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Consideration of Iris Characteristic for Improving Cataract Screening Techniques Based on Digital Image

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Abstract. In this paper we propose a new consideration method for cataract diagnosis by considering a statistical texture approach in iris area to improve performance of cataract screening system based on image processing techniques. Statistical texture approach is including average intensity, average contrast, smoothness, third moment, uniformity and entropy. The results show that statistical texture analysis for iris area gave a significant result for serious and non-serious conditions. These results are promising for additional characteristics for getting a robust method for detecting cataract based on image processing.

Keywords: cataract screening, statistical texture, eye area, image processing, serious condition, non-serious condition.

1. Introduction

Cataract is a kind of eye disease; that is a clouding in the lens of the eye that affects vision. Cataract exhibits a lot of whitish color inside a pupil. The three classes of cataracts are immature, mature and hypermature, which differ in seriousness. In an immature cataract, a whitish color appears inside the pupil but less so than in mature or hypermature cataracts. Usually, the condition is not yet serious. A Hypermature cataract exhibits much whitish color inside the pupil and can cause the lens of the eye to break if surgery is not carried out. This condition is very dangerous [1].

The World Health Report published in 2001 estimated that there were 20 million people who are bilaterally blind (i.e., with eyesight of less than 3/60 in the better eye) whose blindness was caused by age related cataracts [2]. That number will have increased to 40 million by the year 2020. Increasing age is associated with an increasing prevalence of cataracts, but in most developing countries, cataracts often occur earlier in life. One of the developing countries that have the highest number of people with cataracts is Indonesia. There are about 6 million people in Indonesia who suffer from cataracts, but Indonesia only has about 750 ophthalmologists for a population of more than 200 millions people (one for every 350.000 people). In addition, ophthalmologists are not evenly distributed. Many ophthalmologists are located in the capital city, yet many people have no access to ophthalmologists because of geographic conditions. In order to solve the problems about cataract diagnosing in developing countries, there are few studies on the diagnosis of cataract using simple equipment conducted by Supriyanti [3], [4], [5], [6], [7],[8],[9],[10]. Supriyanti in her research [3], [4] using information about specular reflection inside a pupil for getting a characteristic between serious and non-serious condition of cataracts. She got a clear characteristic about serious and non-serious conditions of cataracts using specular reflection appearance inside the pupil. However, in this research she used limited data, therefore it need to be applied in more and varied types of data. In order to improve the performance of cataract screening system, in her research [5], [6], she added texture analysis for getting more characteristics of serious and non-serious conditions. Also, this research applied in more and various types of data. The performance of using specular reflections and texture analysis for cataract screening is promising. There are TPR (True Positive Rate) about 92% and FPR (False Positive

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Rate) about 18%. However, to be a robust cataract screening system, we have to have a TPR 100% and FPR 0%. In order to achieve these values, this paper will analyze the possibility of using statistical texture in the iris of the eye that covers average intensity, average contrast, smoothness, third moment, uniformity and entropy, as an alternative consideration for additional characteristic of our cataract screening system.

2. Proposed Method

2.1. Iris Localization

In our previous research [3], [4], [5], [6], [7],[8],[9],[10], we analyzed specular reflection and texture appearance inside the pupil. However, in this paper, we analyze statistical texture inside iris area only. In order to get iris area, we use the same method to localize pupil in our previous research [3], [4], [5], [6], [7], but currently we implemented this method for localizing iris as described in Figure 1.

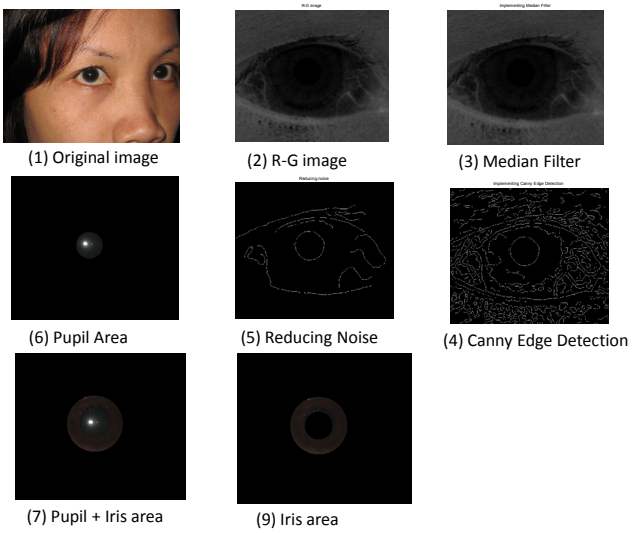

Figure 1: Algorithm for localizing iris area

2.2. Statistical Texture Analysis

2.2.1. Average Intensity

A frequently used approach for texture analysis is based on statistical properties of the intensity histogram. In this part, average intensity is used to calculate the average intensity of gray image in histogram. The purpose for calculating average intensity in iris area is to know the difference intensity between serious and non-serious conditions. The equation for calculating average intensity is showed in Equation 1.

$$m = \sum_{i=0}^{L-1} z_i p\,(z_i) \tag{1}$$

2.2.2. Average Contrast

The term contrast refers to the amount of color or grayscale differentiation that exists between various image features in both analog and digital images. Images having a higher contrast level generally display a greater degree of color or grayscale variation than those of lower contrast. The purpose for calculating average contrast in iris area is to know the standard deviation of color in iris area between serious and non-serious conditions. The equation for calculating standard deviation is showed in Equation 2.

$$\sigma = \sqrt{\mu_2(Z)} = \sqrt{\sigma^2} \tag{2}$$

2.2.3. Smoothness

The purpose of this part is for measuring the relative smoothness of the intensity in a region. R is O for a region of constant intensity and approaches 1 for region with large excursions in the values of its intensity levels. In practice, the variance used in this measure is normalized to the range [0,1] by dividing it by $(L-1)^2$. Equation 3 is describing equation to calculate smoothness.

$$R = 1 - \frac{1}{1+\sigma^2} \tag{3}$$

2.2.4. Third Moment

The purpose of this part is for measuring skewness of a histogram. This measure is 0 for symmetric histogram, positive by histograms skewed to the right and negative for histogram skewed to the left. Values

of this measure are brought into a range of values comparable to the other five measures by dividing μ_3 by $(L-1)^2$ also, which normalize the variance. To calculate third moment we used Equation 4.

$$\mu_3 = \sum_{i=0}^{L-1}(z_i - m)^3\, p(z_i) \quad (4)$$

2.2.5. Uniformity

The purpose of this part is for measuring uniformity. This measure is maximum when all gray levels are equal (maximally uniform) and decrease from there. Equation 5 is described for calculating uniformity.

$$U = \sum_{i=0}^{L-1} p^2(z_i) \quad (5)$$

2.2.6. Entropy

The purpose of considering entropy is to measure randomness in iris area between serious and non-serious conditions. Equation 6 is described for calculating entropy.

$$e = -\sum_{i=0}^{L-1} p(z_i) log_2\, p(z_i) \quad (6)$$

3. Experimental Results and Discussion

All data used in these experiments were acquired from Indonesia. Especially, for cataracts data were taken from Kamandaka Eye Clinic. The first we take a photograph using portable digital camera. Second we localize iris area using algorithm as discussed in subtitle 2.1. Then we analyze statistical texture including average intensity, average contrast, smoothness, third moment, uniformity and entropy. The result is described in Figure 2.

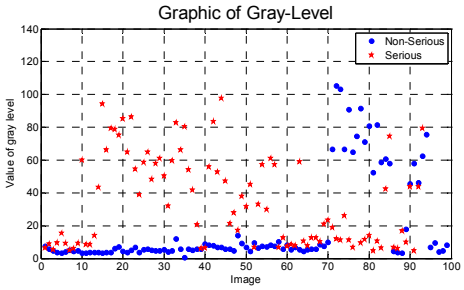

Fig 2.a. Graph of Average Intensity

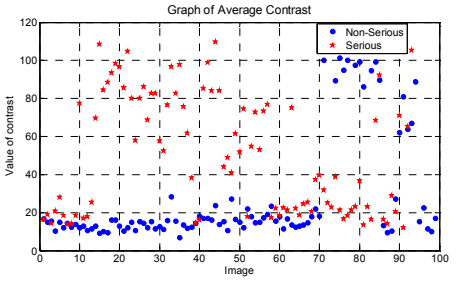

Fig 2.b. Graph of Average Contrast

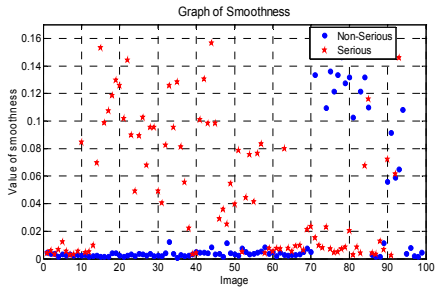

Fig 2.c. Graph of Smoothness

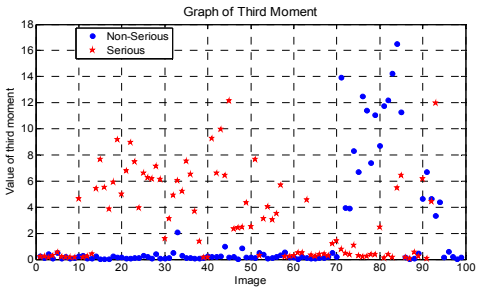

Fig 2.d. Graph of Third Moment

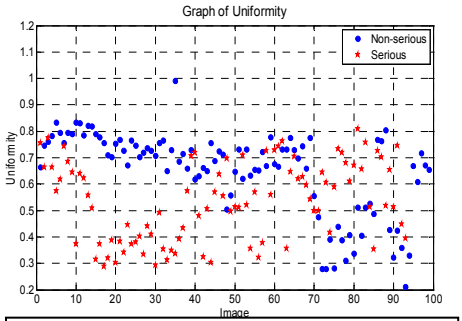

Fig 2.e. Graph of Uniformity

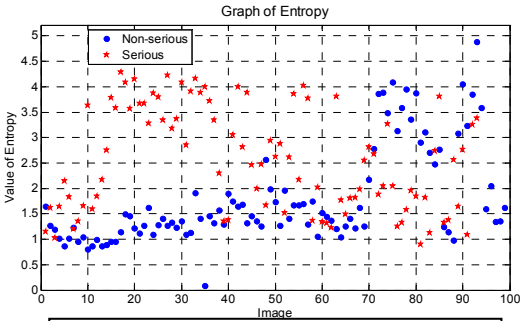

Fig 2.e. Graph of Entropy

Figure 2: Experiment Results

4. Conclusions

Basically, in order to improve our cataract screening system based on image processing techniques, consideration for using statistical texture analysis to iris area is promising method. However, this method will be useful for implementation with a note that this analysis should be combined with the analysis of specular reflection and texture analysis which appears in the pupil area as discussed in our previous research. The combination between these methods will be a robust cataract screening system.

5. Acknowledgment

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6. References

[1] H. Shidarta, ' Eye Diseases', *Balai Penerbit FKUI*, Jakarta, 2005.

[2] G. Brian and H. Taylor, 'Cataract Blindness-Challenges for 21st Century', *In Bulletin of the World Health Organization Report*, 2001.

[3] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, Satoru Nagata, 'A Simple and Robust Method to Screen Cataracts Using Specular Reflection Appearance', *SPIE Medical Imaging International Conference*, San Diego, California,February, 2008.

[4] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, Satoru Nagata, 'Cataract Screening using Reflection on Eye Lens', *Symposium of Sensing via Image Information (SSII)*, Yokohama, Japan, June, 2008.

[5] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, Satoru Nagata, 'Cataract Screening by Specular Reflection and Texture Analysis', *Journal of SIWN, Vol. 6, pp. 59-64*, April, 2009.

[6] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, Satoru Nagata, 'Extracting Appearance Information inside the Pupil for Cataract Screening', *IAPR Conference on Machine Vision Application*, Tokyo, Japan, May, 2009.

[7] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, Satoru Nagata, 'Compact Cataract Screening System: Design and Practical Data Acquisition', *International Conference on Instrumentation, Communication, Information Technology and Biomedical Engineering (ICICI- BME)*, Bandung, Indonesia, November, 2009.

[8] Retno Supriyanti, Yogi Ramadhani, Hitoshi Habe, Masatsugu Kidode, "Performance of Various Digital Cameras for Cataract Screening Techniques based on Digital Images", International Seminar of Electrical Power, Electronics, Communications, Control and Informatics (EECCIS), Malang, East Java, Indonesia, December, 2010.

[9] Retno Supriyanti, Yogi Ramadhani, "*The Achievement of Various Shapes of Specular Reflections for Cataract Screening System Based on Digital Images"* International Conference on Biomedical Engineering and Technology (ICBET), Kualalumpur, Malaysia, June 17-19, 2011

[10] Retno Supriyanti, Hitoshi Habe, Masatsugu Kidode, "Low-Cost and Easy-to-Use Equipment for Cataract Screening based on Digital Images", The 12th International Conference on Quality in Research (QIR), Bali, Indonesia, July 4 – 7, 2011