Volume 6, Issue 10, October 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Study on Image Processing Concepts Used for the Detection on Leukaemia – A Survey

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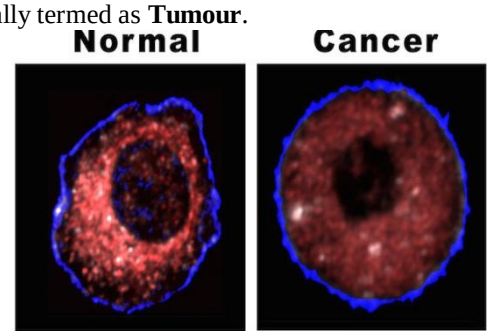
Abstract: ***In medical science, cancer cell detection can be done through the microscopic images of the collected blood samples. Medical world states that Leukaemia is a type of blood cancer which occurs on the White Blood Cell (WBC) of the bone marrow. In Image processing, various techniques can be used in the detecting the cells that are affected by cancer. This paper deals with the comparison of different algorithms that are used for leukaemia detection from the collected sample images. This paper consists of the introduction of various cancerous cells in Section 1, the literature review in Section 2, the various modules that are used for the detection in Section 3.***

Keywords: Leukaemia, Image Segmentation, Clustering algorithms, White Blood Cells (WBC), Microscopic images.

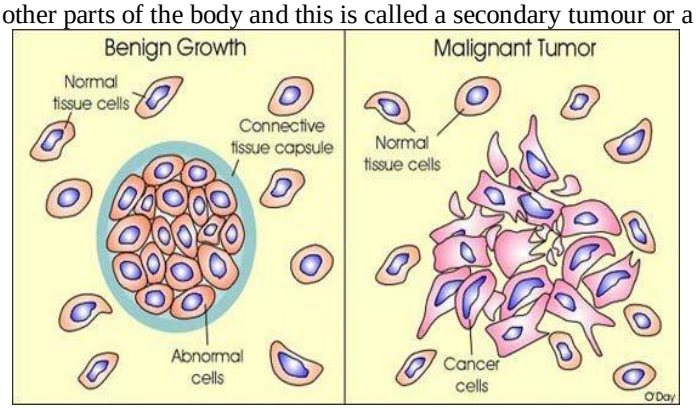
I. INTRODUCTION

The human body is made up of cells, tissues, muscles and veins. The cells which grows in a very fast manner or the cells which shows some changes in the body are termed to be **Cancerous Cells**. The cancer cells may be in the form of masses or lumps, which are medically termed as **Tumour**.



Some lumps that are formed in the body may not be harmful and they are termed to be **benign**. Some lumps may be a group of cancer cells and are to be **malignant**. These lumps are to diagnosed and removed immediately in order to avoid the death[1].

There are more than 200 different types of cancer. A primary tumour is the name where the cancer starts. Cancer sometimes spread to other parts of the body and this is called a secondary tumour or a metastasis.



Cancers are grouped into five main categories.

1. Carcinoma – This type of cancer begins in the skin or in the tissues that line or cover internal organs.
2. Sarcoma – This type of cancer begins in the connective or supportive tissues.
3. Blood cancer – This type of cancer begins in the blood cells and spreads through blood.
4. Lymphoma & Myeloma – This type of cancer begin in the cells of the immune system.
5. Brain & Spinal cord cancer – These type of cancer are known as the central nervous system cancer[2].

Blood cancer – Leukaemia [3]

Leukaemia is a malignancy(cancer) of blood cells. In leukaemia, abnormal blood cells are produced in the bone marrow. White Blood Cells(WBC) are the cells responsible for fighting infections. Leukaemia involves the production of the abnormal WBC.[3]

Large numbers of leukaemia cells accumulate very quickly in the blood and bone marrow, and leads to tiredness and infections. Leukaemia makes up 3% of all new cancer cases.[3]

Leukaemia is of many types. Some of the common types of leukaemia are

a. Acute Lymphocytic Leukaemia(ALL)
b. Acute Myeloid Leukaemia(AML)
c. Chronic Lymphocytic Leukaemia(CLL)
d. Chronic Myeloid Leukaemia(CML)[3]

Symptoms of Leukaemia[4]

A patient who is suffering from leukaemia type of blood cancer may have the following symptoms.

a. Lethargy (lack of energy)
b. Anaemia (Low RBC level)
c. Fever
d. Easily bruised
e. Frequent nose bleeds
f. Swelling in lymph nodes in the neck and armpits[4].

Treating Leukaemia[4]

The medicines used to treat the different types of leukaemia may vary but treatments can include:

a. Chemotherapy – Medicines that destroy the cancer cells.
b. Bone marrow or stem cell transplants – To replace the patient's bone marrow with healthy bone marrow.
c. Blood and platelet transfusions to replace red blood cells and platelets.
d. Antibiotic – To fight infections as the patient's immune system is not working well[4].

II. LITERATURE REVIEW

Various Digital Image Processing techniques may be used to identify the affected White Blood Cells(WBC) and classify which type of cancer, the patient is affected with and suffering from.

The paper, "Detection of Acute Leukaemia using White Blood Cells Segmentation based on Blood Samples", by Ms.Minal D.Joshi, Prof.A.H.Karode, represents the image segmentation for the blood sides and then the classification for the automatic leukaemia detection. The paper states that the features of an image such as the perimeter, circularity, area etc., are calculated using the feature extraction method. The normal cell and the blast cells are differentiated using the pattern recognition. The KNN classifier is used for the calculation of features such as the circularity, area, perimeter, etc. An accuracy of 98% was obtained on applying on 108 images[6].

The paper, "Improving Blast Segmentation of Cute Myelogenous Leukaemia(AML) Images using Bright Stretching Technique", by Azian Azamini Abdullah, proposes a technique for the Acute Myelogenous Leukaemia(AML) detection. By using the combination between the contrast enhancement WBC can be detected. Partial contrast and bright stretching are used as the contrast enhancement technique. To produce a better result, HSI color space technique is used instead of the RGB color model. The end result states that after the usage of the enhancement technique, the reduction of the interference on the background images is found to a great extent and extraction of the morphological images from the blood samples is allowed efficiently[7].

The paper "An automated white blood cell localization and segmentation using image arithmetic and automatic threshold" by Madhloom HT, Kareem SA, Ariffin H, Zaidan AA, Alanazi HO, Zaidan BB, states that the white blood cell nuclei can be detected by using some image arithmetic operation and some image threshold operations[8].

The paper "Automation of differential blood count" by Sinha[9] differentiates five types of leucocytes. K-means algorithm is used for the differentiation. The author says that some other clustering model algorithms can also be used for the differentiation purpose.

The paper "Robust segmentation and measurements techniques of the white cells in blood microscopic images" by Scotti[10] is based on the white blood cell segmentation clustering and removal of background. Some threshold operations and low-pass filters were used for removing the background and clustering the WBC segmentation.

The paper "Automated leukocyte recognition using fuzzy divergence" by ghosh[11] deals with finding out the accurate threshold for the leukocyte segmentation. The fuzzy divergence technique and some functions such as Gamma, Gaussian, Cauchy techniques are used in this paper. The paper deals with the advantage and the disadvantage of using this technique. The advantage is that the nucleus segmentation is performed well by using this technique. Whereas, the disadvantage is that the cytoplasm extraction is not performed well.

The paper "Microscopic image analysis using mathematical morphology: Application to haematological cytology" by Angulo[12] proposes a system as "two-stage blood image segmentation algorithm". This system comprises of two techniques such as the binary filtering and automatic threshold techniques. The nucleus, cytoplasm and nucleolus are extracted from the lymphocyte images and performed well by using these techniques. The computing time is comparatively high since two stage segmentation processes is applied.

The paper "A Data Mining Of Leukemia Cancer Detection Using Genetic Algorithm and Neural Network" by Pawandeep [13], states that data mining techniques are used for framework proportion and genetic algorithm and neural networks are used for detecting the leukaemia type of cancer. The leukaemia data set and the gene set is reduced by using the genetic algorithm. The matched and the unmatched values are classified by using the neural networks. The accuracy of the data set values are checked by the accuracy parameters.

Comparison Table

The following table shows the comparison between various techniques which are used in the leukemic detection.

S No	TECHNIQUES	AUTHORS	FEATURES/FACTORS	LIMITATIONS
1	Image segmentation, classification, feature extraction, pattern recognition, KNN classifier	Ms.Minal D. Joshi, Prof. A. H. Karode	Malignant cells are determined by the morphological changes from the blood samples.	The output can be improved by the cost effective and robust automated system for the screening of leukaemia.
2	Contrast enhancement techniques, Color space enhancement techniques.	Aimi Salihah, A. N., M.Y. Mashor, Azian Azamimi Abdullah	Shape, size, contour signature can determine the presence of leukaemia.	Staining of the cells, noise detection and segmentation.
3	Image arithmetic operation, Image threshold operation	Madhloom HT, Kareem SA, Ariffin H, Zaidan AA, Alanazi HO, Zaidan BB	Nucleated cells are analysed, remaining components are removed and blood cells are automatically recognized from the samples.	White blood cells should be localized from large number of datasets.
4	K-means algorithm and other Clustering may also be used.	Sinha N, Ramakrishnan AG	No parameter tuning is done as the scheme proposed is automatic.	Existing systems which uses sophisticated features is comparable with the classification accuracy.
5	Threshold operations and low-pass filters	Scotti F	Automatic identification of leukocytes is performed from the microscopic images.	The adjacent leukocytes segmentation phase may be affected.
6	Fuzzy divergence technique, Gamma, Gausian, Cauchy techniques	M. Ghosh, D. Das, C. Chakraborty and A.K. Ray	Recognition of leukocyte and modification of thresholding is carried out.	Better recognition may be obtained when more thresholding is done in images.
7	Binary filtering and automatic thresholding techniques	J. Angulo and G. Flandrin	Mathematical based morphology operations like image filtering, segmentation, feature extraction in color images in carried out in a generic method.	The shape, texture and color of the objects are classified in an image by operators such as the granulometries and color histograms.
8	Data mining techniques, genetic algorithm and neural networks.	Pawandeep and Arshdeep Singh	Cancer can be predicted by using the ANN and genetic algorithms.	Support vector machine may be used for classification.

From the above literature review, K-Means algorithm may be stated as the best algorithm, since it is used very commonly for the detection of cancer. The differentiation of the leukocytes, the types of leucocytes may be segmented and identifies by this algorithm. Though K-Means algorithm is used very frequently for the differentiation, some other clustering algorithms can also be used in the future works.

III. RELATED WORK

Cancer Detection Modules

A microscopic image of the blood set can be analysed and the cancer cells can be detected. The analysis may be done by five different modules such as the image pre-processing, image classification, image segmentation, fuzzy rule based detection. Each module may have its own features and functionalities.

a. Image Pre-processing Stage

Image pre-processing generally defines the improvement in the data set that are collected. This stage removes the unwanted pixel values and selects the pixels from the image that are needed for the detection and enhances them for a better result. Removing low-frequency background noise, normalizing the intensity of the individual particles images, removing reflections, and masking portions of images are the commonly carried out in the pre-processing stage.

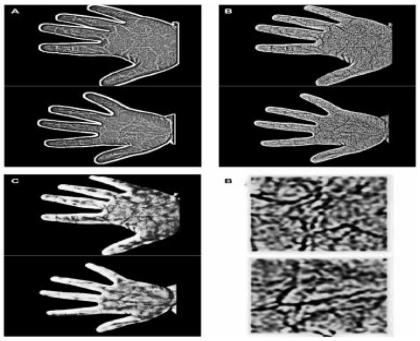
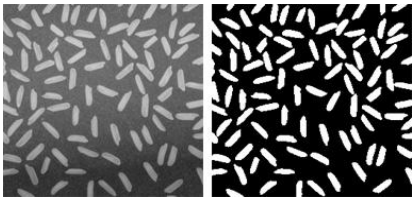


Figure 1. Image preprocessing. (a) Original images; (b) Cropping the palm region near the wrist; (c) DoG filtering; (d) Histogram equalization.

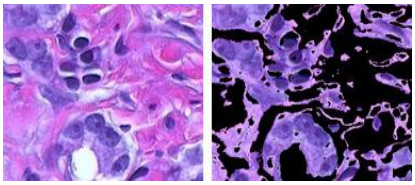
b. Image Segmentation

Image Segmentation generally refers to the division of a single image into multiple parts. This stage is used to identify the objects and other relevant data from the image. Image segmentation includes

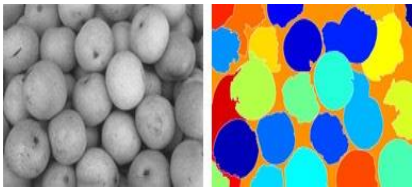
a. Thresholding method – Otsu's method



b. Color-based segmentation – K-Means clustering



c. Transform method – Watershed segmentation



d. Texture method – Transform filters

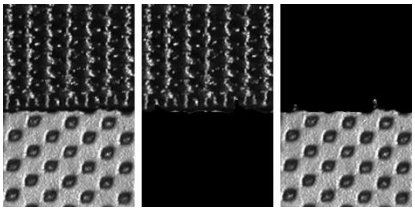


Figure 2. Image segmentation methods

c. Image Classification

Image classification generally refers to the grouping of similar category images from the original image. Image classification can be done in three ways.

a. Unsupervised image classification
b. Supervised Image classification
c. Object-based image analysis

d. Fuzzy Rule based detection system

Fuzzy logic is generally a multi-valued logic which allows the intermediate values to define results such ah yes or no, true or false, black or white, etc.

The table illustrates the algorithms which are commonly used in detection of cancer from the collected microscopic sample images.

S NO	ALGORITHM	ADVANTAGES	DISADVANTAGES
1	K –Means algorithm	1. Very simple method. 2. Converges to a local minimum of the error function.	1. Memory intensive. 2. Need to pick k. 3. Sensitive to initialization, outliers.
2	Edge detection	1. Easy to understand. 2. Easy to implement.	1. It is not suitable for very noisy and edgeless images. 2. It is not suitable for images whose boundaries are very smooth.
3	Threshold	1. Simple to implement. 2. Fast and good for some kinds of images.	1. No guarantees of object coherency-might have holes, extraneous pixels.
4	Histogram Equalization	It is a most effective technique for grayscale images. But the color images	But the color images it is a difficult task to work.
5	Image Noise	It is used to reduce the noise from an image easily.	While the dispensable image in low light.

IV. CONCLUSION

In this paper, the literature review deals with detecting blood cancer and leukaemia from the microscopic images and the blood samples that are collected. Many image processing techniques and various algorithms can be used in detecting the cancerous cells from the collected data. Any abnormal changes in the images such as the change in colour, shape, size, texture etc., of an image detects the problem. The detection may be carried out by various stages as discussed in Section III.

From the survey carried out on the leukaemic detection, K-Means algorithm is the algorithm which is generally used for the differentiation purpose. Many other algorithms and image processing techniques are also used for the processing of the collected datasets.

Though after the detection is carried out by using these techniques, some drawbacks are still faced in finding the accurate result from the data collected. Research is still carried out on overcoming these drawbacks in order to provide an efficient and accurate result.

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