ISSN:0975-9646

Survey on Image Segmentation Techniques and Color Models

Savita Agrawal
Student :-Mtech Computer science
Mats University
Raipur, India

Deepak Kumar Xaxa
Dept. of computer science
Mats University
Raipur, India

***Abstract*—segmentation is a low level operation concerned with partitioning of images by determining similarity or discontinuity , or equivalently , by finding edges or boundaries'. image segmentation is the process of partitioning an image into multiple partitions, so as to change the epitomization of an image into something that is more meaningful and easier to analyze . Several general-purpose algorithms and techniques have been developed for image segmentation. This paper trace the different segmentation techniques used for multichannel images. Firstly this paper investigates and compiles some of the technologies used for image segmentation, which are well suited for gray scale images as well as multichannel images. Afterwards a bibliographical survey of currently utilizing color models for segmentation of multichannel images techniques is given in this paper then a comparative analysis of different methods is done and finally general tendencies in image segmentation are presented.**

***Index Terms*— segmentation , color model, fuzzy c means clustering,**

I. INTRODUCTION

Images are considered as one of the most important medium of conveying information, in the field of computer vision, by understanding images the information extracted from them can be used for other tasks for example: navigation of robots, finding injurious tissues from body scans, detection of cancerous cells, identification of an airport from remote sensing data. Now a strong need of a method, which can be used for understand images and extract information or objects, image segmentation fulfill above requirements. Thus, image segmentation is the first step in image analysis. Some time removal of noise from image is done before the segmentation to avoid from the false contour selection for segmentation to segment the image without loss of information for medical diagnosing purpose is a challenging job. The purpose of writing this paper is to provide a literature review in this area of image segmentation. The rest of this paper is organized as below; section II introduces the term image segmentation. Section III describes the color models for image segmentation techniques and section IV Concludes the overall study.

II. IMAGE SEGMENTATION

The Research on Image segmentation for many years has been a high degree of attention. Thousands of different segmentation techniques are present in the current scenario, but there is not even a single method which can be considered well suited for different images, all methods are not equally applicable for a particular type of image [7].Thus, algorithm development for one class of image may not always be suited to other class of images. Hence, there are many challenging issues like development of a unified approach to image segmentation which can be applied to all type of images, even the selection of an suitable technique for a particular type of image is a difficult issue. Thus, in spite of several decades of research, there is no universally supported method for image segmentation for all categories of images and therefore it remains a challenge in image processing and computer vision. Based upon different technologies, image segmentation are currently divided into following classes, based on two different aspects of image properties

- Tracking differences in intensity
  Here an image is partitioned based on abrupt changes in intensity [1], this includes image segmentation algorithms like edge detection.
- Tracking similarities in regions
  Here an image is partitioned into regions that are similar according to a set of predefined criterion [1]; this includes image segmentation algorithms like thresholding, region growing, region splitting and merging.

a) SEGMENTATION BASED *ON EDGE DETECTION*

This method attempts to resolve image segmentation by detecting the edges or pixels between different regions that have rapid transition in intensity are extracted [1, 5] and linked to form closed object boundaries .The result is a binary image [2]. Based on theory there are two main edge based segmentation methods- gray histogram and gradient based method [4].Edge detection is a well-developed field on its own within image processing. Relation between Region boundaries and edges are closel, since there is often a sharp adjustment in intensity at the boundary region. Therefore Edge detection techniques been used as the base for another segmentation approach for sharp segmentation. The edges traced by edge detection are often discontinuous. For segmenting an object from an image with high complexity however, one needs closed connected region boundaries. The desired edges are the boundaries of such objects. Segmentation approaches can also be applied to already traced edges using edge detectors for more sharp edges. Lindeberg andLi [8] developed an integrated method that segments edges into straight and curved edge segments for parts-based object recognition, based on a

minimum description length (MDL) criterion that was optimized by a split-and-merge-like method with candidate breakpoints obtained from complementary junction cues to obtain more likely points at which to consider partitions into different segments

b) THRESHOLDING METHOD

Thresholding algorithms can be selected manually according to a priori knowledge or automatically by image information. These algorithms further splited to edge-based algorithms, region-based segmentation and hybrid methods. Edge-based algorithms are related with the information at the edge of an image. The Structures of an object can be render by points on edges. Popular edge detection algorithms like canny edge detector and Laplacian edge detector can be classified to this area. These algorithms are used to find the edge pixels by removing the noise influence .For example, canny edge detector used the threshold of gradient magnitude to find the potential edge pixels and suppressed them through the procedures of the non-maximal suppression and hysterics Thresholding. As the operations used in these algorithms are pixels based, the traced edges are consisted of discrete pixels and hence considered to be incomplete or discontinuous. Hence, it must be further processed by morphological operation to connect the breaks or the holes elimination. This method is reliable so can be used to segment3D image with a high accuracy, but the drawback of this method is that it is not fit for images of textured blob objects. Image segmentation using Thresholding is a simple as well as a promising approach for segmenting images having light objects with a dark background [1]. Thresholding technique is based on image space regions i.e. on characteristics of image [4]. Thresholding operation convert a multilevel image into a gray channel image i.e., it is done for choosing a proper threshold T, it divide the pixels of image into several different regions and separate the light and more useful objects from background. Any pixel (x, y) is considered as a part of object if its intensity exceed or is in the range of the threshold value i.e. $f(x, y) \geq T$, otherwise the pixel belong to background [3, 11]. As per the selection of Thresholding value, however two class of Thresholding methods are in trend [12], global and local Thresholding. When T is kept fixed, the approach is called global Thresholding otherwise it is called local Thresholding. Global Thresholding is limited to even background illumination if the background illumination is uneven it does not survive. In local Thresholding, multiple thresholds are used to manage uneven illumination [8]. Threshold selection is typically done interactively however; it is possible to derive automatic threshold selection algorithms. boundary of Thresholding method is limited upto two classes , and it cannot be applied to multichannel/color images. additionally, Thresholding does not deal with the spatial characteristics of an image due to this it is prone to noise [4], as both of these artifacts damage the histogram of the image, making separation of image from background more difficult.

c) REGION BASED SEGMENTATION METHODS

Compared to edge detection method, segmentation algorithms falls in the category of region are relatively simple and more immune to noise [4, 6]. Edge based methods partition an image based on rapid changes in intensity near edges whereas region based methods, deploy an image into regions that are same according to a set of predefined criteria [10, 1]. Segmentation algorithms based on region mainly include following methods:

1. Region Growing

Region growing is a procedure [2-3] that group's pixels in whole image into sub regions or larger regions based on predefined criterion [13]. Region growing can be processed in four steps:-

(i) mark the group of seed pixels in original image [7].
(ii) Select a clustering criterion such as grey level intensity or color and set up a stopping rule.
(iii) expand the regions by connecting to each seed to the neighboring pixels that have satisfied the cluster properties similar to seed pixels.
(iv) Stop region growing when no more pixels met the criterion for inclusion in that region (i.e. Size, likeness between a candidate pixel & pixel grown so far, as a result shape of the region being grown)

2. Region Splitting and Merging

Instead of choosing seed points, one can divide an image into a set of impulsive unconnected regions and then merge the regions [2, 4] in an attempt to satisfy the conditions of reasonable image segmentation. Splitting and merging of regions usually implemented with quad tree concept. Let R is the entire region of the image(super set) and select a predicate Q

(i) We start with entire image if Q(R) = FALSE [1], we divide the image into quadrants, if Q is false for any quadrant that is, if Q (Ri) = FALSE, We subdivide the quadrants into sub quadrants and so on till no further splitting is possible.
(ii) If only splitting is used, the final partition may contain adjacent regions with identical properties. This drawback can be penalized by allowing both merging and splitting at the same time i.e. merge any adjacent regions Rj & Rk for which ,Q(Rj U Rk) = TRUE.
(iii) Stop when no merging is possible.

d) SEGMENTATION BASED ON CLUSTERING

Clustering is an unsupervised learning process, where one needs to define a finite set of bunches known as clusters to classify pixels [17]. Clustering use no training stages rather train themselves using presented data. Clustering is usually used when classes are known in prior. A similarity mapping is defined between pixels [2],and then similar pixels are grouped together to become a clusters. The combination and groups of pixels into clusters is based on the principle of increasing the intra class similarity and increasing the inter class similarity. The degree of a clustering result depends on both the similarity measure used by the method and its operational procedure.

Clustering algorithms are characterized as (i)hard clustering, (ii)k- means clustering, and (iii) fuzzy clustering, etc

e) SEGMENTATION BY ARTIFICIAL NEURAL NETWORK

A neural net is an artificial representation of human brain that tries to simulate its learning strategies and can be used for decision making process. An artificial neural network is often called a neural network or simply neural net. In recent years, artificial neural networks have been widely used to solve the problem of medical image segmentation. Neural network that simulate life, especially the human brain's learning procedures, constitutes a large number of parallel nodes. Each node can perform some basic computing. The learning process can be achieved through the transferring the connections among nodes and connection weights[43]. Its main advantage is not dependent on the probability density distribution function. It can also prove the segmentation results when the data deviation from the normal situation. Neural network can also reduce the requirements of expert intervention during the image segmentation process. This problem is prevalent in many age segmentation methods. Firstly, the image segmentation problem is converted into energy minimization or classification issues and so no. Then the issues are solved based on neural network in this method. The neural network was trained with training sample set in order to determine the connection and weights between the nodes. Then the new images were segmented with trained neural network. Neural network segmentation method includes two important steps: feature extraction and image segmentation based on neural network.

III. COLOR MODELS FOR IMAGE SEGMENTATION

In this part, we show how the colors of the pixels of digital color images can be represented in different color spaces for color image segmentation applications .In this part of this paper, the most classical color spaces are discussed . In the framework of the use of these color spaces by color image analysis applications.With the color format, a digital image can record and provide more information than the gray scale format image does. Digital acquisition devices (such as scanners and digital cameras) can separate beams of light into three primary colors- red, blue, and green, through the assistance of spectroscopes and filters. In order to record the color information, we need at least three parameters (e.g. red, blue, and green) to represent a color. We use the color model to represent the color information of digital images. Since we need three parameters to represent a color, those color models must be with a three dimensional format. The models use some mathematical functions to represent a point position (in the three dimensional space) that is assigned to a color. Some color models (RGB, CMY, YIQ, HSI, l1_l2_l3, and L*a*b) are summarized as follows [2,3,10]:

1. RGB color model

The three primary colors (red, green, and blue) and their combination in visible light spectrum are shown in Fig.1. With different weights, (R, G, B), their combination can indicate different colors. After normalizing the values of R, G, B, we can get the color cube (Fig.2).The colors on the diagonal line, from the origin to the coordinate (1,1,1) of the cube, means the gray-level values.

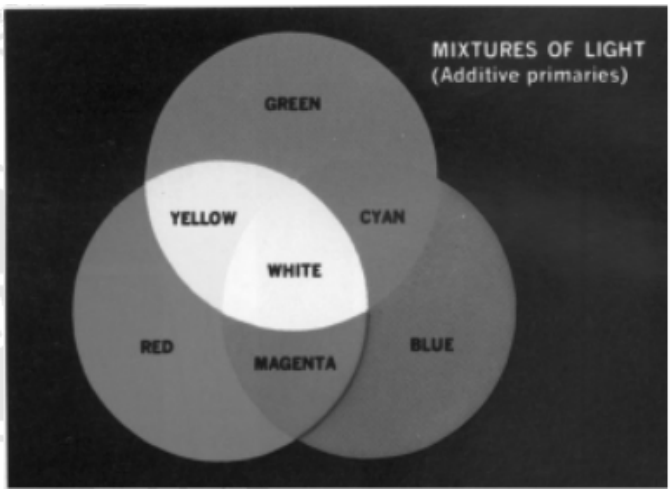

Fig. 1RGB graph of the primary colors [2].

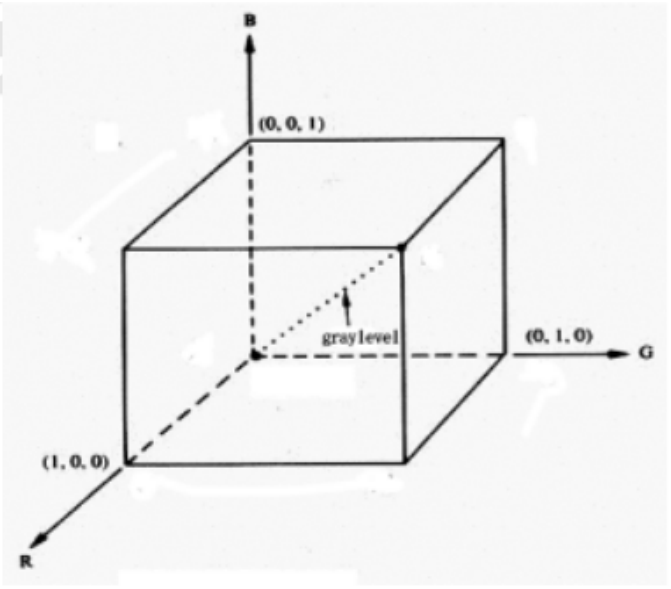

Fig. 2RGB primary color cube [2].

2. CMY color model

The CMY color model is based on complementary colors-cyan, magenta, yellow. This color model can be expressed as

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (3)$$

Fig. 3 shows the relationship of the component

color of the CMY color model. The CMY color model can be utilized for all result generating devices , such as printers etc.

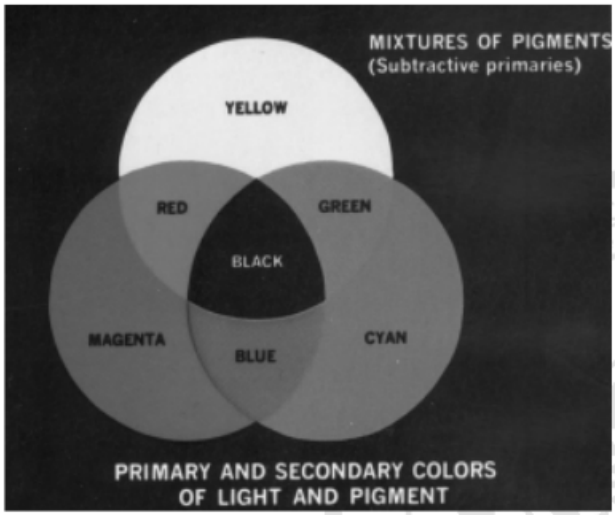

Fig. 3CMY color model [2]

3. YIQ color model

The YIQ color model is designed using the perception used by human's visual system. In the human's visual system, people are more sensitive to the lightness component than the hue component. So, the YIQ color model is set to separate colors into luminance (Y) and hue (I and Q). The relationship between YIQ and RGB is expressed as

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}, \quad (4)$$

where Y is the luminance ,I and Q indicate the weights of hue.

The advantage of the YIQ color model is that we can deal with the luminance component independently. The YIQ color model is the standard model applied to the signal transmission of color TV sets.

4. HSI color model

The HSI color model is also based on the characteristics of the human's visual system. I denotes the light intensity, H denotes the hue that indicates the measure of the color purity, S is the saturation (the degree of a color permeated the white color). If a color is with high saturation value, it means the color is with the low white color. The relationship between HSI and RGB can be described as

$$\begin{aligned} I &= (R+G+B)/3\ , \\ S &= 1-\min(R,G,B)/I\ , \\ H &= \arctan'(\sqrt{3}(G-B), 2R-G-B) \end{aligned}$$

5. I1_I2_I3

The I1_I2_I3 color model is also based on the human visual system. I1 denotes the luminance, while I2 and I3 indicate the color information. When I2 and I3 are positive, the color tends to red and yellow, respectively. When I2 and I3are negative, the color tends to green and blue, respectively. The relationship between I1_I2_I3 and RGB can be described as

$$I1=1/3(R+G+B) \quad (8)$$

$$I2=R-G \quad (9)$$

$$I3=1/2(R+G)-B \quad (10)$$

6. L*a*b

Commission International del'Eclairage (CIE) proposed the L*a*b color model as the international standard of color survey in 1931. In 1976, this color model was revised and named CIE L*a*b. A color can be defined by a lightness component (L) and two color components (a and b).a shows the degree from green to red. b means the degree from blue to yellow. The composition of the L*a*b color model components is shown as Fig.4.

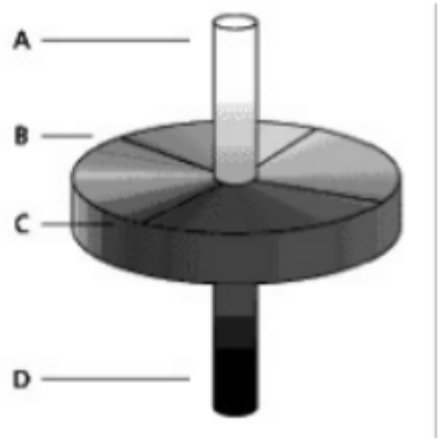

Fig. 4 The L*a*b color model diagram. A and D denote the lightness components, B and C describe the information of hue [2].The relationship between I1_I2_I3 and RGB can be described as

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.607 & 0.174 & 0.200 \\ 0.299 & 0.587 & 0.114 \\ 0.000 & 0.066 & 1.116 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (11)$$

And

$$L^*=25(100Y/Y_0)^{1/3}-16, \quad (12)$$

$$a^*=500[(x/x_0)^{1/3}-(y/y_0)^{1/3}] \quad (13)$$

$$b^*=200[(y/y_0)^{1/3}-(z/z_0)^{1/3}] \quad 14)$$

IV. COMPARISON OF DIFFERENT IMAGE SEGMENTATION TECHNIQUE

Segmentation Technique	Method Description	Advantages	Disadvantages
Edge Detection Technique	Based on the detection of inhomogenity, generally tries to ltrace points with more or less abrupt changes in gray level.	Edge detection technique is the way in which human perceives objects and works well for images having good contrast between regions.	1)Does not fit for images in which the edges are ill-defined or there are too many edges; 2)It is not a tedious task to generate a closed curve or boundary; 3)Less immune to noise than other techniques.
Thresholding Technique	Requires that the histogram of an image has a number of peaks, each correspond to a region	It does not need a prior information of the image. And it has less computational complexity	1)Does not work well for an image where desired peaks or with broad and flat valleys; are not present 2)Does not account the spatial details, so cannot assures that the segmented regions are contiguous .
Region-Based Technique	Group Pixels into homogeneous regions. Including growing region, splitting region , merging region or their combination	Work best when the region homogeneity criterion is easy to define. They are also less noise prone than edge detection approach.	1)Are by nature sequential and quite expensive both in computational time and memory; 2)Region growing has inherent dependence on the selection of seed region and the order in which pixels and regions are examined; 3)The resulting segments by region splitting appear too square due to the splitting scheme.
Fuzzy Technique	Apply fuzzy operators, properties, mathematics, and inference rules, provide a way to handle the uncertainty inherent in a variety of problems due to ambiguity rather than randomness.	Fuzzy membership function can be used to locate the degree of some properties or linguistic phrase, and fuzzy IF-THAN rules can be used to perform approximate inference .	1)The determination of fuzzy membership is not a trivial job; 2)The computation involved in fuzzy approaches could be intensive.
Neural Network Technique	Using neural networks to perform classification or clustering	No need to write complicated programs. Can fully utilize the parallel nature of neural networks.	1)Training time is long; 2)Initialization may effect the result; 3)Overtraining should be avoided

V. CONCLUSION

In this survey paper we have briefly explained the various techniques of image segmentation , the overview of various segmentation methodologies applied for digital image processing is discussed. The study also reflects the various color models used for segmentation. These segmentation methods discussed are most important for detection of pattern and recognition using edges, images and points. The image segmentation techniques mentioned in this survey paper are used in many advanced technologies for recognition of faces, and pattern recognition . Image segmentation used in medical science to detect falsy parts from medical images. They also detect roads and features from satellite images .The last section of this paper shows the comparison between all available segmentation techniques.

REFERENCES

[I] Rastgarpour M., and Shanbehzadeh J., Application of AI Techniques in Medical Image Segmentation and Novel Categorization of Available Methods and Tools, Proceedings of the International MultiConference of Engineers and Computer Scientists 2011 Vol I, IMECS 2011, March 16-18, 2011, Hong Kong.

[2] Zhang, Y. J, An Overview of Image and Video Segmentation in the last 40 years, Proceedings of the 6 th International Symposium on SignalProcessing and Its Applications, pp. 144-151, 2001.

[3] Wahba Marian, An Automated Modified Region Growing Technique for Prostate Segmentation in Trans- Rectal Ultrasound Images, Master's Thesis, Department of Electrical and Computer Engineering,

University of Waterloo, Waterloo, Ontario, Canada, 2008. [4] W. X. Kang, Q. Q. Yang, R. R. Liang, "The Comparative Research on Image Segmentation Algorithms", IEEE Conference on ETCS, pp. 703-707, 2009.

[5] N. R. Pal, S. K. Pal,"A Review on Image Segmentation Techniques", Pattern Recognition, Vol. 26, No. 9, pp. 1277- 1294, 1993.

[6] H. Zhang, J. E. Fritts, S. A. Goldman/Tmage Segmentation Evaluation: A Survey of unsupervised methods' , computer vision and image understanding, pp. 260-280, 2008.
[7] K. K. Singh, A. Singh,'A Study of Image Segmentation Algorithms for Different Types of Images", International Journal of Computer Science Issues, Vol. 7, Issue 5, 2010.
[8] T. Lindeberg and M.-X. Li "Segmentation and classification of edges using minimum description length approximation and complementary junction cues", Computer Vision and Image Understanding, vol. 67, no.1, pp. 88-98, 1997. "
[9] P. Karch, I. Zolotova,'An Experimental Comparison of Modern Methods of Segmentation", IEEE 8th International Symposium on SAMI, pp. 247-252, 2010.
[10] H. G. Kaganami, Z. Beij, "Region Based Detection versus Edge Detection", IEEE Transactions on Intelligent information hiding and multimedia signal processing, pp. 1217-1221, 2009.
[II] L.Aurdal, "Image Segmentation beyond thresholding", Norsk Regnescentral, 2006.
[12] Y. Zhang, H. Qu, Y. Wang, "Adaptive Image Segmentation Based on Fast Thresholding and Image Merging' , Artificial reality and Telexistence-Workshops, pp. 308-311, 1994.
[13] Y. Chang, X. Li,"Adaptive Image Region Growing", IEEE Trans. On Image Processing, Vol. 3, No. 6, 1994.Prof. Dinesh D. Patil et al, International Journal of Computer Science and Mobile Computing Vol.2 Issue. 1, January- 2013, pg. 22-27
[14] T. Gevers, V. K. Kajcovski,"Image Segmentation by direct region subdivision", Proceedings of the 12th IAPR International Conference on Pattern Recognition, Vol. 1.
[15] X. Jiang, R. Zhang, S. Nie,"Image Segmentation Based on PDEs Model: a Survey", IEEE conference, pp. 1-4,2009.
[16] C. Zhu, J. Ni, Y. Li, G. Gu,"General Tendencies in Segmentation of Medical Ultrasound Images", International Conference on ICICSE, pp. 1 1 3- 1 1 7, 2009.
[17] V. K. Dehariya, S. K. Shrivastava, R. C. Jain,"Clustering of Image Data Set Using K-Means and Fuzzy K- Means Algorithms", International conference on CICN, pp. 386- 391, 2010.
[18] F .Z. Kettaf, D. BI, J. P., "A Comparison Study of Image Segmentation by Clustering Technique",Proceedings of ICSP, pp. 1280-1282, 1996.
[19] S. Naz, H. Majeed, H. Irshad,"Image Segmentation using Fuzzy Clustering: A Survey", International Conference on ICET, pp.181-186, 2010.
[20] STatiraju, A. Mehta,"Image Segmentation using k-means clustering, EM and Normalized Cuts", Department of EECS, pp. 1-7.
[21] B. C. Wei, R. Mandava,"Multi-objective Nature-inspired Clustering Techniques for Image Segmentation", IEEE Conference on CIS, pp. 150-155, 2010.
[22] B. C. Wei, R. Mandava,"Multiobjective optimization Approaches in Image Segmentation- the Directionand Challenges", ICSRS Publication, 2010.
[23] P.Lukac, R. Hudec, M. Benco, P. Kamencay, Z. Dubcova, M. Zachariasova,"Simple Comparison of Image Segmentation Algorithms Based on Evaluation Criterion", IEEE Conference on Radioelektronika, pp. 1-4, 2011.
[24]Al Bovik, Ed., Handbook of Image and VideoProcessing. Academic, New York, 2000.
[25]. Rafael C. Gonzales, Richard E. Woods. Digital Im-age Processing. second edition, Prentice Hall,2002.
[26]. Scott. E. Umbauch. Computer Version and Image Processing:a Pratical Approach using CVIPtools.Prentice Hall,1998.
[27]. H.Brown, D.M.Cauchi,J.L.Holden,H.Wrobel and S.Cordner . Image Analysis of gunshot residue on entry wounds I - The Technique and Preliminary Study.Forensic Sci. International,Vol.100,No.3,p.163-177,Mar.,1999.
[28]. H.Brown, D.M.Cauchi,J.L.Holden,F.C.L.Allen,S.Cordner and P.Thatcher. Image Analysis of gunshot residue on entry wounds II-A Statistical estimation of firing range. Forensic Sci. International, Vol. 100, No.3, p.179-186, Mar.,1999.
[29]. Vigo GP, Hueber DM, Vo-Dinh T. Evaluation of Data Techniques for Improved Analysis of Finger- print Images. J Forensic Sci. 1995; 40(5): 826-37.
[30]. Moler E, Ballarin V, Pessana F, Torres S, Olmo D. Fingerprint Identification Using Image Enhancement Techniques. J Forensic Sci. 1998; 43(3): 689-92.
[31]. Kaymaz E, Mitra S. A Novel Approach to Fourier Spectral Enhancement of Laser-Luminescent Finger- print Images. J Forensic Sci. 1993; 38(3): 530-41.
[32]. Rui-Jun Shie. Summary of the CCD - the Kernel of Scanners and Digital Camera. Forensic Science. Criminal Investigation Bureau of police official of interior affair department, Set. 1998:143-148