ITDS: Iris Tumor Detection System using Image Processing Techniques

Abdulkader Helwan

Near East University, Biomedical Department, Near East Boulevard, Lekosa, Mersin 10, Turkey

Abdulkader.helwan90@gmail.com

Abstract— Iris tumors, so called intraocular tumors are kind of tumors that start in the iris; the colored part of the eye that surrounds the pupil. There is a need for an accurate and cost-effective iris tumor detection system since the available techniques used currently are still not efficient. The combination of the image processing different techniques has a great efficiency for the diagnosis and detection of the iris tumor. Image processing techniques improve the diagnosis of the tumor by enhancing the quality of the images, so the physicians diagnose properly. Moreover, using some techniques such as edge detection and image fusion helps in detecting and segmenting the tumor, located in the iris. This paper aims to develop a detection system that automatically detects the presence of abnormalities or tumors in the iris. The suggested system combines different image processing techniques such as image filtering, images adding, canny edge detection, and image fusion. These methods are used in order to analyze and segment the tumor into the iris, and then mark this abnormal region onto the original grayscale image. The iris images are obtained from a public database available on the internet, "Miles Research". The computer experimental results proved that the proposed detection system can successfully segment an iris tumor, and mark it to be then superimposed on the original image using image fusion.

Index Terms— Iris tumor, intraocular, canny edge detection, image fusion

— — — — — — — — ◆ — — — — — — — —

1 INTRODUCTION

The eye is structured as follows: the sclera which is the white part. The iris: the black part of the eye excluding the pupil which is the black part into the iris. Eye cancer can be defined as an anarchical growth of abnormal cells. This may be produced in or around the eye and then develop into a mass (tumor) [1]. A tumor is a mass of tissues formed by an uncontrolled growth of cells. There are different types of eye tumors, and each type can affect certain parts of the eye. The eye tumor can be called as ocular which is the medical name of the eye. It can be intraocular, means inside the eye or extraocular which means that it affects the outside part of the eye. The most common types of the intraocular iris tumors are the Cyst, Nevus, and Melanoma. The cyst is a benign tumor that takes place inside the stroma; the front of the iris, or in the iris pigment epithelium; the back of the iris [2]. Nevus is a benign pigmented growth iris tumor featured as yellow spots in the iris. It can be around the iris or beneath the retina. Nevus has a rare malignancy transformation into ocular melanoma; a cancer of the eye. The melanoma is a malignant tumor that can start in the skin or in the lining of the eye. The melanoma often grows and develops in the tissues in the middle layer of the eyeball. This middle layer is called the uvea and contains the iris [3]. This iris tumor has many signs and symptoms such as the dark spots in the iris area, the change in size or even the shape of the pupil, and the changes in the vision and other signs. Since our system is an image processing system, which stimulates the human vision, so it can detect the first two signs which are the dark spots and the change in the size and shape of the three discussed iris tumors [4]. The proposed system aims to automatically detect the tumor into the iris region. This can be achieved by extracting the tumorous areas using different image processing techniques discussed in the next sections.

This paper is structured as follows: the first section is an introduction about the eye tumors and the proposed system. The second one is a methodology of the system in which we provide flowcharts and figures that explain the system stages and the methods used. In the subsections of the second part we explain each image processing technique that is used in the system. Section three is the experimental results which show the system efficiency.The last section is a conclusion about the developed approach.

2 IRIS TUMOR DETECTION SYSTEM (ITDS): METHODOLOGY

In this paper an iris tumor detection system is developed. The system is implemented using Matlab programing language (Matlab 2013 software tools). ITDS is based on different image processing techniques used in order to stimulate the human visual inspection for detecting the iris tumor into an eye. The eye images (fig. 1 & 2) are obtained from "Miles research" [5]; a public database available on the internet. The images are converted first to grayscale images, and then these images are filtered using median filter in order to enhance their quality. The background image is extracted in order to be then substracted from the original one. Image adjustment is applied to the resulted image, thus increases its pixels intensity which clears that area that is then segmented in the next step, the edge detection using canny operator. After extracting the region of interest, the unwanted components are removed using an algorithm discussed in section 2. The last method is to superimpose the extracted ROI on the original grayscale image using image fusion in order to mark the tumor region onto the original image. The flowchart below shows our proposed system algorithm by setting successively the methods used. fig. 3 is an example of our proposed iris tumor detection system, in

which an iris melanoma image undergoes all previously discussed image processing techniques in order for the tumorous area to be segmented and then to mark the region of interest on the original grayscale image using image fusion.

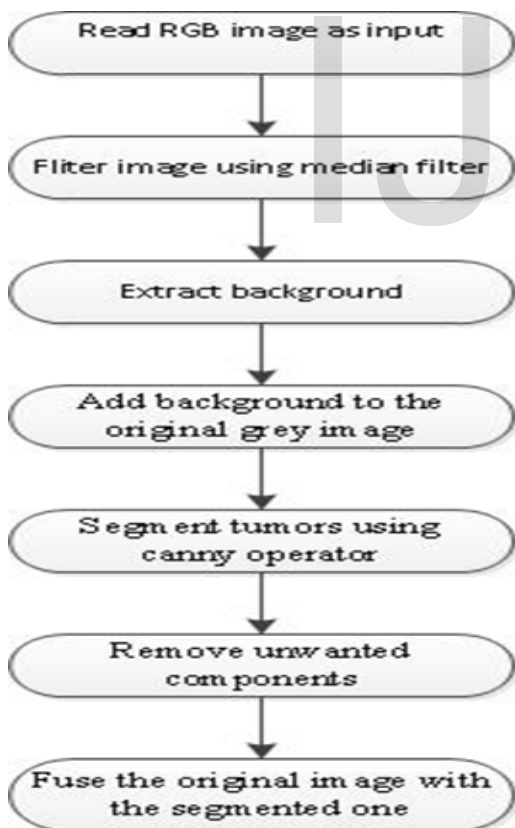[5] Fig.1. Normal eye

[5] Fig.2. Eye with an iris tumor
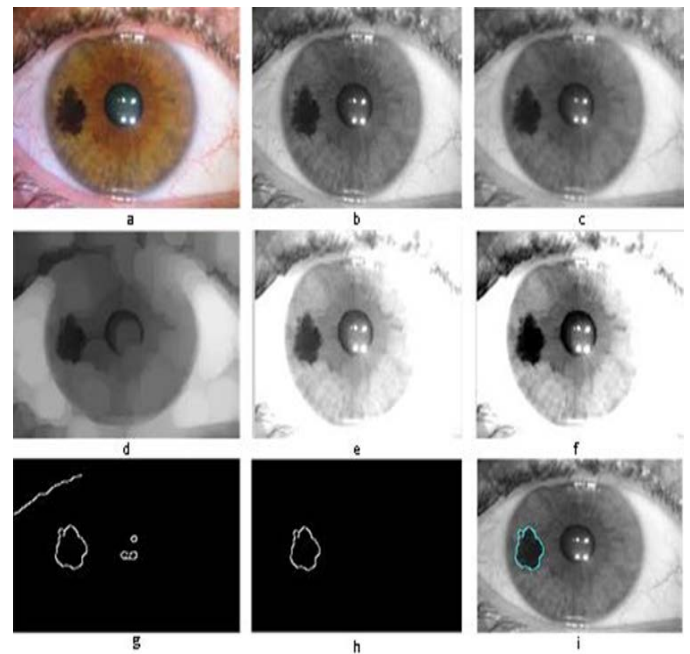

Fig.3. Flowchart of the proposed algrithm

Fig.4. Iris melanoma (a) the original RGB image, (b) the grayscale image, (c) the median filtered image, (d) the extracted background, (e) the added image: original + background, (f) the adjusted image, (g) the segmented region of interest using canny edge detection, (h) ROI after removing unwanted components, (i) superimposing the ROI on the original grayscale image using image fusion.
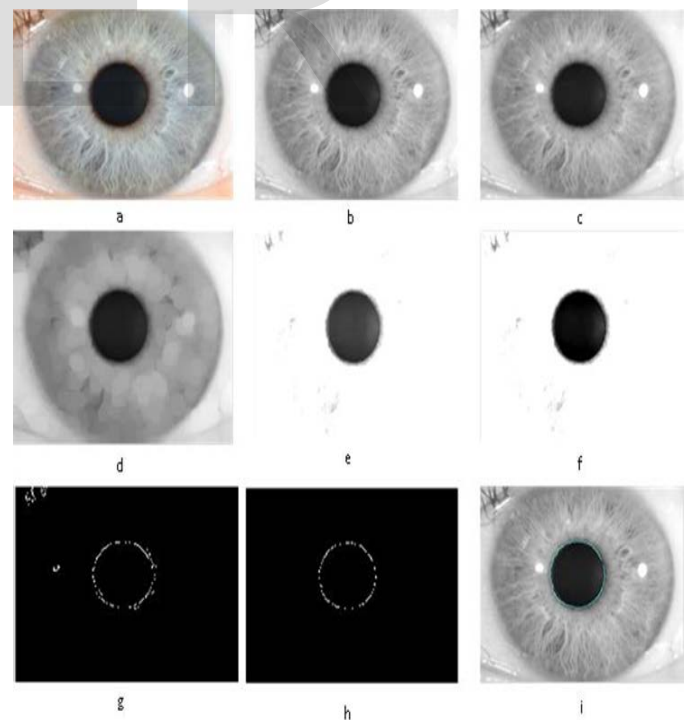

Fig.5. Normal Iris (a) the original RGB image, (b) the grayscale image, (c) the median filtered image, (d) the extracted background, (e) the added image: original + background, (f) the adjusted image, (g) extracted region of interest using canny edge detection (iris), (h) ROI after removing unwanted components, (i) fused image.

2.1 Grayscale conversion

The first step is to convert the RGB image to grayscale. This conversion is done using the luminosity method which relies on the contribution of each color of the three RGB colors. Using this method, the grayscale image is brighter since the colors are weighted according to their contribution in the RGB image not averagely [7].
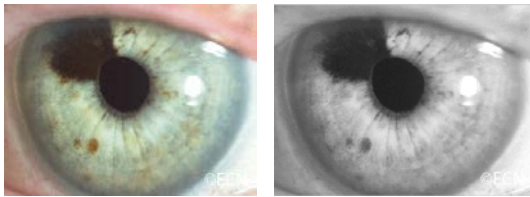

| (a) | (b) |

Fig.6. (a) RGB image of an eye with iris tumor, (b) Grayscale converted image of (a).

2.2 Smoothing using median filtering

A smoothing filter is mainly used to reduce noise in an image. In a specific pixel, it takes into consideration the neighbor pixels to that studied pixel. The pixels are filtered out and the noise is reduced by taking the neighboring pixels into account. One of the most useful filters used for smoothing images is the median filter. This type of filters is used to reduce impulsive noise or the salt-and pepper in an image with preserving the useful features and image edges [7]. Median filtering is a linear process in which the output of the being processed pixel is found by calculating the median of a window of pixels that surrounds that studied pixel [7].
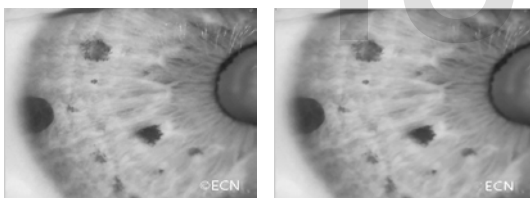

| (a) | (b) |

Fig.7. (a) Grayscale image before median filtering, (b) Grayscale image after median filtering.

2.3 Background extraction

Morphological operations are used for the extracting of background. Morphology can be defined as set of image processing operations that process images based on shapes [8]. These operations can be done by applying a structuring element to an input image, resulting in an output image of the same size. The structure element is a matrix consists of 0's and 1's, where the 1's are called the neighbors. The value of each pixel in the output image is set according to a comparison of the corresponding pixel in the input image with its neighbors. Structure element has many shapes according to its application. Here, the "disk" structure element with a "radius" of 15 is used to extract the background. The most common morphological operations are erosion and dilation. The latter is used to respectively remove or add a pixel at object boundary

based on structuring element shape and radius. The formula of finding the output pixel in both operations is the maximum of input pixels neighborhood matrix. Image opening is used to extract background in the proposed system. Morphological opening is erosion followed by dilation using the same structure element for both operations. The opening technique can remove objects that cannot completely contain the structuring element in order then to extract the background [8, 9].
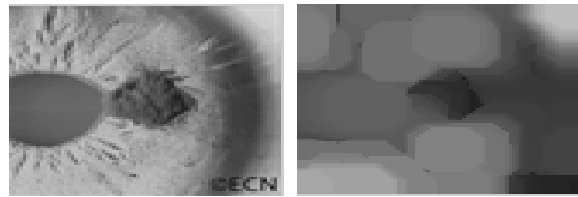

| (a) | (b) |

Fig.8. (a) Original grayscale image of iris tumor, (b) Removed background.

2.4 Adding images

This operation is to add the background image to original grayscale image. Adding two images can be done by adding each pixel in the first image to its corresponding one in the second image [10] . This increases the intensity of pixels, and then the region of interest (cancer area) gets brighter and clearer since the pixels under this region have higher intensities than other pixels. Figure 3(e) shows the result image of adding two images (background and original image). The following equation represents the adding operation. The original iris cancer image is being defined as O(x,y), the background image as B(x,y), and the resulted image as R(x,y).

$$R(x, y) = \sum_{i}^{n} \sum_{j}^{m} (O(x_i, y_j) + B(x_i, y_j)) \qquad (1)$$

Where i and j represent the rows and columns respectively. $O(x_i, y_j)$ and $B(x_i, y_j)$ are the elements values of the original and background images matrices. The number of elements of both images matrices which should be equal for both images matrices. Figure below shows the result image of the adding operations of an original iris tumorous image with its background.
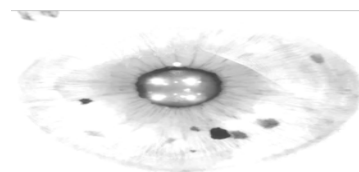

| (a) | (b) |

(c)
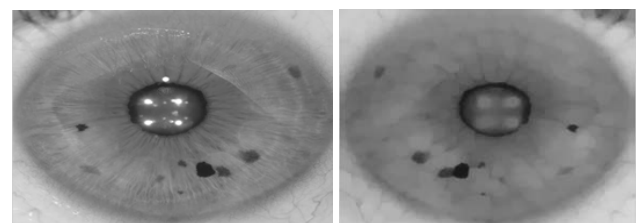
Fig.8. (a) Original grayscale image, (b) Removed background, (c) Added image.

2.5 Image intensity adjustement

The images then undergo intensity adjustment in which the input image's intensities are mapped to a new range of in the output image. This can be done by setting the low and high input intensity values that should be mapped and the scale over which they should be mapped (fig. 1.f) [10].
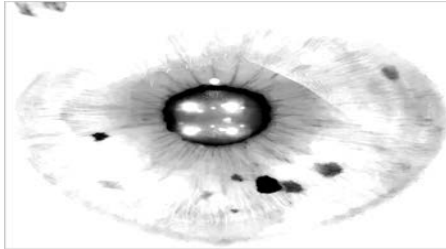

Fig.9. Adjusted image og fig.8(c).

2.6 Segmentation using canny edge detection

Segmentation is the process of partitioning the image into different and many regions [11]. This process can be done using different methods. The most common method for segmentation is the edge detection using canny operator. The latter is an algorithm used for detecting range of edges in an image. It detects the intensity discontinuities and finds boundaries of objects in an image by classifying pixels into edges. A pixel is classified as pixel if the gradient magnitude of it is greater than those of its both neighbors on the left and right sides (fig. 1.e) [12, 13].
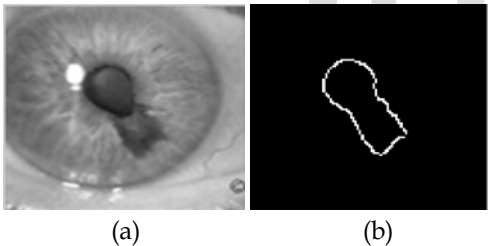

(a)   (b)

Fig.10. (a) Iris tumor grayscale image, (b) Segmented tumor using canny edge detection.

2.7 Removing unwanted components

The images then undergo an operation called as area opening. This technique is used to remove the un-wanted components into an image using a matlab function "bwareaopen". This technique is to remove form a binary image all the connected components (objects) that have pixels lower than than a set value [10]. After applying this technique we could get a result image showing the segmented region of interest (tumor region) for abnormal images and an image with only one circle, the pipil circle; representing the normal image (fig. 4.h) and (fig. 5.h).

2.8 Image fusion

For the purpose of superimposing the extracted region of interest onto original grayscale image we use a technique called image fusion. This image processing technique is a process of superimposing or combining relevant information from two or more images into a single output image [14] in order to come up with a more informative image. Image fusion can be categorized into three categories: pixel level, feature level, and decision level [15]. In our proposed system we use the pixel level fusion, in which the input images are fused pixel by pixel followed by the information extraction which is in our case marking the tumor area onto the original grayscale image.
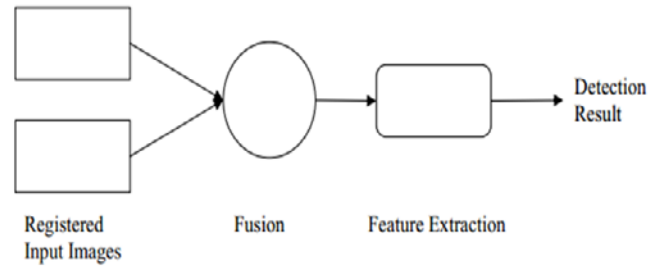
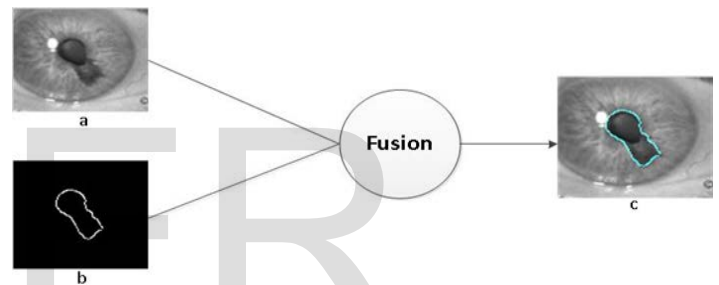[13]Fig.11. Pixel level image fusion

Fig.12. Image fusion (a) original image, (b) Segmented tumor, (c) Fused image.

2.9 Experimental results

The proposed iris tumor detection system was implemented using 2.8 GHz PC with 4 GB of RAM, Windows 7 OS and Matlab 2013 software tools. The system has been tested using 100 RGB images of iris tumors (melanoma, cyst, and nevus) and normal irises obtained from the online database: Miles Research [5]. The images are of size 431*688, however; they are directly converted to grayscale images of size 250*250. The experimental tests of the suggested system show efficient and successful results for the detection and segmentation of the tumor regions in an affected iris image. Table 2 represents the overall detection ratio achieved when testing the system. The images consist of 70 tumorous images (with tumor) and 30 normal images (without a tumor). The overall detection ratio is 98.5 % which is a sufficient result for such detection system.

Table 1: Peroformance of the proposed system

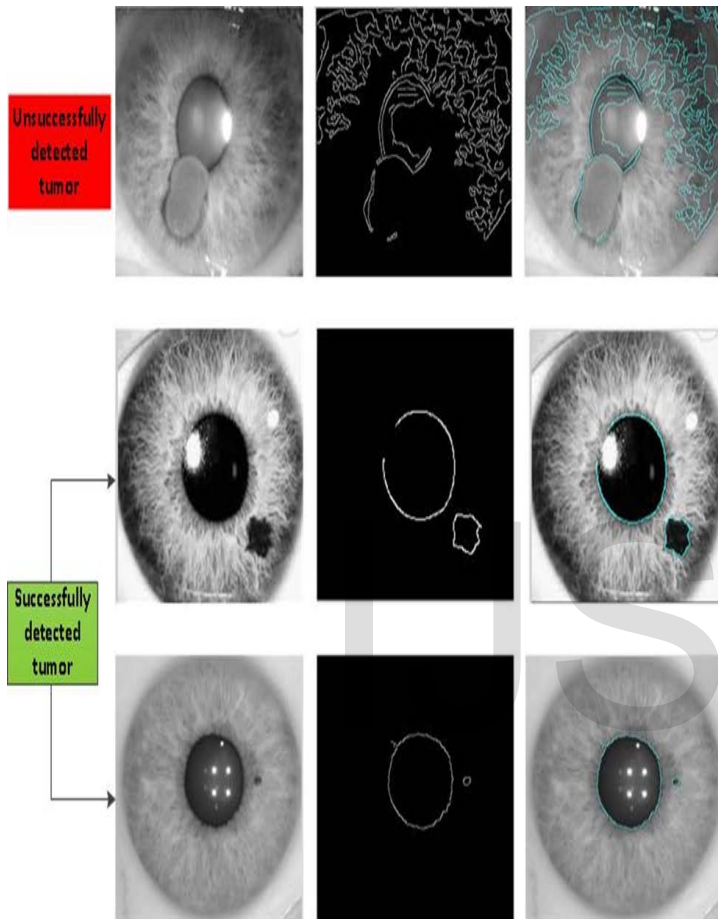|	Number of images	Detection ratio
Normal	30	30/30 100%
Abnormal	70	68/70 97.1%
Total	100	98.5%

Fig.10. Images of some successfully and unsuccessfully segmented tumors.

2.10   Conclusion

This paper presented a novel approach for the detection of the iris tumor using segmentation and image fusion. The developed system reads the tumorous iris image, processes it, and marks the regions of interest (tumorous regions) including pupil for the affected images. However, for the normal images, only pupils are marked since there are no tumors into the iris. The system has been tested for normal and abnormal images obtained from Miles Research and the experimental results were successful which proves that our effective system can be implemented into real life applications.

ACKNOWLEDGMENT

REFERENCES

[1] Heath grades, "Eye Cancer", available: http://www.healthgrades.com/conditions/eye-cancer.
[2] Richard D Grutzmacher, Thomas D Lindquist, Mark E Chittum, Ann H Bunt-Milam, And Robert E Kalina," Congenital iris cysts". *British Journal of Ophthalmology*, 1987, 71, p.p. 227-234H.
[3] Cancer Research UK, available: http://www.cancerresearchuk.org/about-cancer/type/eye-cancer/about/types-of-eye-cancer#mel
[4] The Eye Cancer Foundation Eye Cancer Network Education and Support for Eye Tumor Patients and Their Families,available:http://www.eyecancer.com/conditions/34/iris-melanoma
[5] Miles Research, available: http://www.milesresearch.com/main/links.htm.
[6] Digital image processing, available: http://www.tutorialspoint.com/dip/Grayscale_to_RGB_Conversion.html.
[7] James Church, Dr. Yixin Chen, and Dr. Stephen Rice, "A Spatial Median Filter for Noise Removal in Digital Images". *Southeastcon, 2008. IEEE*, p.p.618 – 623.
[8] R.Radha and Bijee Lakshman, "Retinal Image Analysis Using Morphological Process and Clustering Technique". *Signal & Image Processing: An International Journal (SIPIJ)* Vol.4, No.6, December 2013.
[9] Ms. M. Parisa Beham, Ms.A.B.Gurulakshmi, Morphological Image Processing Approach on The Detection of Tumor and Cancer Cells. Devices, Circuits and Systems (ICDCS), 2012 International Conference, 2012, p.p. 350 – 354.
[10] Gonzalez and Woods, *Digital Image Processing*, Second Edition, Prentice-Hall, pp. 108-120, 2002.
[11] Khashman, A., Al-Zgoul, E., "Image Segmentation of Blood Cells in Leukemia Patients". *Recent Advances in Computer Engineering and Application*, 2010 pp. 104–109.
[12] Xie Mei, Zhen Zheng, Wu Bingrong, Li Guo, The Edge Detection ofBrain Tumor. "Communications, Circuits and Systems". ICCCAS 2009. International Conference. 2009.pp. 477-479.
[13] Lijun Ding, Ardeshir Goshtasby, "On the Canny edge detector". *Pattern Recognition Society*, 2001. p.p.721-725.
[14] Z. Zhang and R. S. Blum, "Region-Based Image Fusion Scheme for Concealed Weapon Detection". Proceedings of the 31st Annual Conference on Information Sciences and Systems, 1995.
[15] J. Lanir, et al., "Comparing multispectral image fusion methods for a target detection task". *Optical Engineering*, vol. 46, pp. 66402-1, 2007.

- *A. Helwen is a member of the **Intelligent Systems Research Group, Near East University, Nicosia, Mersin-10, Turkey**. He is currently studying masters' degree program in biomedical engineering in Near East University. He received his bachelor of engineering in biomedical engineering from Al Manar University of Tripoli, Lebanon, 2013. Research interests include aritificial intelligence in medicine, artificial neural networks, image processing, and tissue engineering.*