

## Improved Fuzzy C Means Clustering For Complete Blood Cell Segmentation

Neha Vyas  
M.Tech. Scholar

Central India Institute of Technology Indore (India)  
[nehavyas0029@gmail.com](mailto:nehavyas0029@gmail.com)

Mrs. Megha Singh  
Assistant Professor

Central India Institute of Technology Indore (India)  
[maggii.megha@gmail.com](mailto:maggii.megha@gmail.com)

**Abstract** – Blood Cell count is a preliminary process in major applications related to disease diagnosing and medical research. This seeks transparent perfection in cell counting as they witness the strength of candidate's health. The conventional process of cells counting was practiced with microscopic visualization and was subjected to expertise of an individual. The automated methods ease the efforts of human and loaded the significant calculations and observations on algorithms and computational calculations. In this paper, a digital image photography of blood cells is taken for test for determination of white blood cells, platelets and red blood cells. The photograph before computation was digitally modified and HSV coding was applied for saturating the image. Improved Fuzzy clustering was applied on 2<sup>nd</sup> level saturation and the image is converted into binary via morphological operations.

**Keywords** – Improved FCM, HSV, Morphological Operations.

**I. INTRODUCTION** Blood is a connective tissue consisting of cells suspended in plasma. Blood's major functions are to transport various agents such as oxygen, carbon dioxide, nutrients, wastes and hormones. Blood cells are composed of erythrocytes (red blood cells, RBCs), leukocytes (white blood cells, WBCs) and thrombocytes (platelets). The most abundant small reddish cells are erythrocytes and called red blood cell. An erythrocyte is a discoid cell with a thick rim and a thin sunken center [1]. RBCs' two principal functions are to move oxygen from lung to tissues elsewhere and transport carbon dioxide from tissues to the lung. Whereas, the Leukocytes or white blood cells are part of the immune system. The conventional device used to count blood cells is the hemocytometer. It consists of a thick glass microscope slide with a rectangular indentation creating a chamber of certain dimensions. This chamber is etched with a grid of perpendicular lines. It is possible to count the chamber of cells in a specific volume of fluid, and calculate the concentration of cells in the fluid [2, 3]. To count

blood cell, physician must view hemocytometer through a microscope and count blood cells using hand tally counter. The overlapped blood cells on the top-side and right-side of hemocytometer are not counted. Normally, the counting task is timeconsuming and laborious. Several attempts have been made to mimic the procedure of cell recognition from image. The major application of neural networks was devoted to the WBCs classification via extracted morphologic parameters [4-6]. Some red blood cell classification task using neural network was adapted for Thalassemia diagnostic tool [7]. Many commercially available products have been developed to automatically count RBCs or WBCs [8]. Their advantages include automatic cell counting cells without hand tally counter, no requirement of messy washing and no associated biohazard. However, these products are expensive.

This work aims to apply a software based approach to count a number of red blood cells from the blood smear image taken by the digital camera attached with the microscopic setup. This work can help release physicians from tedious and laborious blood cell counting task. The images of blood cell were digitized by the optical microscope. The composition of blood image consists of red blood cells, white blood cells and sickle red blood cells. The image was analyzed by manually looking for red blood cells. After that, the red blood cells were counted using the proposed red blood cell counting method, automatically.

In this paper, for segmentation of image Gamma processing method is implemented considering the benefits against the non-linearities of capturing devices. The luminance generated by a physical device is generally not a linear function of the applied signal. Considering the pre-processing and proper segmentation which can define maximum accuracy of fully automated cell counting.

**II. PROPOSED METHOD** There are five steps involved in the process of estimating the white

blood cells, platelets, and red blood cells. These are input image acquisition, preprocessing, segmentation, feature extraction and finally the counting for platelets, RBC and WBC. In the pre-processing step the original blood smear image is converted into saturation image using Gamma Correction. Segmentation is done by Improved Fuzzy segmentation method. Next, feature extraction is accomplished through morphological operations in order to differentiate red blood cell other cells (WBC and platelets) and background. The final step is to find out the number of red blood cell from the blood smear image by using morphological operations.

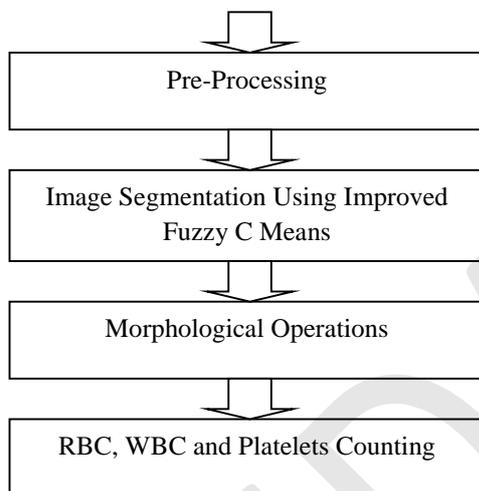


Figure 1: Flowchart of RBC, WBC and Platelets Counting Process

### **Pre-processing**

Image pre-processing is a technique of adjusting images suitable for the next step of computational process. In this work we use simple image processing technique to enhance the image. We first convert the input image into HSV image. From this HSV image, we precede the analysis of the saturation component S, because the S image shows clearly the bright objects such as WBC and platelets. So it is easy to distinguish the red blood cells. A color's identity may be represented in terms of a set of color space parameters termed a gamut. Many range have been researched for color image processing including RGB, YUV, YCrCb, HSI and the related HSV range [9][10][11][12]. After extensive MATLAB evaluation, we determined that the HSV gamut was a clear leader in both classification accuracy and computational

simplicity. In this chapter we discuss the RGB and the HSV gamuts in particular and declare the implemented color space transformation algorithm.

### **RGB Gamut**

The most common color gamut for image acquisition and display is RGB. As identified this is the representation acquired from the video camera. In the RGB color space, color is divided into 3 primary color components: Red, Green, and Blue. Using this representation, all colors of light are represented as an intensity of each of the primary colors that combine to create the resulting color. Geometrically, these components form the orthogonal axis of a 3-dimensional cube as shown in Figure 2.

This color representation is often convenient for use by computer displays and video cameras, where photo emitters and receptors sensitive to each of these three primary colors are used. While convenient for use in computer displays and video cameras, this color representation is not very convenient for perceptually based image analysis, where changes in lighting cause a color displacement along a non-orthogonal axis.

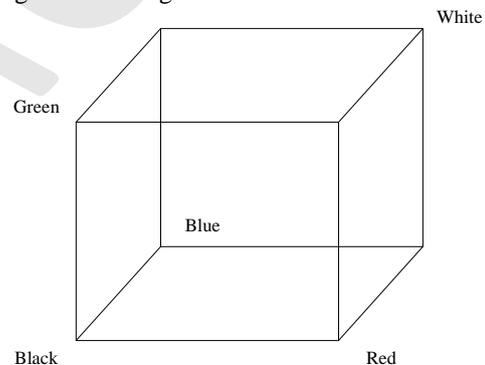


Figure 2: RGB Gamut

### **HSV Gamut**

An alternate color gamut is HSV. In the HSV color space, color is divided into 3 perceptual components: Hue, Saturation, and Value. Geometrically these components form a cone, as shown in the diagram below:

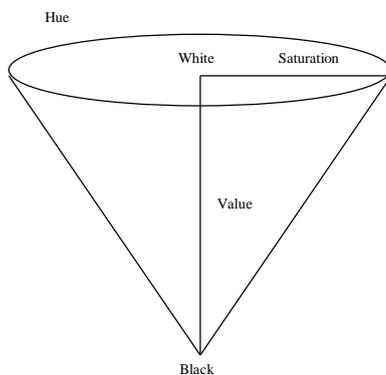


Figure 3: HSV Gamut

In the HSV gamut, changes in lighting result in a translation along the Saturation and Value axes, with little effect on the Hue axis. It is this light-invariance that makes both HSV and HSI gamuts robust and computationally economical for color-based classification. As a result of this characteristic, accurate classification based on color may be performed very quickly using simple look-up table techniques once the image is represented in the HSV gamut.

**RGB to HSV Transformation** The non-linear transform between the RGB and HSV gamuts [12] is:

$$\begin{aligned}
 M &= \max(R, G, B) \\
 m &= \min(R, G, B) \\
 d &= M - m \\
 r &= (M - R) / d \\
 g &= (M - G) / d \\
 b &= (M - B) / d
 \end{aligned}$$

From these values we calculate the resulting Hue, Saturation, and Value using the non-linear algorithm as shown in Figure.

Since this non-linear color space transformation must be performed on each pixel within a bounding region, for highest performance the RGB to HSV gamut transformation was coded in assembly language.

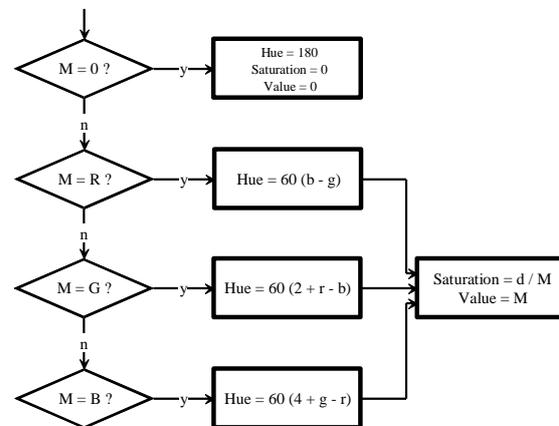


Figure 4: Algorithmic flow of HSV using non-linear algorithm

### Image Segmentation using Improved Fuzzy CMeans Clustering

Improved Fuzzy C-means (FCM) algorithm, in which the data set are taken and cluster will be initialized, normally variable will be selected. The improved FCM is used to form the cluster group by taking some data set. The quality of cluster is calculated by finding the distance measurement. The improved FCM method are applied in large volume of data and give the true prediction. The objective function is minimized in improved fuzzy c-mean algorithm. The overlapped function is less as compared to other by using the hermitition distance formula. The result are improved by hermitition distance. It gives true prediction.

The improved FCM algorithm by using two step, first is by decision tree approach with it which mine the data in accurate and sequential manner and second by creating the noise free data. Cluster validity function are often used to evaluate the performance of clustering in different index and even two different clustering method. Among the criteria there are important type of FCM in which fuzzy partition based sample set. The main idea of validity function based on fuzzy partition is that the less fuzziness of the partition is the better the performance.

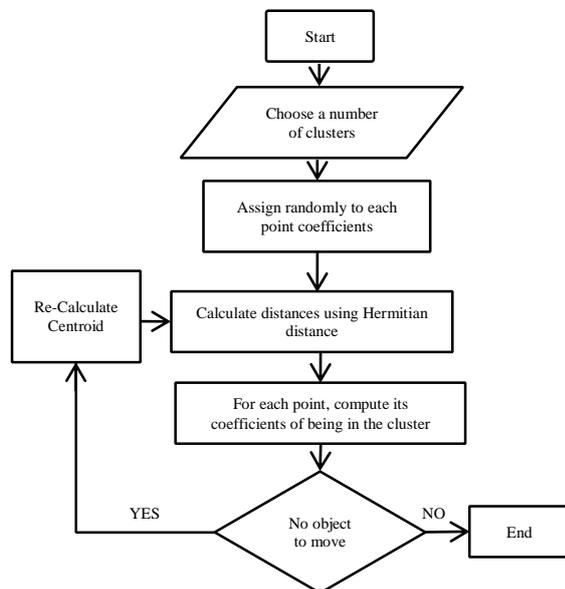


Figure 5: Flow chart of the improved fuzzy c-mean algorithm

**Algorithm**

1. First the initial fuzzy partition matrix is generated and the initial fuzzy cluster center are calculated.
2. In each step of iteration the cluster center and the membership grade point are updated and the objective function is minimized to find the best location for the cluster.
3. Improved FCM is proposed cluster technique. It is used to solve the minimal distance by using the Hermitian distance method formula:

$$X = [(x_1 - y_1), (x_2 - y_2), (x_3 - y_3) \dots (x_n - y_n)] \tag{1}$$

$$D = (X * X^t)^2 \tag{2}$$

Where X is a matrix and X<sup>t</sup> is a transpose of matrix X.

4. The process stops when the maximum number of iteration is reached or when the objective function improvement between two consecutive iteration is less than the minimum amount of data specified.

**III. SIMULATION AND RESULTS** The performance of proposed algorithms has been studied by means of MATLAB simulation.

The original image is a digital image captured with microscopic device attached. The following results were obtained via simulation of proposed architecture.

Original Image



Figure 6: Original image representing various elements of blood

The image taken for the research is of a healthy individual and shows the red blood cells (red circles), white blood cells (blue part of image) and noise.

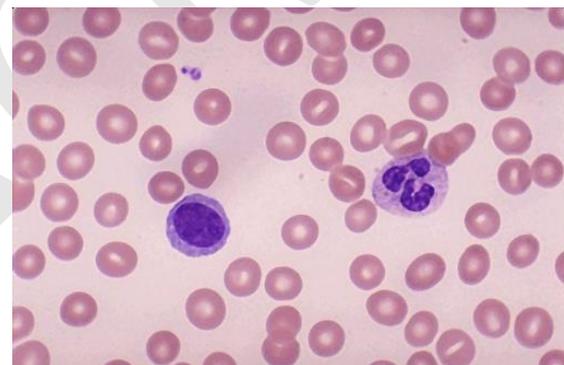


Figure 7: The image is filtered with a median filter as the stage of pre-processing

The noise reduction of image however cannot be visualized in this figure. It may be possible that error is too small to be filtered as we did not present any special mark for such.

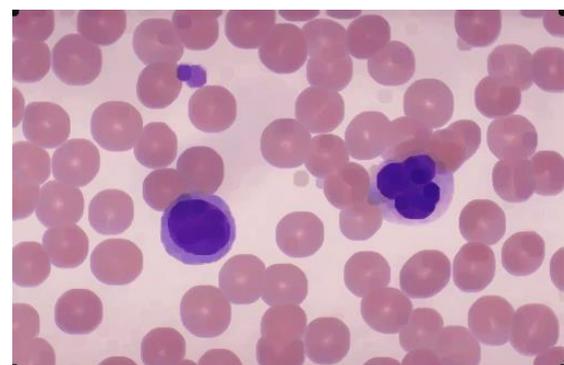


Figure 8: The conversion of original image as the Eroded image

The color enhancement of denoised image leaves the cells with small holes (vacant point of cells) and enhanced cell circles. The visible white circles in previous image are shrunk and cell gained their density. The color of cells in the image is highlighted using HSV color transform

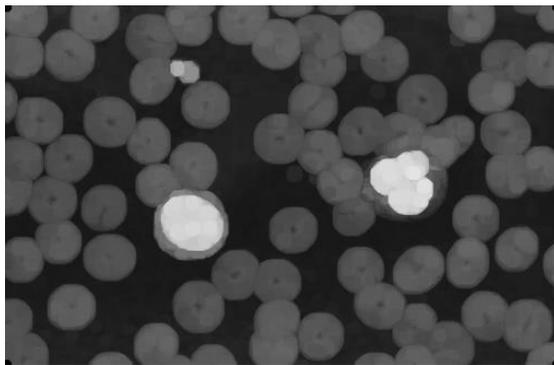


Figure 9: Calculation of Saturation component using HSV component algorithm

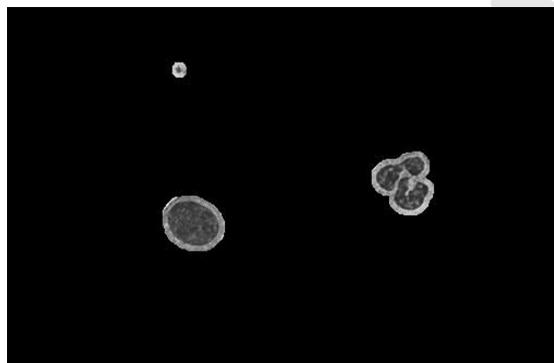


Figure 10: Image with removed background of a blood cell after saturation

The saturation of image clipped the background from the image. Only white and red blood cells are visible.



Figure 11: Conversion of a saturated image into binary image

Morphological operations (four step process) is applied for two purposes. Based on the area of cells, the cell regions are marked. This is essential as many cells are overlapped and needed to be classified. Another, at the edge of images, the operations determines whether the cells should be considered in counting or not.

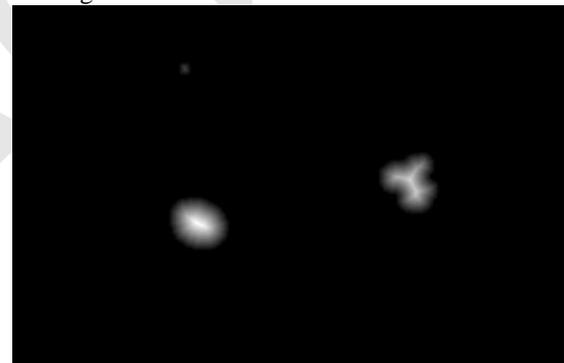


Figure 12: Connectivity of Pixels through centroid calculation of cells

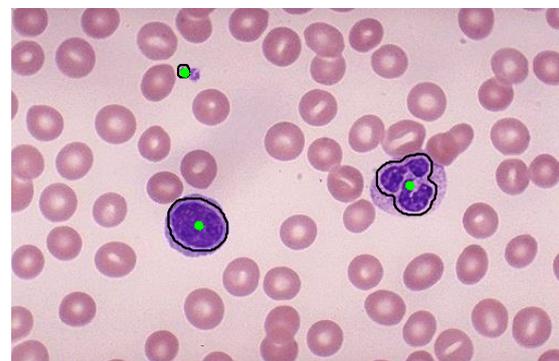


Figure 13: Counting of cells for test input for WBC and Platelets

Figure 13 shows that the cells that have holes are considered for counting and rest are discarded.

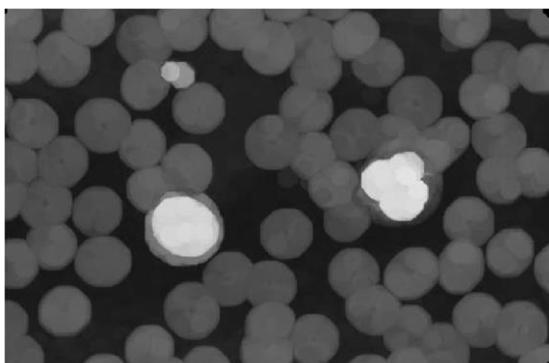


Figure 14: Calculation of Saturation component using HSV component algorithm

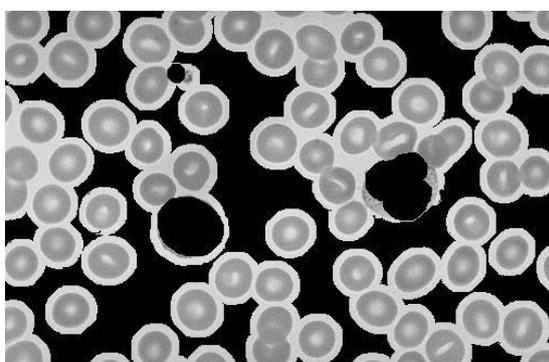


Figure 15: Image with removed background of a blood cell after saturation

The saturation of image clipped the background from the image. Only white blood cells are visible.

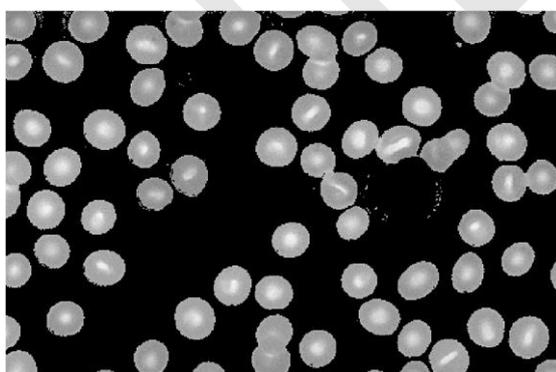


Figure 16: Removal of white blood cells and platelets as second stage of saturation

Figure above shows second level of clustering which discards the white blood cells and platelets in image. Then the Morphological operations are applied again. Figure 17 shows the binary conversion of

image and Figure 18 shows pixel connectivity for image.

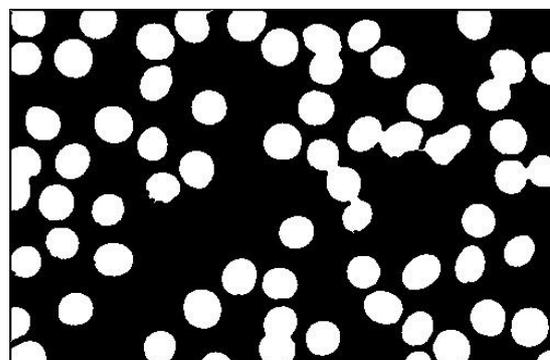


Figure 17: Conversion of a saturated image into binary image

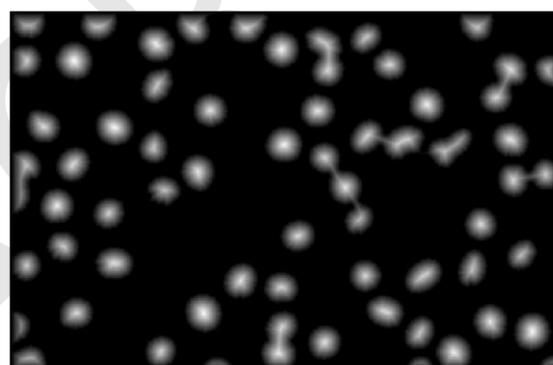


Figure 18: Connectivity of Pixels through centroid calculation of cells

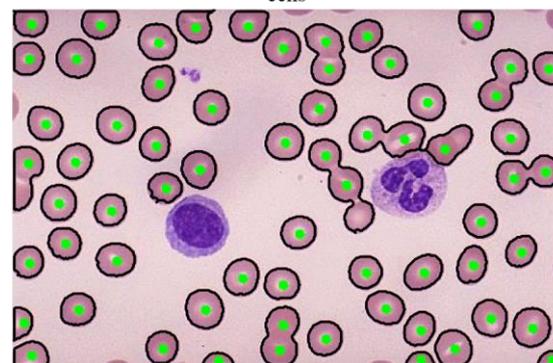


Figure 19: Counting of cells for test input

Figure 19 shows that the cells that have holes are considered for counting and rest are discarded. Also those cells are taken into account for counting which are not completely overlapped.

#### IV. CONCLUSION

## International Journal of Digital Application & Contemporary Research

Website: [www.ijdacr.com](http://www.ijdacr.com) (Volume 4, Issue 7, February 2016)

Platelets and blood cell counting is a mandatory and efficient approach in determination of various blood related disease. The cell count provides optimal information of the fitness of an individual as the blood is carrier of various essential elements. The approaches of cell count are autonomic in nature and accuracy depends on algorithmic capability of various methods. The two stage improved fuzzy cmeans clustering and morphological operations are efficient on their part and customizes the image in various states that collectively determines the accuracy and precision in blood cell count. The preprocessing stage, clipped the un-necessary background of image and filtering of white blood cells and platelets were performed based on nature of their classification. The red blood cells are enormous in number and outrages the WBC and platelets. The morphological operations determined the nature of red blood cells and also considered blood cells that are over-lapped or were clipped at the edge of image. The half circles were considered as a full circle and the cells at edge of image that were almost out of image were taken into consideration.

In comparison with the Hough Transformation for cell counting [7], the manual observations of both the results (WBC and RBC count) demonstrate that Hough Transform did not efficiently consider the cells at edge of image. Many cells were dropped in Hough transform that should have been considered. This comparison is done at manual basis as the input image for both the researches were different and also the environments of experimentations were distinct.

### REFERENCE

- [1] K.S. Saladin, *Anatomy and Physiology: The unity of form and function*, McGraw-Hill, NY, 4th, chap. 18, pp.680-696, 2007.
- [2] J.P. Mather and P.E. Roberts, *Introduction to cell and tissue culture: Theory and Technique*, Plenum Press, Nandi London, 1998.
- [3] D.R. Caprette, "Introduction Laboratory: using accounting chamber," Bios211, 2007.
- [4] Q. Zheng, B.K. Milthorpe, and A.S. Jones, "Directneural network application for automated cell recognition," *Cytometry 57A*, pp. 1-9, 2004.
- [5] T. Markiewidz and S. Osowski, "Data mining techniques for feature selection in blood cell recognition," in *Proc. ESANN. Symp. Bruges, BG*, pp.407-412, April2006.
- [6] F. Scotti, "Automatic Morphological Analysis for Acute Leukemia Identification in Peripheral Blood Microscope Images," in *Proc. IEEE Int. Symp. CIMSIA, GiardiniNaxos, Italy*, pp. 96-101, July 2005. [7] Venkatalakshmi, Thilagavathi, "Automatic Red Blood Cell Counting Using Hough Transform" *Proceedings of 2013 IEEE Conference on Information and Communication Technologies (ICT 2013)* [8] Valliammal, N., & Geethalakshmi, S. N. (2011, July). Hybrid image segmentation algorithm for leaf recognition and characterization. In *Process Automation, Control and Computing (PACC), 2011 International Conference on* (pp. 1-6). IEEE.
- [9] I. Pitas, *Fundamentals of colour image processing*. In: *Digital Image Processing Algorithms* Prentice-Hall, Englewood Cliffs, NJ (1993), pp. 23- 40.
- [10] R.C. Gonzalez and R.E. Woods, *Image transforms*. In: *Digital Image Processing Addison-Wesley, New York* (1992), pp. 81- 128.
- [11] Zarit, B.D., Super, B.J., Quek, F.K.H., "Comparison of five color models in skin pixel classification" *Proceedings International Workshop on Recognition, Analysis, and Tracking of Faces and Gestures in RealTime Systems*.
- [12] *Video Demystified – On Color Space Conversions*.