataset used in this proposed methodology is called as BCCD – Blood Cell Count Dataset that contains the annotated images of blood cells, which are downloaded from the Kaggle website. Kaggle website is publically available community for the machine learning professionals. It helps users for searching, exploring also publishing of the datasets. It is also helpful in building of models based on web environment. Then the data will be splitted into training sets, validation sets. The framework will be trained with training data set by using training blood cell detection algorithm i.e. the YOLO algorithm. The model will be trained with the training images along with their annotation files. After training, the model will be tested by some of the validation datasets. With the identification and counting algorithm the model will automatically detects and counts the three different blood cells (RBC, WBC and Platelets) from the image and gives the output as the cell count number. Sometimes the model will give output with some spurious prediction which means sometimes it will double counts the platelet cells. In order to remove this spurious predication the model uses the k nearest neighbour algorithm along with IoU-Intersection over Union algorithm and gives the final output with the single count of the platelets as shown in the block diagram Fig -1.

3.2 YOLO Algorithm: 'YOLO' abbreviated as You Only Look Once is a real time convolutional deep neural network algorithm which will work for both detection also classification of the objects. This is the most popular algorithm because of its speed and accuracy. This algorithm will takes regression problem as object detection hence providing class probabilities of the detected objects in the image. This algorithm will applies single neural network to whole image. This algorithm will takes the entire image, detects bounding boxes also class probabilities just within one run of the algorithm hence the name 'you only look once'. The bounding boxes predicted will be weighted with their probabilities that are predicted. Excellent speed is it's biggest advantage. This can process upto 45 frames per second and this is incredibly fast compared with other object detection algorithms. The name itself suggest that for an image this algorithm will 'look only once', meaning that to make the prediction this will requires just a single forward pass propagation into the neural network. Let's see the working of YOLO algorithm by taking the example of the below image. First the algorithm will take the entire image and divides the image into grids as shown in Fig -2. Then the responsibility of every grid cell is to predict the bounding boxes. Then for each of the grid in the image, image classification and localization is applied

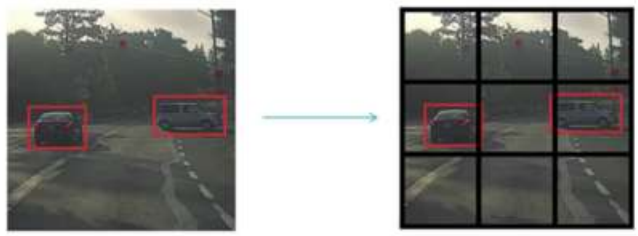

Fig -2: Image into Grids

Here image is divided to 3x3 grid size and three objects need to be detected from the image those are car, pedestrian, and motorcycle. The data which is labelled should be passed to the framework for training it.

3.3. Proposed algorithm: This proposed model includes the modified training model where the final convolutional layers will be changed for three outputs (RBC, WBC and Platelet), with an appropriate threshold identifying the blood cells and counting them from their labels.

There is no misunderstanding in this framework among the different cells like recognizing WBCs as RBCs, or RBCs as platelets, so on. There are cases where the model may predict and counts same platelet twice. It is because of the presence of same platelet at two corresponding grids so it will double counts the same platelet. This problem can be resolved by applying k-nearest neighbor (KNN) and IoU algorithms in each platelet. First the KNN is applied to every platelet for the determination of the nearest platelet. After that by applying Intersection over Union (IoU) among two of the platelets and calculates the range of the overlap between those two platelets. In this proposed model 10% of overlap between those two platelets is allowed and taken that as a threshold. If the overlap is greater that threshold then that platelet will be ignored as double count and thus it will get rid of spurious counting as shown in figure below. In this way this proposed model will detects the blood cells automatically from the blood images and gives their count

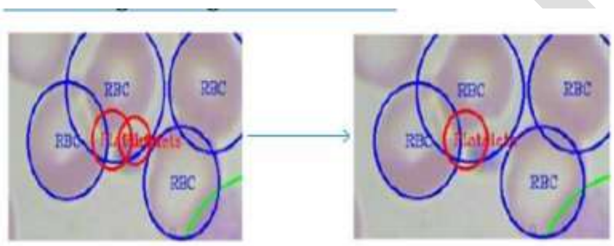

Fig 3: Discarding of Spurious prediction

3.4 Prediction of Proposed Model: The proposed model will automatically identifies and count the RBCs, WBCs and Platelets from the blood smear images. The model has been tested with the 60 tests data set where the ground truth is known. First this model will counts the different cells present in the validation sets of smear image with different confidence truths. It has been noted that the threshold plays an important role in the YOLO algorithm as this algorithm uses this threshold for the grid cells not for the entire image. Grid cells don't contain the cells with low confidence. Hence by choosing appropriate confidence threshold we can get rid of the redundant and spurious predictions.

CONCLUSION In this research based project paper, machine learning approach for the identification and counting of blood cells automatically using YOLO framework has been presented, which is a deep neural network object detection and classification algorithm. This framework will uses the blood smear image datasets as its input and gives the blood cell identification and its count as the output. It automatically detects the three different types of blood cells and gives the count of the respective blood cells. This model does not misinterpret between the types of blood cells and produces the accurate results. But sometimes it may double count the platelet cells which can be further removed by this algorithm by using the verification model. Thus the accuracy of the model is improved by employing the KNN – K nearest neighbor algorithm along with the IoU - Intersection Over Union operation to avoid the repeated counting of single object by the algorithm and gives the correct prediction with the single count of the cells. This model has been tested on various validation datasets of images of blood and it had outputted satisfactorily. Thus by its detection and the accuracy performances this model has gains potential to ease blood cell detection and counting manually which can be used in the practical applications.

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