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# MICROSCOPIC RGB COLOR IMAGES ENHANCEMENT FOR BLOOD CELLS SEGMENTATION IN YCbCr COLOR SPACE FOR K-MEANS CLUSTERING

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**ABSTRACT**

Blood is the main component of human body. Blood is composed of Red Blood Cells, White Blood Cells, Platelets and other artifacts. Blood is considered as the main source of identifying various diseases like Malaria, Anemia, and Leukemia etc. In these diseases the main region of interests are the blood cells. The main focus in these diseases is to carefully check the blood cells because these cells in one way or another are either attacked by the parasites or some disorder in their shapes, sizes and colors. These features of blood cells have fundamental importance in the study, because different disorders result in different diseases. Due to the challenges in the light microscopy the digital images produced are noisy and need proper processing, that the features like size, shape, color and internal features like nucleus its size and color (WBC) of the various blood cells are clearly studied. This work mainly focuses on the enhancement of contrast in the YCbCr color for algorithms like KNN and K-means Clustering as because in the YCbCr color space the enhancement results in different colors for Malarial Parasites, WBCs nucleolus and other artifacts. Hence, it is easy for grouping these regions into different classes. This work is the start of a complete automatically diagnosis of Malaria, Anemia and Leukemia.

***Keywords:*** *Anemia, Malaria, Leukemia, Red Blood Cells (RBC), White Blood Cells (WBC), RGB, YCbCr, K-NN and K-means Clustering.*

## 1. INTRODUCTION

The Blood is composed up of various components in which the main components are: Red Blood Cells(RBCs), White Blood Cells (WBCs), Platelets and other artifices as shown in Figure: 1. There are a lot of diseases in which these cells are attacked either by parasites or internally some disorder they varies in their shapes sizes and even in colors. As in Malaria the parasites are injected by the female Anopheles in to the blood which travels to the liver and become parasites on it. After some time these parasites introduced their selves by the process of mutation to the RBCs. In initial stages they are detected as rings in the cells which are very small and needed to be examined carefully as because Malaria parasite has four species and the identification of the specie is necessary. In the same way, due to the iron deficiency causes acute anemia and the size of the cells become smaller than the actual size. Similarly is the case in Leukemia, it is group of cancer of the blood cells, in this the abundance of WBCs is checked as because in normal blood the WBCs are small in number. All these diagnoses need proper attention and visualization, because the underlying patient is at the disposal of the physician and his life is important.

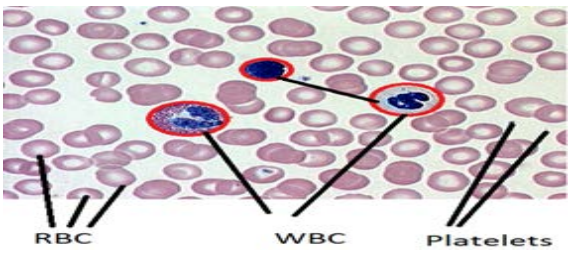


*Figure1 Shows The Different Types Of Blood Cells*

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Currently, the microscopic studies are mainly manual, which results in poor identification as human to err needs a lot of expertise in the field and also requires a lot of time and effort as compare to the automatic method. The rest of the paper is organized in the following sections: Section-II mainly deals with the related work in the field, Section-III reveled the details of using YCbCr color space instead of any other and the conversion processes from RGB to YCbCr color space. Section-IV focuses on the proposed methodology, Section-V discusses results and its comparison in the three color components of YCbCr and Section-VI puts light on the conclusion and future work.

## 2. RELATED WORK:

Most of the studies for blood cells segmentation, counting and parasites detection has been made but did the underlying work just as pre-processing and mostly concentrate the smoothing by median filter or some other filters. This is the main step which lay down the foundation for further studies. Thus, for proper identification and extraction features the work has fundamental importance. In the work [1], apply the local low pass filter for adaptive luminous correctness and then RGB image was décor- related into luminous and chrominance components using YCbCr, but no any enhancement is performed further. Studies [5,6], only applied the median filters of 5*5 with SE=disk for smoothness and pay no any attention to enhancement. In study [2], the color normalization using adapted gray world normalization is used but this computationally complex and time consuming. The study in [3], gives attention to the de-noising the image and then used Brightness Preserving Dynamic Histogram Equalization (BPDHE) algorithm, having better results. In [4], the uneven illumination was dealt by using a separate image of illumination to subtract from images later , which is not a logical way as the problems is to enhance the image first not at later stages. In the same way in [7], the RGB image is transformed to black and white and then some thresholds are set but the results have no, answer for dark regions. While the studies [6, 7, 13], do not addressed the color enhancement or image enhancement at all, in the work for the danger of parasites removal. In the same way in [11], only the RGB image is converted to gray scale, filtering 3*3(Median) is then applied and also histogram equalization is performed but the results smoothened the image but do not clearly show the hidden features in the darkness. The study [12], is purely related with the enhancement of color images RGB, for Malaria parasite specie, "*Falciparum*" but only focus on the dark stretching. In the RGB, color space the partial, dark and bright stretching was done in [17]. The 3*3 average filter is used as image as de-noising the image and then for contrast adjustment the image is transformed to YCbCr color space, shows better results as compare to RGB.

## USING YCbCr AND CONVERSION FROM RGB:

Actually the microscopic images have the problems of illumination in the RGB color space and have best results in the YCbCr color space. The de-correlated YCbC color space also provides three de-correlated channels Y, Cb and Cr. Channel Y is a chromatic luminance channel, where as chromatic channels Cb and Cr correspond to the difference between blue component with a reference value and difference between red components with a reference value, respectively.[19] Also the use YCbCr the image dark areas plus minute details are clearly exposed without the stretching and when the proper stretching is applied the results have clearly shows the differences.[16] The conversion follows the recommendations of CCIR 601 but is normalized so as to occupy the full 256 levels of a 8-bit binary encoding. [18] The equation:1 shows the conversion:

$$Y=\{0.299\ R+0.587\ G+0.114\ B\}$$
$$Cb=\{-0.1687\ R-0.3313\ G+0.5\ B+128\}$$
$$Cr=\{0.5\ R-0.4187\ G+0.0813\ B+128\}$$

**Equation: 1**

## 3. PROPOSED METHODOLOGY:

As the image set in this work is obtained from the image database of web-site [20], the thin blood smears are used as because they have more details as compare to the thick blood smears. In the proposed method the acquired image is passed directly without de-noising from conversion process i.e. from RGB color space to YCbCr color space as the reason is mentioned earlier. In the enhancement two things are important that the features may not lose and the original shape may not disturbed. The de-noising step is eliminated as the features are very poor in appearance and near to loss when any filter even at 3*3 is applied. Next, each channel of the YCbCr is checked by plotting histogram of the Luminance (Y), Chrominance Cb and Cr, and then each channel is enhanced using the histogram matching (ENav algorithm) with the given below equations:

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$$f(i) = I_o{}^1[I_i(i)] \quad (1)$$

where,

$I_o{}^1$ *mapping defined when the input is CDF of the Input image* $I_i(\,)$

$$I_i(k) = \sum_{j=0}^{k} q_i\,(j) = \frac{1}{Tpel}\sum_{j=0}^{k} i_j \quad (2)$$

where,

$I_i(k) = CDF\ of\ Input\ Image$

$i_j$, *is the population of jth intensity level in Input Image*

*Tpel is the total no. of pels in the input image*

*k={0,1,2,3, …….Max}, Max= Maximum Gray Level*

$$I_o(l) = \sum_{j=0}^{l} q_o\,(j) = \frac{1}{Tpel}\sum_{j=0}^{k} o_j \quad (3)$$

where,

$I_o(l) = CDF\ of\ Output\ Image$

$o_j$, *is the population of jth intensity level in Output Image*

*Tpel is the total no. of pels in the Output image*

*l={0,1,2,3, …….Max-1}, Max= Maximum Gray Level*

After enhancement of all the channels i.e the Y (Luminance), the Cb (Chrominance) and the Cr (Chrominance) are combined in single image, which shows best result as shown in the results section, clearly the image is then ready for any processing like segmentation. In the results section, all the results including histogram details are subjected to examine. Two images are taken one is an ordinary blood smear having RBCs, WBCs and platelets while the other is an in-vitro slide in which only Red blood cells having malaria parasite specie "*falciparum*", in its ring stage can be easily examined. The flow diagram of the proposed methodology is given in figure: 2

## CONCLUSION AND FUTURE WORK:

In this paper the main interest is that to enhance the image in such a way that it becomes suitable for further processing, like segmentation of Red blood cells, counting of Red blood cells, Segmentation and identification of White blood cells, platelets removal, checking the morphology of the cells, malarial parasites detection and identification in detail, as the method is also checked on the smears having parasites and other abnormalities of cell and gives good results. The main advantage in this method is that the every component becomes visible in a separate color and this is the main goal in any identification or in any segmentation process to segment the object of interest in a unique color or identification to easily extract them from the background.

As a future work, we do not stop it at this point because this is an initial step of a complete process i.e. how to segment Red blood cells?, how to count them further?, how we can detect leukemia?, how we can detect malarial parasites in Red blood cells, their four species identification, their life cycles study etc. The main hurdle in this whole process is this preliminary work because the slides of blood were stained with the Gimesa and all the components has then very slight variation in intensity levels as one can examine it in the original image.

Moreover, the histogram studies clearly show the problems and then their solutions as one can examine them all in the results section. The proposed method is checked on a set of 90 images and has good results, but due to the space deficiency only two results are showed in the results section.

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**Diagrammatic Representation of Proposed Methodology:**

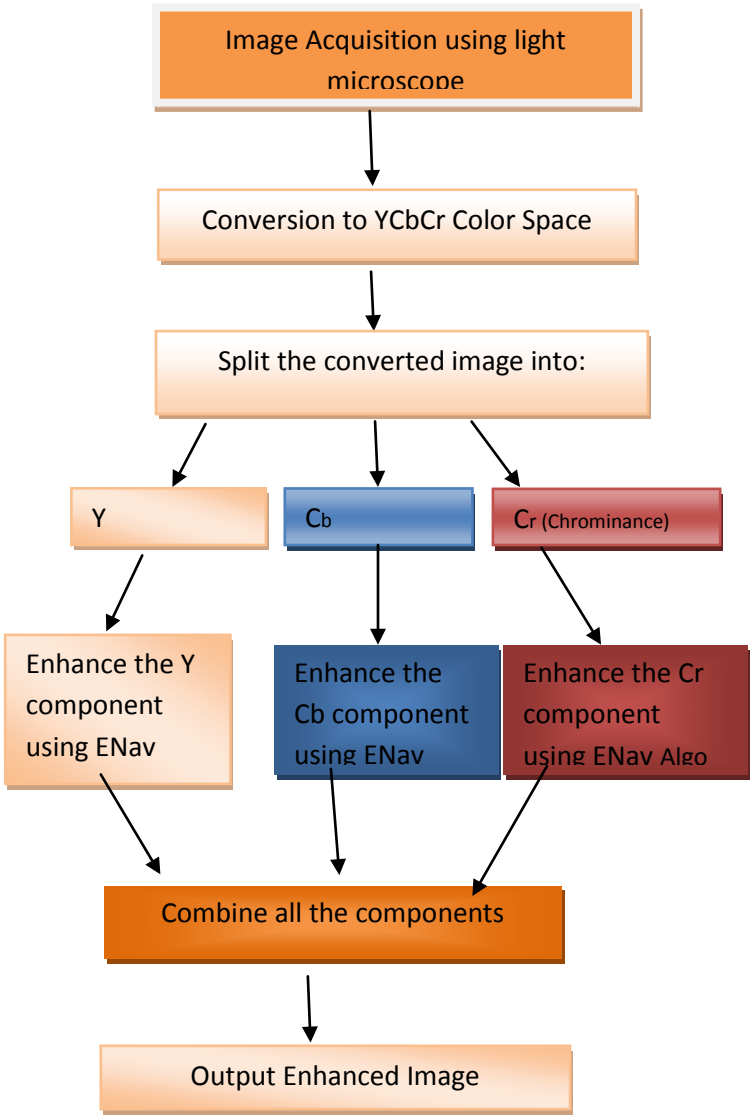


*Figure 2: Shows The Proposed Methodology Work*

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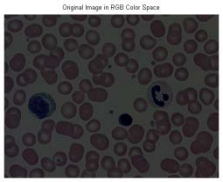
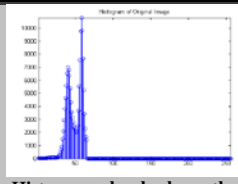
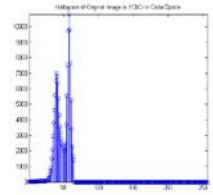
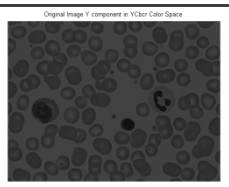
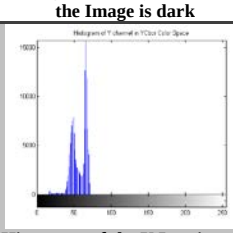
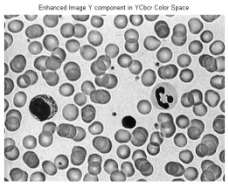
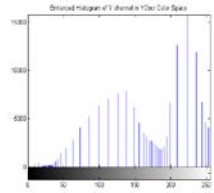
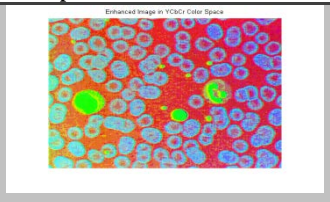
*RESULTS: "Results of normal thin blood smear having RBCs, WBCs, and Platelets" a) Original RGB Image, b) Original YCbCr Image, c) Original Y Component Image, d) Enhanced Y component Image, e) Original Cb component image, f) Enhanced Cb Component Image, g) Original Cr component Image, h) Enhanced Cr component Image, i) Enhanced image in*

| Image | Histogram |
|---|---|
|  |  |
| **a) Original RGB Image** | **Histogram clearly shows that the Image is dark** |
|  |  |
| **b) Original Image in YCbCr Color Space** | **Histogram clearly shows that the Image is dark** |
|  |  |
| **c) Image Y Luminance Component** | **Histogram of the Y Luminance Component of the Image** |
|  |  |
| **d) Enhanced Y Luminance Component** | **Histogram clearly shows the distribution of intensity levels** |



**i) Final Enhanced Image in YCbCr Color Space**

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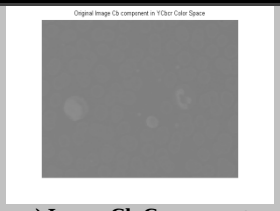
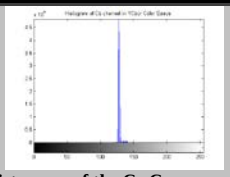
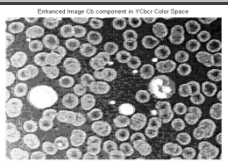
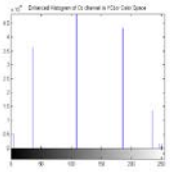
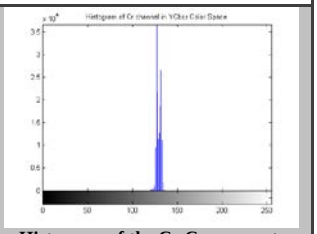
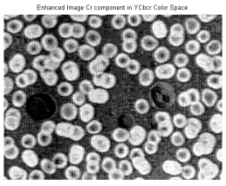
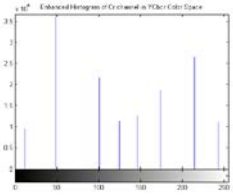
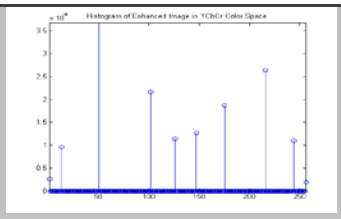
*Results of Malaria parasite "Falciparum" affected thin blood smear a) Original RGB Image, b) Original YCbCr Image, c) Original Y Component Image, d) Enhanced Y component Image, e) Original Cb component image, f) Enhanced Cb Component Image, g) Original Cr component Image, h) Enhanced Cr component Image, i) Enhanced image in YCbCr color space*

| Image | Histogram |
|---|---|
|  **e) Image Cb Component** |  **Histogram of the Cr Component shows the group of intensity levels at the middle** |
|  **f) Enhanced Cb Component Image** |  **Histogram clearly shows the distribution of intensity levels** |
|  **g) Image Cr Component** |  **Histogram of the Cr Component** |
|  **h)Enhanced Cr Component Image** |  **Histogram clearly shows the distribution of intensity levels** |
|  **Histogram clearly shows the distribution of intensity levels** | |

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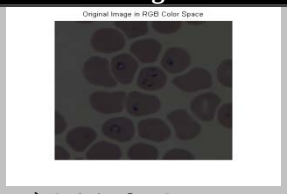
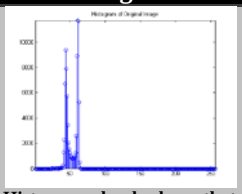
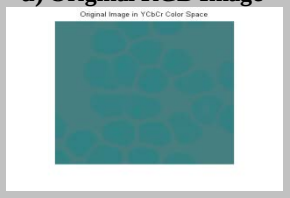
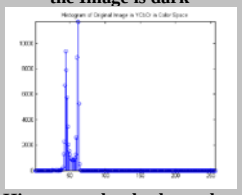
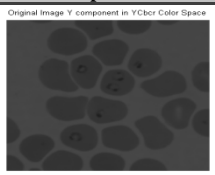
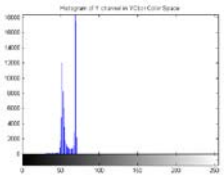
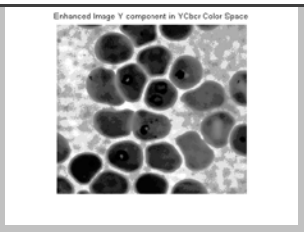
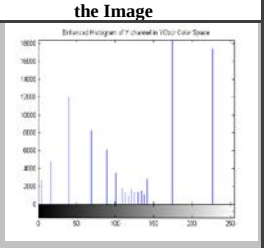
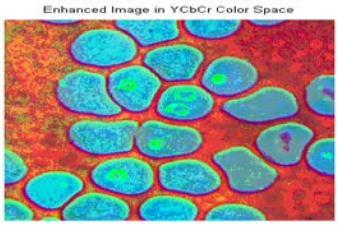
| Image | Histogram |
|---|---|
|  |  |
| a) Original RGB Image | Histogram clearly shows that the Image is dark |
|  |  |
| b) Original Image in YCbCr Color Space | Histogram clearly shows that the Image is dark |
|  |  |
| c) Image Y Luminance Component | Histogram of the Y Luminance Component of the Image |
|  |  |
| d) Enhanced Y Luminance Component | Histogram clearly shows the distribution of intensity levels |




i) Final Enhanced Image in YCbCr Color Space

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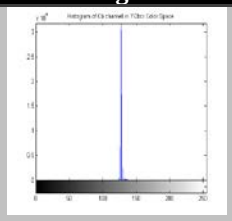
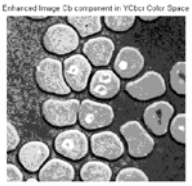
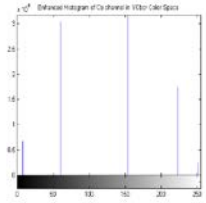
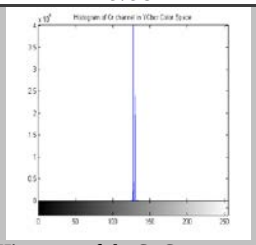
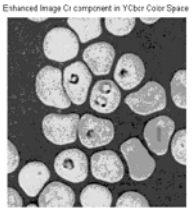
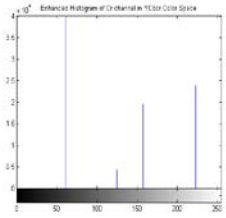
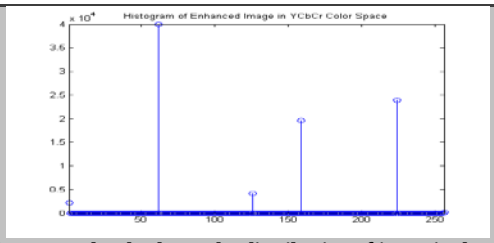
| Image | Histogram |
|---|---|
|  |  |
| **e) Image Cb Component** | **Histogram of the Cr Component shows the group of intensity levels at the middle** |
|  |  |
| **f) Enhanced Cb Component Image** | **Histogram clearly shows the distribution of intensity levels** |
|  |  |
| **g) Image Cr Component** | **Histogram of the Cr Component** |
|  |  |
| **h)Enhanced Cr Component Image** | **Histogram clearly shows the distribution of intensity levels** |




**Histogram clearly shows the distribution of intensity levels**

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**REFERENCES:**


[1]. Díaz, Gloria González, Fabio A Romero, Eduardo "A semi-automatic method for quantification and classification of erythrocytes infected with malaria parasites in microscopic images", Journal of Biomedical Informatics, 2009, Volume 42, issue 2, pages: 296-307

[2]. Hirimutugoda, Ym Wijayarathna, Gamini "Image Analysis System for Detection of Red Cell Disorders Using Artificial Neural Networks", Sri Lanka Journal of Bio-Medical Informatics, 2010 Volume 1, issue 1, pages: 35-42

[3]. Mandal, Subhamoy Member, Graduate Student Kumar, Amit "Segmentation of Blood Smear Images using Normalized Cuts for Detection of Malarial Parasites" pages 1-4 2010 Annual IEEE India Conference (INDICON)

[4]. Tek, F Boray Dempster, Andrew G Kale, Izzet "Computer vision for microscopy diagnosis of malaria.", Malrial Journal, 2009, volume:08 Page:153

[5]. Ross, Nicholas E Pritchard, Charles J Rubin, David M Dusé, Adriano G, "Automated image processing method for the diagnosis and classification of malaria on thin blood smears". Journal of Medical & biological engineering & computing, 2006, Volume: 44, issue:5, pages:427-36

[6]. Le, Minh-Tam Bretschneider, Timo R Kuss, Claudia Preiser, Peter R, "A novel semi-automatic image processing approach to determine Plasmodium falciparum parasitemia in Giemsa-stained thin blood smears." Journal: BMC cell biology, 2008, Volume :09 page 15.

[7]. Suwalka, Isha Sanadhya, Ankit Mathur, Anirudh Chouhan, Mahendra S ,"Identify Malaria Parasite Using Pattern Recognition Technique",

[8]. Tek, F. Boray Dempster, Andrew G. Kale, İzzet, "Parasite detection and identification for automated thin blood film malaria diagnosis" Journal: Computer Vision and Image Understanding, 2010, volume: 114, issue:1, pages: 21-32

[9]. Berge, Heidi Taylor, Dale Krishnan, Sriram Douglas, Tania S "Improved Red Blood Cell Counting in Thin Blood smears", 2011, Pages: 204-207. ISBI 2011,978-1-4244-4128-0/11©2011 IEEE 204

[10]. Delves, Michael J, Sinden, Robert E, "A semi-automated method for counting fluorescent malaria oocysts increases the throughput of transmission blocking studies" , Malarial Journal, 2010, pages 1-8.

[11]. Anggraini, Dian Nugroho, Anto Satriyo Pratama, Christian Rozi, Ismail Ekoprayitno Iskandar, Aulia Arif Hartono, Reggio Nurtanio, "Automated Status Identification of Microscopic Images Obtained from Malaria Thin Blood Smears", 2011 International Conference on Electrical Engineering and Informatics 17-19 July 2011, Bandung, Indonesia, page 2-7

[12]. "Image Enhancement and Segmentation Using Dark Stretching Technique for Plasmodium Falciparum for Thick Blood Smear", 2011 IEEE 7th International Colloquium on Signal Processing and its Applications, pages 257-260.

[13]. Klinzmann, Alissa Park, Fred Esser, Ernie,"Centroid Distance Function and the Fourier Descriptor with Applications to Cancer Cell Clustering"

[15]. I. Pitas and P. Kiniklis , "Multichannel Techniques in Color Image Enhancement and Modeling", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 5, NO. 1, JANUARY 1996

[16]. Sharif, J M Miswan, M F Ngadi, M A Hj, Sah Mahadi, Muhammad ,"Red Blood Cell Segmentation Using Masking and Watershed Algorithm : A Preliminary Study", 978-1-4577-1991-2/12/$26.00 ©2011 IEEE 258 pages:27,28

[17]. Aimi Salihah, A.N., M.Y.Mashor, Nor Hazlyna Harun , H.Rosline ,"Colour Image Enhancement Techniques for Acute Leukaemia Blood Cell Morphological Features", 978-1-4244-6588-0/10/$25.00 ©201 0 IEEE, pages 3677-3682

[18]. http://www.w3.org/Graphics/JPEG/jfif3.pdf visited: 24-04-2013, time: 12:00 p.m.

[19]. Kumar, Smriti Singh, Deepak, Colorization of Gray Scale Images in YCbCr Color Space Using Texture Extraction and Luminance Mapping, IOSR Journal of Computer Engineering (IOSRJCE) ISSN: 2278-0661 Volume 4, Issue 5 (Sep.-Oct. 2012), PP 27-32