ISSN 2320 - 2602

International Journal of Advances in Computer Science and Technology (IJACST), Vol. 4 No.1, Pages : 56 –62 (2015)
Special Issue of ICCSIE 2015 - Held during January 16, 2015, Bangalore, India
http://warse.org/pdfs/2014/iccsie2017sp01.pdf

LEUKEMIA IN HUMAN BLOOD SAMPLE USING ARTIFICIAL NEURAL NETWORKS

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Abstract

Leukemia is one of the most common cancers in children, comprising more than a third of all childhood cancers. Newly affected patients in USA are estimated as 10100cases, and if these cases are diagnosed late or proper treatment is not applied, then it can be mortal. Because rapid and proper diagnosis of leukemia based on clinical or medicinal findings (without biopsy) is impossible, we decided to apply artificial neural network for rapid leukemia diagnosis.parameters of 131 patients were applied for training network with Levenberg-Marquardt learning algorithm, with learning rate of 0.1.

Methods

We carried out independent sample T-test with SPSS software for 38 parameters. With regard to the results of this analysis we selected 8 parameters that had lowest sig for ANN analysis (among parameters, whose sig were less than 0.05). Selected parameters of 131 patients were applied for training network with Levenberg-Marquardt learning algorithm, with learning rate of 0.1.

Keywords

Artificial Neural Network, Multilayer Perceptron (MLP),Blood Disorder, Cancer, Megaloblastic Anaemia ,cancer, leukemia, prediction.

INTRODUCTION

Medical imaging has become one of the most important visualization and interpretation methods in biology and medicine over the past decade. This time has witnessed a tremendous development of new, powerful instruments for detecting, storing, transmitting, analyzing, and displaying medical images. This has led to a huge growth in the application of digital image processing techniques for solving medical problems. The most challenging aspect of medical imaging lies in the development of integrated systems for the use of the clinical sectors. Main objective of analyzing through images is to gather information, detection of diseases, diagnosis diseases, control and therapy, monitoring and evaluation .At the moment, identification of blood disorders is through visual inspection of microscopic images of blood cells. From the identification of blood disorders, it can lead to classification of certain diseases related to blood. One of the most feared by the human disease is cancer. Leukemia is a type of blood cancer, and if it is detected late, it will result in death. Leukemia occurs when a lot of abnormal white blood cells produced by bonemarrow. When abnormal white blood cells are a lot, the balance of the blood system will be disrupted. The existence of abnormal blood can be detected when the blood sample is taken and examined by hematologists.

In order to know all information about blood, expensive testing required. Automatic image processing system is urgently needed and can overcome related constraints in visual inspection. The system to be

developed will be based on microscopic images to recognize types of leukemia. The early and fast identification of the leukemia type greatly aids in providing the appropriate treatment for particular type of leukemia. leukemia will be based on texture, shape, size, color, and statistical analysis of white blood cells.

This research is hoped can assist to increase efficiency globally and at the same time can benefit and be a huge contribution in medical and pattern recognition field. The main objective is to enhance algorithms that can extract data from human blood where human blood is the main source to detect diseases at earlier stage and can prevent it quickly. This system should be robust towards diversity that exists among individual, sample collection protocols, time and etc .It is hoped that this system can be automated in order to produce lab results quickly, easily and efficiently. The purpose of this paper is to review some work done in blood cell recognition and to overview the proposed approach to be used in this research. In this paper, we will propose of using reinforcement learning (RL) in classifying types of leukemia. Medical images have very similar gray level and texture among the interested objects. Segmentation error may occur and increase. Another problem is may be lack of a sufficient number of training samples if a supervised learning technique is employed. By using RL approach, a minimum training dataset is required.

MLP networks: There are many types of neural networks used for various applications. MLPs are the simplest and therefore most commonly, used neural network architectures programs due to their structural flexibility, good representational capabilities and availability, with a large number of programable algorithms. MLPs are feed forward neural networks and universal approximators, programmed with the standard back propagation algorithm. With one or two hidden layers, they can approximate virtually any input-output map. An MLP consists of three layers: an input layer, an output layer and an intermediate or hidden layer. In this network, every neuron is connected to all neurons of the next layer, in other words, an MLP is a fully connected network.

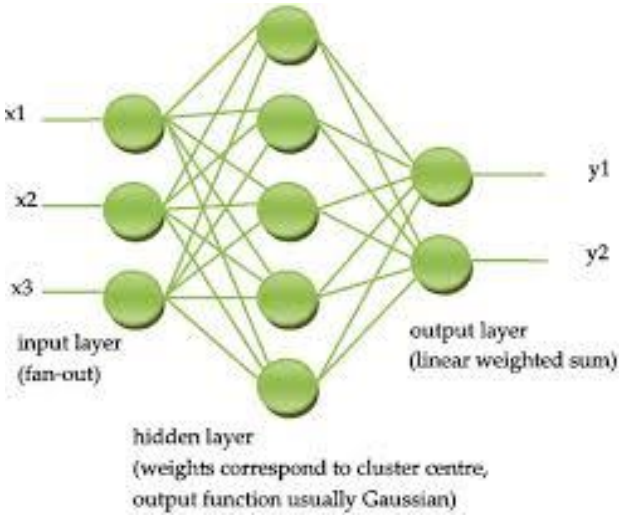

Figure-1 shows the structure of an MLP.

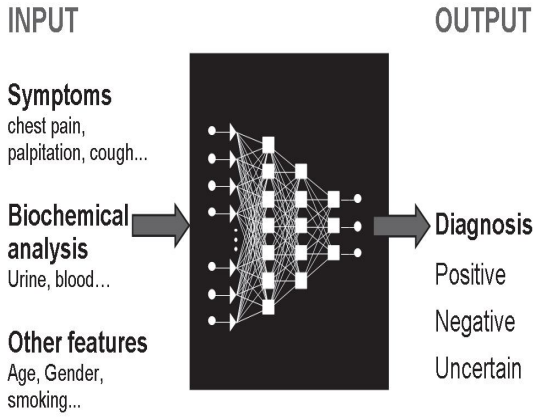

Figure- 2: An MLP network's structure

Example of training database structure.

Each row refers to a different patient labeled with a numerical code. The element data*k,i* refers to the *i*-th medical data (symptom, laboratory data, etc.) of the *k*-th patient.

Patient code	MEDICAL DATA	DIAGNOSIS
1	$data_{1,1}$ … $data_{1,i}$ … $data_{1,m}$	POSITIVE
2	$data_{2,1}$ … $data_{2,i}$ … $data_{2,m}$	POSITIVE
3	$data_{3,1}$ … $data_{3,i}$ … $data_{3,m}$	POSITIVE
…	……	
k	$data_{k,1}$ … $data_{k,i}$ … $data_{k,m}$	NEGATIVE
k+1	$data_{k+1,1}$ … $data_{k+1,i}$ … $data_{k+1,m}$	NEGATIVE
…	……	
n	$data_{n,1}$ … $data_{n,i}$ … $data_{n,m}$	NEGATIVE

Blood is the main source of information that gives an indication of changes in health and development of specific diseases. Changes in the number or appearance of elements that formed will guide health condition of an individual.

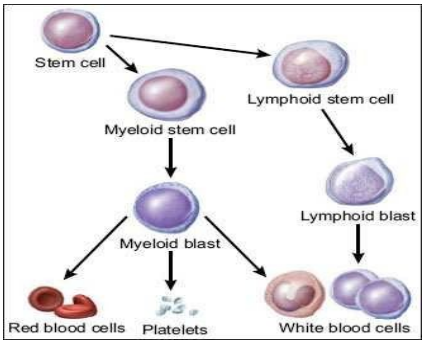

Figure 3. Production Of Blood Cell

Leukmia

Most blood cells produced from the cells in the bone marrow called stem cells. Bone marrow is a soft material found in the middle of each bone. Stem cells will mature and become some kind of blood cells. Each blood type has their own function. Blood components consist of:

a. Red blood cells (erythrocytes) - carry oxygen to tissues and back to the lungs with carbondioxide.

b. White blood cells (leukocytes) - Defending the organism from infection. There are several types of white blood cells.

c.Platelets –helps blood clotting to control bleeding.

d.Plasma -The fluid in blood containing dissolved ions needed for cell function and consists of sodium, potassium, chloride, hydrogen, magnesium and iron. When blood cells are old or damage, the cells will die and new cells will replace it It shows that how stem cells became mature and evolve into several components of blood. They evolve into either myeloid stem cell or lymphoid stem cell. Myeloid stem cells eventually mature and became myeloid blast. White blood cells from The study will focus on leukemia because the disease is dangerous and can lead to death. For someone who has leukemia, bone marrow produces abnormal white blood cell. Compared with normal cells, abnormal white blood cell will not die when they should. This also causes an imbalance of blood system in the human body. Leukemia can be grouped based on how quickly this disease develops and become severe. Leukemia is either Chronic or Acute.

Chronic Leukemia – at earlier stage, leukemic cells can make tasks such as normal white blood cells. Gradually they will become severe chronic leukemia.

Acute leukemia - leukemia cells cannot make tasks like normal white blood cells. The number of leukemia cells will grow rapidly and become severe in a short timeGenerally, leukemia can be divided into 4 types .They are

a. Acute Lymphocytic Leukemia (ALL) – usually occurs in children aged 2-10 years. This type of leukemia is most common. It also always occur in adults

Figure 4. Acute Lymphocytis Leukemia (All)

b. Acute Myeloid Leukemia (AML) – This type of leukemia is common in children under the age of 1 year. It is extremely rare in teenagers. Even so it is mostly in adults aged 40 years.

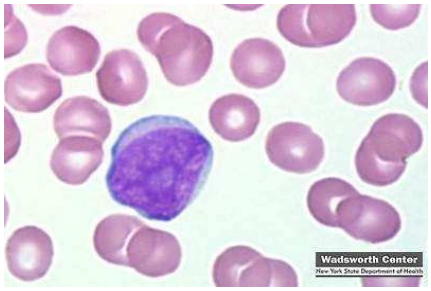

Figure 5. Acute Myeloid Leukemia (Aml)

c. Chronic Lymphocytic Leukemia (CLL) – This type of leukemia often happens to older patients. It is extremely rare in patients under the age of 40.

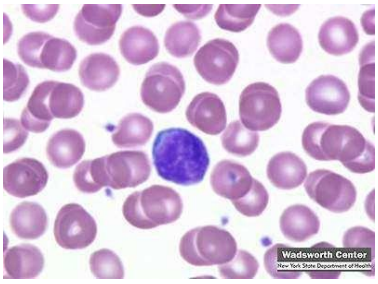

Figure 6. Chronic Lymphocytic Leukemia (Cll)

d. Chronic myeloid leukemia (CML) This typ of leukemia can occur in all but the most common is for adults age after 45 years.

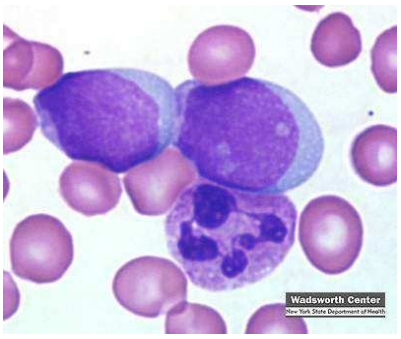

Figure7.Chronic Myeloid Leukemia

There are various aspects that make the process of recognition of blood cell images became very difficult task.

Types of leukocytes that covers a wide range of features for eg. shapes and colors in microscopic images. The use of different illumination for captioning image that lead to a variation of color distribution in the images .Two neighboring cells or adjacent cells that are very similar to each other and the border point between two neighbors is not well defined.Squashed leukocytes that appear as blurred image regions

Blood cell Research

Some research has been done in automating the process of blood cell identification and next can diagnose the patient correctly. Some of them are who develop a system to identify and classify malaria parasite through microscopic images of blood cells.

The result acquired is using multi layer perceptron (MLP) with 2 hidden layers. Training data results have maximum accuracy 99.27%, mean accuracy 98.16% and standard deviation of 0.64%. While testing data results have maximum accuracy 88.72%, mean accuracy 84.44% and standard deviation 2.41%.While develop a system called *Leuko* and they use textural information to increase

differences among leukocytes. e.g. image enhancement, edge erosion, color, size normalizing and many more. At the end, they use SVM to classify. The accuracy of 93% was observed use global contrast stretching to enhance the images. By doing this, the visual aspect of blast cells can be increased and they do the segmentation based on HSI color space.

There are several applications in medical images that use reinforcement learning have used reinforcement learning (RL) in their work. They use RL in order to overcome some problems in medical images. They use abdominal X- Ray CT images. Q-learning is used within the rough kidney region and kidney contour edge is detected. The success probability is quite low that is 53%.

Another RL application use CT images of lung to classify lung nodules either benign or malignant. They use 3D geometric nodules characteristics to guide classification. The obtained results are very encouraging and show that the RL classifier can effectively classify the benign or malignant nodules based on CT images.

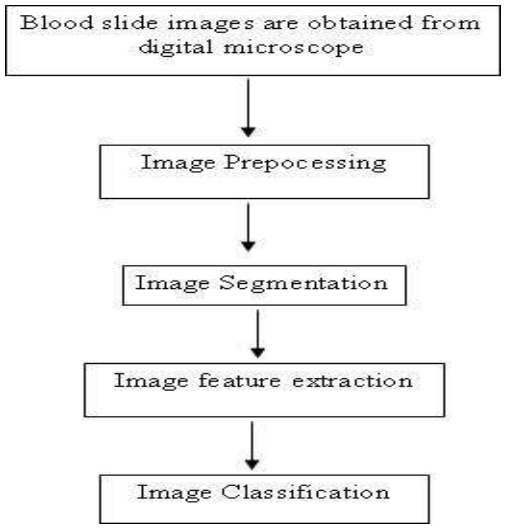

Figure 8. Typical Steps In Process Of Automating Blood Recognition

From the literature, it is found that typical steps for the process of automating blood recognition are as in Figure

RESEARCH METHODOLOGY

Research methodology that will be used in this research includes:

1.Image Acquisition

Blood image from slides will be obtained from nearby hospital with effective magnification. **2. Preprocessing**

During image acquisition and excessive staining, the images will be disturbed by noise.During this preprocess, image enhancement will be done as the contrast enhancement technique is capable to improve the medical image quality

2. Segmentation

Segmentation of white blood cell (WBC) and determine ROI that is nucleus for WBC only. This is because in leukemia cell images, the cytoplasm is scanty [18]. So, focus will be on nucleus of WBC only. Determination the types of WBC should be done from the nucleus. Only lymphocytes and myelocytes should be considered and need to determine them whether they are blast cells or not.

3. Feature Extraction

The most important problem in generation of features of blood cells that characterize them in a way enabling the recognition of different blast types with the highest accuracy [23]. The features to be used are for nucleus of lymphocytes and myelocytes:

4.Geometrical Features – which includes area, radius, perimeter, symmetry, concavity, compactness, solidity, eccentricity, elongation, form factor will be obtained.

5. Statistical Features – the mean value, variance, skewness, kurtosis of the histograms of the image matrix and the gradient matrix for RGB or HSV or L*a*b color space (whichever appropriate) will be obtained.

Classification

Classification is the task of assigning to the unknown test vector to a known class. In this step, a reinforcement learning algorithm is proposed. The RL approach will classify the types of leukemia into ALL, AML, CLL and CML. The idea behind RL is an intelligent agent learns on how to act with its environment in order to maximize rewards that it gets with respect to predefined measures. The agent will require a trial- and-error learning in its action to achieve the optimal goal.

Types of acute Leukemia Cells	**Training Data**	**Testing Data**
AML	**545**	**221**
ALL	**555**	**253**
Total	**1100**	**474**

The distributions of the training and testing data sets are shown in Table 1

From the Table 2, the results show that the HMLP network classified the ALL type betterthan AML type in the training phase with 98.00% and 97.43% accuracy respectively.Meanwhile, the overall performance of the HMLP network produced 97.72% of accuracy.

Classification	**True**	**False**	**Total**	**Accuracy**
ALL	544	11	545	98.00%
AML	531	14	555	97.43 %
Overall	**1075**	**25**	**1100**	**97.72**

Table 2.Results for acute leukemia cells size classification in training phase

Classification	**True**	**False**	**Total**	**Accuracy**
ALL	242	11	253	95.65
AML	218	3	221	98.64
Overall	**460**	**14**	**474**	**97.04**

Table 3.Results for acute leukemia cells size classification in testing phase

The results obtained in Table 3 represent that the HMLP network successfully classified98.64% of AML type as compared to 95.65% of ALL type during testing phase. Besides that , the overall performance of the HMLP network classified 97.04% blasts size from acute leukemia samples correctly

Table 2 and 3 shows the diagnosis performance of the HMLP neural network using MRPE training algorithm for training and testing phase respectively. The HMLP neural network using MRPE training algorithm produced the highest and best performance at 5 training epochs and 30 hidden nodes.

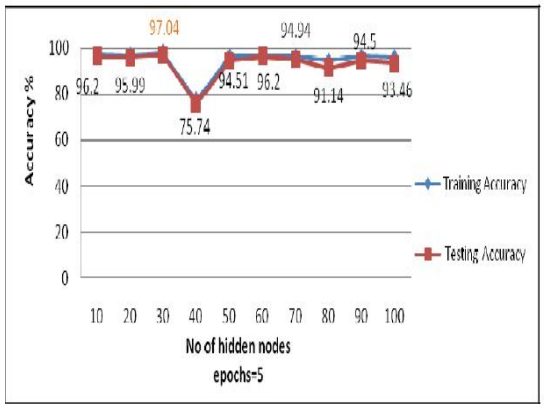

Figure12 :Overall performance accuracy during Training and Testing Phase

Figure indicates the resulted graph for HMLP neural network using MRPE training algorithm was achieved an optimal result at 5 training epochs and 30 hidden nodes. The results represent that the HMLP network has high capability and ability to classify the blasts in acute leukemia samples into two types, namely ALL and AML

CONCLUSION

This research involves detecting the types of leukemia using microscopic blood sample images. The system will be built by using features in microscopic images by examining changes on texture, geometry, colors and statistical analysis as a classifier during the testing phase. Only 14 (3%) data is miss - classified. It is concluded that, artificial intelligence using HMLP neural network can contribute efficient and accurate diagnosis for acute leukemia blood samples.

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