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Hemoglobin Estimation through Image Processing of Eye Image via Determination of the Density Parameter of a 2-D Wavelet Processed Image

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***Abstract*: At present the hemoglobin estimation requires withdrawing of blood directly from the vein which is semi-invasive and time consuming. A non-invasive method is developed which involves image processing of the eye image. As the preliminary study, images of eyes were taken from patients of different blood and age group belonging to both sexes. The images were taken using a microscopic camera under fixed lightning conditions and hemoglobin count in their blood was obtained using standard blood test. This method is based on the properties of 2-D wavelet transform which is used to extract the density of red parameter values in the redness of image. This methodology relates the obtained values by estimation of density parameter of the eye image and the hemoglobin count of the individuals.**

***Keywords*: Image Processing, Wavelet Transform, Density Parameter, Hemoglobin, Anemia, Non-invasive method.**

1. Introduction

Anemia is the disorder characterized by lack of red blood cells or hemoglobin in the body that arises due to variety of conditions which can be serious or just barely noticeable. Anemia is more common in women than in men, but by 65, it can occur more often in men. It is diagnosed in about 20% of men and 15% of women of age over 80. Low iron is the very common reason for red blood cell count to be slow as iron is one of the main building blocks for red blood cell production. While, pernicious anemia occurs when there is lack of vitamin B12 or folate. Traditionally, Anemia is measured by the Hemo control method where, a single drop of blood from a finger-prick can be placed in a micro test-tube containing a reagent solution, which is invasive as well as time consuming. Several studies have been published comparing the non-invasive methods to standard practice. The main goal of these studies was to establish the accuracy, bias and precision of the non-invasive point-of-care methods. While, a study performed in France compared both the available non-invasive methods, pulse co-oximetry and occlusion spectroscopy. It was concluded that both devices, the bias was not dependent or directly related to the true value of hemoglobin. The estimation of real blood count values is carried out by applying image processing to the eye images obtained. The images are subjected to 2-D wavelet transform and the density of the redness is obtained from the image. Biomedical applications based on image processing is gaining various areas of diagnosis and monitoring [Walter et al 2002, Shiffman 2008]. The main idea of the work is that if a human observer can give an approximate hemoglobin count only using hemoglobin estimation. The aim of the work is to explore determination of hemoglobin quantitatively with greater accuracy by analysis of the images of eye.

2. Methods and materials

Target was to develop a method in which the images of the eyes can be obtained by digital camera under specific conditions and to predict the percentage of hemoglobin using the collected images. The result of this optical image blood test is compared with the values obtained via the standard blood hemoglobin test carried out worldwide.

A. Subject

Test was performed by collecting images of eyes using camera under specific lightning condition on individuals having different hemoglobin levels and blood groups belonging to different age groups and sexes. While, for comparison the hemoglobin count was obtained using the standard blood test used worldwide.

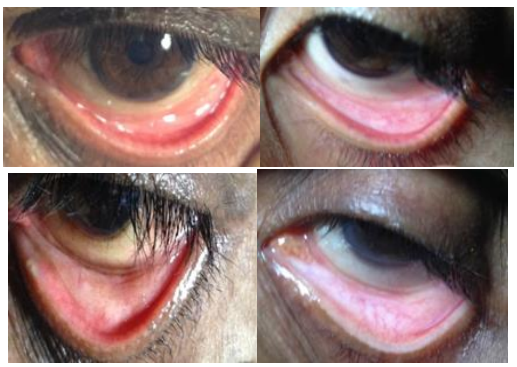

Fig. 1. The image collected from the subjects

B. Measurements

The eye images obtained are subjected to various process described below and density of the red parameter in the redness of the image is obtained.

C. Image clustering

The eye image obtained is fed with Image clustering process. Image segmentation is the classification of images into different groups. The popular method of image segmentation is k-means clustering. K-means clustering is an unsupervised algorithm and it is used to segment the interest area from the background. Segmentation partitions the image into distinct regions containing each pixel with similar attributes. But before applying k- means algorithm, first partial stretching enhancement is applied to the image to improve the quality of the image. Then finally medical filter is applied to the segmented image to remove any unwanted region from the image.

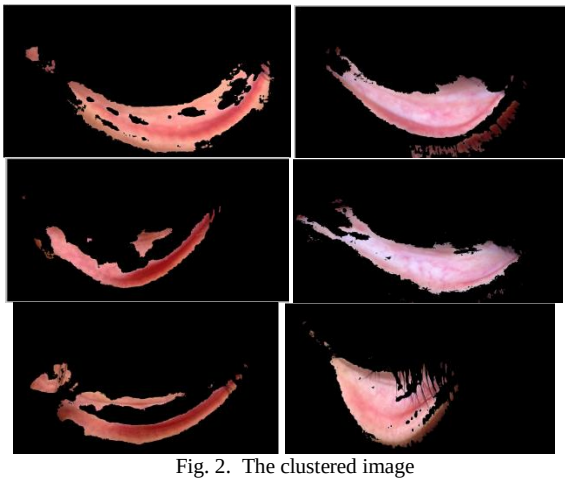

Fig. 2. The clustered image

D. Background elimination

The background elimination process is carried out on the clustered eye image as the depth information has been used in computer vision for a wide range of task. Background subtraction algorithms can be improved by fusing depth and color inputs, which are complementary and allow one to solve many classic color segmentation issues. A common approach for segmenting objects from the background is called background elimination. This technique consists of analyzing to create a reference background model and detect regions that belong to foreground objects.

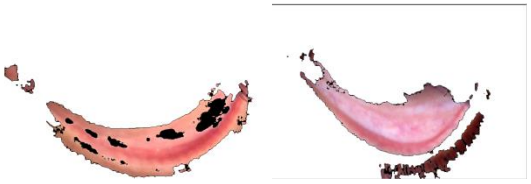

Fig. 3. The background eliminated image

E. RGB color model

The RGB values of the background eliminated images are determined. The choice of primary color is related to the physiology of the human eye; good primaries are stimuli that maximize the difference between the response of the cone cell of the human retina to the light of different wavelengths and thereby make a larger color triangle.

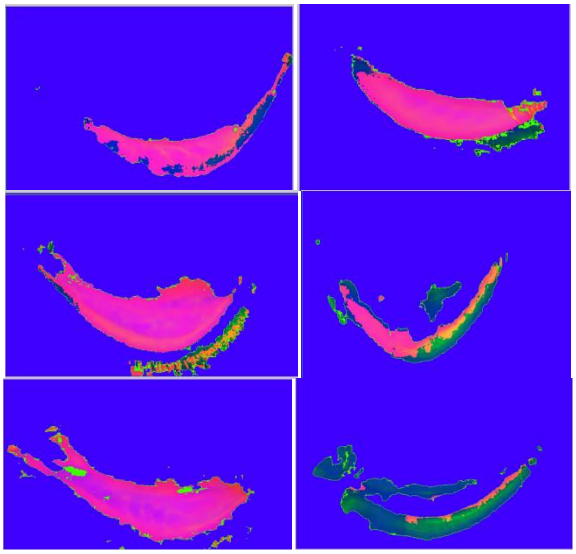

Fig. 4. The RBG color model image

F. Wavelet transform

The image is then processed to 2-D wavelet transform for multi-resolution decomposition that can be used to analyze images. A multi-resolution approach based on a modified wavelet transform called the tree structure wavelet transform is proposed. The development of this transform is motivated by the observation that a large class of natural textures can be modeled as quasi-periodic signals whose dominant frequencies are located in the middle frequency channel. With, this transform it is possible to zoom into a desired frequency channel for further decomposition. This transform performs further decomposition in low frequency channel. A progressive texture classification algorithm which has excellent performance is developed.

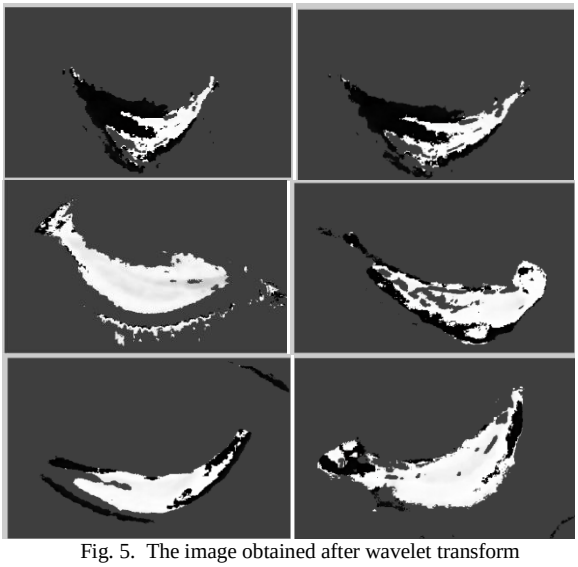

Fig. 5. The image obtained after wavelet transform

G. Density of the image

After application of wavelet transform the density of red parameter in the redness of the image is obtained via the developed algorithm.

3. Results, observation and conclusion

The estimated density values of the red parameter in the redness of the image are set as the input values. While, the hemoglobin count obtained through the standard blood test, carried out worldwide is set as the target. The input and target values are fed into the neural network for pattern recognition and the accuracy of 96% is obtained.

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