Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/bbe

Original Research Article

Computer assisted classification framework for prediction of acute lymphoblastic and acute myeloblastic leukemia

Jyoti Rawat [a,*], Annapurna Singh [a], H.S. Bhadauria [a], Jitendra Virmani [b], Jagtar Singh Devgun [c]

[a] Department of Computer Science and Engineering, G B Pant Engineering College, Pauri Garhwal, Uttarakhand 246194, India
[b] Council of Scientific & Industrial Research, Central Scientific Instruments Organization, Sec-30 C, Chandigarh 160030, India
[c] M. M. Institute of Medical Sciences & Research, Department of Pathology, Solan, Himachal Pradesh, India

ARTICLE INFO

Article history:
Received 22 December 2016
Received in revised form
3 May 2017
Accepted 7 July 2017
Available online xxx

Keywords:
Acute leukemia
Texture features
Color features
Geometric features
Genetic algorithm
SVM

ABSTRACT

Hematological malignancies i.e. acute lymphoid leukemia and acute myeloid leukemia are the types of blood cancer that can affect blood, bone marrow, lymphatic system and are the major contributors to cancer deaths. In present work, an attempt has been made to design a CAC (computer aided classification system) for diagnosis of myeloid and lymphoid cells and their FAB (French, American, and British) characterization. The proposed technique improves the AML and ALL diagnostic accuracy by analyzing color, morphological and textural features from the blood image using image processing and to assist in the development of a computer-aided screening of AML and ALL. This paper endeavors at proposing a quantitative microscopic approach toward the discrimination of malignant from normal in stained blood smear. The proposed technique firstly segments the nucleus from the leukocyte cell background and then computes features for each segmented nucleus. A total of 331 geometrical, chromatic and texture features are computed. A genetic algorithm using support vector machine (SVM) classifier is used to optimize the feature space. Based on optimized feature space, an SVM classifier with various kernel functions is used to eradicate noisy objects like overlapped cells, stain fragments, and other kinds of background noises. The significance of the proposed method is tested using 331 features on 420 microscopic blood images acquired from the online repository provided by the American society of hematology. The results confirmed the viability or potential of using a computer aided classification method to reinstate the monotonous and the reader-dependent diagnostic methods.

* *Corresponding author at*: Department of Computer Science and Engineering, G B Pant Engineering College, Pauri Garhwal, Uttarakhand 246194, India.
E-mail addresses: jyotisonirawat@gmail.com (J. Rawat), annapurnasingh78@gmail.com (A. Singh), hsb76iitr@gmail.com (H.S. Bhadauria), jitendra.virmani@gmail.com (J. Virmani), jagtardevgun@yahoo.com (J.S. Devgun).
http://dx.doi.org/10.1016/j.bbe.2017.07.003
0208-5216/

Please cite this article in press as: Rawat J, et al. Computer assisted classification framework for prediction of acute lymphoblastic and acute myeloblastic leukemia. Biocybern Biomed Eng (2017), http://dx.doi.org/10.1016/j.bbe.2017.07.003

1. Introduction

In human health, only the most mature forms (mature myelocytes) of cells appear in the peripheral blood. Cells at various stages of immaturity such as nucleated red cells, polychromatic red cells, myelocytes, and metamyelocytes may be released from the bone-marrow in a condition where the bone-marrow is overactive or functionally abnormal. Their presence in the peripheral blood indicates that active haemopoiesis is taking place. Blood forms in bone marrow that are the soft tissue inside a bone cavity called center of all bones, this process is known as haemopoiesis. Initially, blood cell works as totipotent cells then converts into stem cells which are really small but are capable of a replicate vital number of white blood cells, red blood cells, and platelets when stimulated. The stem cells made up of two families, first one is myeloid stem cells that develop into erythrocytes, leukocytes (neutrophils, eosinophils, basophils, and monocytes), and platelets and the second one are lymphoid stem cells which are developed into another type of leukocytes as T-cells and B-cells [1].

Leukemia is one of the most frequent disorders found in blood worldwide. Leukemia is a cluster of multiple blood disorders which is usually instigated in the bone marrow and outcome as a lot of abnormal leukocyte cells which are not in the mature form known as blasts cells. Different classes of leukemia found in medical practice which has different causes like inheritance or environmental effect. Clinically leukemia can be characterized into four classes which are acute lymphocytic leukemia (ALL), acute myelocytic leukemia (AML), chronic myelocytic leukemia (CML) and chronic lymphocytic leukemia (CLL) based on their appearance, origin cell and function. Acute type of leukemia is cancer that grows rapidly and gets worse quickly while the chronic type of leukemia grows slowly and gets worse gradually with respect to time [2]. The signs and a medical indication of the patient are the primary concern to take a quantifiable step to identify the existence of leukemic cells. A cytological investigation of fringe blood tests (samples) permits getting the amount and different kind of blood cells (red cells, white cells, and platelets). On the off chance that there are variations in cells examination, a morphological bone marrow smear examination is performed to approve the presence of immature cells.

The ALL and AML are the most widely recognized types of acute leukemia diagnosed in both children and youngsters. As indicated by hematological specialists ALL is described by an overproduction of immature white cells, called lymphoblasts or leukaemic blasts. These cells swarm the bone marrow, keeping it from making ordinary white cells. They can likewise spill out into the circulatory system and course around the body. Similarly, a clonal expansion of myeloid cells and their precursors in the bone marrow, fringe blood, and spleen caused abnormality. At the point when the multiplying cells are immature myeloid cells and myeloblasts, it is called acute myeloid leukemia [3].

The FAB characterization framework isolates ALL into three subtypes L1, L2, L3, and AML isolates into eight subtypes, M0–M7, in view of the cause cell and cell development [4].

The aim of this study is to discriminate the prevalent subtypes of acute leukemia (acute myeloblast and acute lymphoblast) and FAB classification of these cells. In the present study, for AML only three classes, M2, M3, and M5 are considered because of the database inadequacy. Because of its fast spread into the blood and other vital organs, it is fatal if left unprocessed. For the revitalization of patients, especially for youngsters, early analysis of the infection is crucial. The proposed method may reflect an error depending on the hematologist practice and the complexity to differentiate leukemia types and subtypes. Regardless, stream cytometry is a most steady strategy to set up exact findings of leukemia subtypes.

This is the two-fold problem of leukemic cell identification: (a) the difficult differentiation between healthy leukocytes and leukemic cells since they have some geometrical similarities; and (b) the discrimination between lymphoid or myeloid origin, since these subtypes of leukemia blast cells reveals too many alike patterns.

From the literature study, it can be seen that there are a various number of classification systems are available for the detection of blast cell from the healthy one [3–35]. This type of classification systems used public as the well self-collected dataset from the different government or private institutions or pathology labs and binary classifiers are used for classifying these cells. In present work, different studies are combined together and a multiprocessing system is built for solving various classification problems as healthy leukocyte cell (HLC) versus acute lymphoblastic cells (ALC) versus acute myeloblastic cells (AMC), FAB classification of ALC cells and finally FAB classification of AMC cells. All the studies related to present work which is carried for the classification of healthy leukocyte, acute lymphoblast, and acute myeloblast are tabulated in Tables 1–3.

In Table 1, studies related to the classification of healthy cells from the ALC are depicted. From the literature, it can be seen that the maximum accuracy for the classification of healthy leukocytes and acute lymphoblast is 98.2% achieved in the study [17] by using ANN classifier and multiple clinical and laboratorial features are used for correct classification.

In Table 2, work related to the classification of healthy cells and AMC cells is presented.

From Table 2, it can be seen that highest accuracy for the classification of healthy leukocytes and acute myeloblast is 98% [26,28,29], which can be gained by extracting the various color, texture and shape features from the both type of leukocytes and by using the classifiers like SVM (support vector machine) and FFNN (feed forward neural network).

The work carried for the classification of the acute myeloblast and acute lymphoblast is tabulated in Table 3.

Similarly, in Table 3, it can be observed that 99.8% is the highest accuracy achieved for 2-class (acute myeloblast and acute lymphoblast) classification by using seeded region growing (SRG) based classifier by extracting color, shape, and texture features [35].

From the extensive study of literature, it can be seen that there are few studies related to this problem in which all the healthy cell would discriminate from abnormal cells and further that abnormal cell would discriminate into myeloblast cell and lymphoblast cell. So there is a need for a consistent, reliable Computer Aided Classification (CAC) system that must belong to a publically available dataset where others can validate their systems. Hence present work proposed a

Please cite this article in press as: Rawat J, et al. Computer assisted classification framework for prediction of acute lymphoblastic and acute myeloblastic leukemia. Biocybern Biomed Eng (2017), http://dx.doi.org/10.1016/j.bbe.2017.07.003