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Ascaris Lumbricoides Egg Detection from Digital Microscopic Fecal Sample Images

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Abstract

Diseases caused by intestinal parasite are alarming especially caused by *AscarisLumbricoides*. An efficient technique to detect existence of parasite automatically in fecal sample is vital. Therefore, this research is focus on detecting *AscarisLumbricoides* in fecal sample images by using digital image processing technique. There are four novel steps proposed in the detection process which are boundary detection, midpoint determination, radius distance calculation and parasite detection. The results generated are 100% precision and recall of 73%. This proves that this technique is a success.

Keywords : Helminth egg; Intestinal parasite detection; Ascaris Lumbricoides; Microscopic images; Digital image processing.

1. Main text

Human intestinal parasite infection of air, food, and water cause a major disease health issues. The most common symptoms of worm infestation include diarrhea, stomach bloating, and digestive disorders.Parasite infections are most often due to poorly washed foods, polluted water or insufficient or negligent hygiene. When the parasite invades in the human body, they eat and live off the food we consume; but many of them eat human tissues and even the protein coating on our nerves. In order to diagnose parasite in human body, the common way to examine is by fecal examination. There are 3200 varieties of parasites in the two major groups; the protozoa and the helminths which include nematodes, trematodes, and cestodes [1].

Studies have been conducted for the past 10 years on parasitic infection in Malaysia by Sagin D.D. and V. Nissapatorn [2,3,4]. Samples were taken from blood, serum and stool of rural population and Orang Asli. Most common parasites discovered are *Cryptosporidium Parvum, Cryptosporidium oocyst, Giardia Lambia, Plasmodium spp., Amobiasis, Toxoplasma Gondii,*and*TrichurisTrichiura* depending on personal and environmental hygiene. Studies made by group of researchers from Department of Parasitology, University Malaya, nearly 80% of studies carried out after 1978 still reported high prevalence of soil-transmitted helminthiases among Orang Asli communities and the most common is *AscarisLumbricoides*[5].

This article analyzes the microscopic images of human parasitic worm which is*AscarisLumbricoides* ova (ALO) according to microscopic images processing technology and morphology. Typical analysis includes determining where the edges of an object are, calculating the area, and other useful measurements of each object. The rest of the paper is organized as follows; Section 2 describes the related works, Section 3 explains the methodology, Section 4 will discuss on the results and finally the future work are described in Section 5.

2. Related Works

Recent researches on automated parasite detection were mainly focusing on malaria type diseases. For the past 10 years, only few studies have done in detecting parasite in human fecal sample images. Among the latest findings are discussing below.

Classification of human parasite eggs based on multi-class support vector machine (MCSVM) was done by Avci D. and Varol A. [6]. It consists of four stages which were pre-processing, feature extraction, classification and testing. The MCSVM classifier was implemented in the classification stage on features extracted in the earlier stage. In this study, overall success rates obtained was 97.7%. In another study, a protozoan parasite extraction scheme [7] was developed with the following sequence method: color space transforming, gamma equalization, median-mean filter, two-classes edge enhancement, two-means clustering method, morphological opening operation and largest independent component detection. An average success rate of 96.64% was achieved. However, the input images of both studies were region of interest of parasite images; without the existence of other objects or artifacts in the digital microscopic image. Conversely, a study was done to identify human helminth eggs automatically in microscopic images under 200-fold magnification using digital image processing and artificial neural network (ANN) [8].

Prior to identification process by ANN, the images undergo four operational steps in image processing which were median filtering, binary thresholding, segmentation and feature extraction. In the ANN process, identification performed in two stages; first was to separate parasite eggs from the artifacts whereas the second stage was to identify species of the detected eggs. The results on ANN achievement were 85.1% and 90.3% respectively.

In this paper, similar results with latter discussion above were achieved where parasite eggs were detected in microscopic digital images with 10x objective magnification. Detail implementation is discussed in the following section.

3. Methodology

This research is focusing on detecting the *AscarisLumbricoides* eggs in microscopic image which is full of other feces artifacts. The following steps were implemented in order to detect the existence of parasite eggs in the image; median filtering, thresholding, determine egg size and parasite eggs detection.

- Median filtering: Median filtering is applied for noise reduction without degrading the overall microscopic parasite image quality. The average pixel value in 5x5 windows is generated and relocates the pixel value in the center of the window. It is also well known for edge preserving.
- Thresholding: From grayscale image, thresholding is one of the simplest ways used to create binary images. The threshold value was computed using Otsu's method. It changes all pixels value which is greater than the threshold value into 0 as the background and 1 as the foreground image.
- Determine egg size: *AscarisLumbricoides* egg is measure 45-75µm by 35-50µm. After learning from sample images, the size of *AscarisLumbricoides*in the image is between 5000-9000 pixels area using connected component operator. Any segmented objects in the image that are above or below the range were removed.

Parasite eggs detection: Among the segmented objects is the parasite. Taking into consideration of the smooth egg shell criteria of the parasite, the detection process is consists of four steps; boundary detection, midpoint determination, radius distance calculation and parasite detection.

3.1 Parasite eggs detection

All segmented objects will undergo these four processes to determine which the parasite is. Below is the detail of the detection processes.

- Boundary detection: The purpose of this step is to get the outer shape of the detected object which might be the parasite eggs, after the previous steps were executed. In order to get the best result, every segmented object was filled using algorithm based on morphological reconstruction. This process is implemented to find the midpoint of the object.
- Midpoint determination: The minimum (x_1, y_1) and maximum (x_2, y_2) points of the object boundary were extracted. It was then generate the midpoint (x_0, y_0) as follows :

$$x_0 = \big((x_2 - x_1)/2\big) + x_1 \quad (1)$$

$$y_0 = \big((y_2 - y_1)/2\big) + y_1 \quad (2)$$

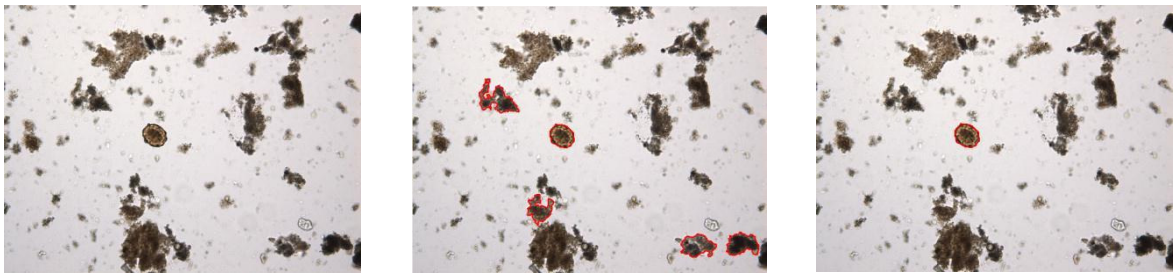
- Radius distance calculation: The distance *R* from the center $(x_0, y_0)$to each border points $(x_b, y_b)$of the object were calculated using Euclidean formula*(3)* which was then used to determine the parasite.

$$R = \left|\sqrt{(\mathrm{x_0} - \mathrm{x_b})^2 + (\mathrm{y_0} - \mathrm{y_b})^2}\right| \quad (3)$$

- Parasite detection: Standard deviation was generated from the radius distance data for each segmented object. Any of the segmented objects with low standard deviation is said to have high precision that leads to parasite detection.

4. Results and Discussion

In this paper, microscopic digital images with 10x objective magnification were used in the experiment with a total of 30 sample images containing *AscarisLumbricoides* eggs. Figure 1(a) shows the original image of fecal sample that has a parasite egg. The result after segmentation process is shown in Figure 1(b) where there are 5 potential parasite eggs detected based on the size of the object which their boundaries were marked in red. The other unmarked objects were removed due to their size did not fall into the range of 5000 – 9000 pixels. The radius distance was calculated to all marked objects to determine the standard deviation. Among all 5 segmented objects, the lowest value of standard deviation has proven to be the parasite as in Figure 1(c). The values are shown in Table 1.



(a) (b) (c)

Figure 1 : Results of egg detection; (a) original image, (b) potential eggs detected after segmentation process, (c) *AscarisLumbricoides* egg was detected.

Table 1.Standard deviation value of segmented objects in Figure 1.

Segmented Object	Standard Deviation Value	Detection
1	18.0006	Artifact
2	10.8869	Artifact
3	2.9942	Parasite
4	10.5394	Artifact
5	11.0023	Artifact

Two sets of 30 images each were used on this experiment. The first set is the sample image and the second one is experimental images. The performance evaluation used in this research is precision and recall which is commonly used in information retrieval. Precision measures the exactness of parasite detection against all sample images, whereas recall measures the correct detection against experimental images. The effectiveness of parasite detection was tested against another 30 images that contain *AscarisLumbricoides* egg. Table 2 shows the performance evaluation of this experiment.

Table 2. Precision and recall of parasite detection

	Number of Images
Parasite detected	22
No parasite detected	8
Precision	100%
Recall	73%

Table 2 shows the results generated by the proposed technique towards 30 experimental images; the parasite was detected in 22 images. From the performance result, this experiment had successfully detected *AscarisLumbricoides* egg in digital microscopic fecal sample images. However, only 73% of the experiment images were effectively detected due to certain limitations. This experiment was focus on detecting images that contain only one isolated *AscarisLumbricoides* egg.

5. Conclusion and Future Work

*AscarisLumbricoides*egg was successfully detected in fecal sample of digital microscopic images. As a result of the limitation above, the next experiment will be detecting the parasites that are overlapping with other artifacts and to detect multiple parasites in an image.

References

1. Ash LR, Orihel TC.*Atlas of Human Parasitology*.3rd ed. ASCP Press, Chicago, Ill. Ash, L. R., and T. C. Orihel. 1990.

2. Sagin DD, Mohamed M, Ismail G, Jok JJ, Lim LH, Pui JNF.Intestinal Parasitic Infection Among Five Interior Communities at Upper Rejang River, Sarawak, Malaysia. *Southeast Asian J Trop Med Public Health*2002;33:18-22.
3. Nissapatorn V, et.al. Parasitic Infection in Malaysia : Changing and Challenges.*Southeast Asian J Trop Med Public Health* 2005;36Suppl 4:50-9.
4. Nissapatorn V, Lim YAL, Jamaiah I, Rohela M, KhairulAnuar A. Parasitic Infection : A Recurring Phenomenon in Malaysia,Southeast Asian Journal of Tropical Medicine and Public Health 2007: 38 (Supplement 1); 181-190.
5. Lim YAL, Romano N, Colin N, Chow SC, Smith HV. Intestinal Parasitic Infections Amongst Orang Asli (indigenous) inMalaysia : Has socioeconomic development alleviated the problem?.*Tropical Biomedicine* 2009; 26(2) 110-122.
6. Avci D, Varol A. An Expert Diagnosis System for Classification of Human Parasite Eggs Based on Multi-Class SVM.*Expert Systems with Applications* 2009; 36(2009), 43-48.
7. Lai CH, Yu SS, Tseng HY, Tsai MH. A Protozoan Parasite Extraction Scheme for Digital Microscopic Images.*Computerized Medical Imaging and Graphics* 2010; 34(2010) 122-130.
8. Yang YS, Park DK, Kim HC, Choi M, Chai J. Automatic Identification of Human Helminth Eggs on Microscopic FecalSpecimens Using Digital Image Processing and An Artificial Neural Network,*IEEE Transactions on Biomedical Engineering* 2001; 48(6) 718-730