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Image Analysis for Classification of Stools and Gases in Large Intestine

大腸内の便及びガスの分類のための画像解析

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1. Introduction

Nurses and care-workers frequently provide bowel care to elderly people and home-care patients. In general, the amount and condition of stool that stays in the large intestine are evaluated by history taking, auscultation and palpation [1]. However, in order to improve cares to individual subjects, it is important to assess stool quantitatively without their intuitions and experiences.

By the way, an ultrasonic imaging machine is useful for visualizing inside of the human body. Furthermore, recently the number of the machine users are increasing. However, the diagnostic accuracy of ultrasound imaging depends on proficiency of users; thus, it is valuable to suggest the state of stools and gases in large intestine for nurses and care-workers who are unfamiliar with operation of ultrasonic imaging machines.

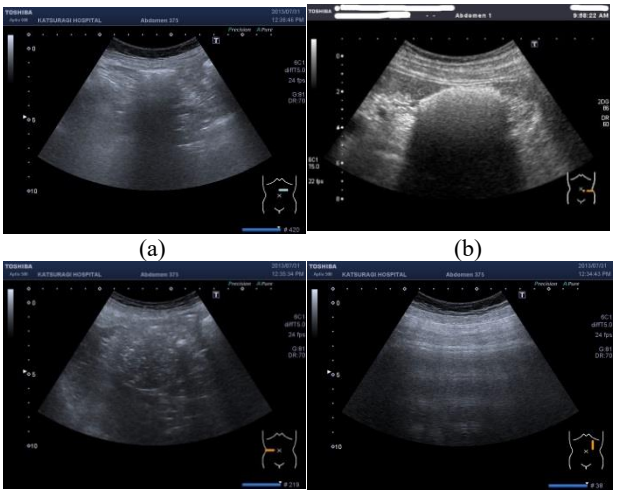
In this paper, we propose a method that estimates the state of stools and gases accumulated in the large intestine according to types using machine learning, and apply to real ultrasound images.

2. Method

Ultrasound images with four types of state are analyzed: normal, hard, loose and gas, as shown in **Fig. 1**. Attenuation gradient and auto-correlation function (ACF) in beam axis are used as characters for the assessment. These analyses are all calculated by MATLAB (The MathWorks, Inc.).

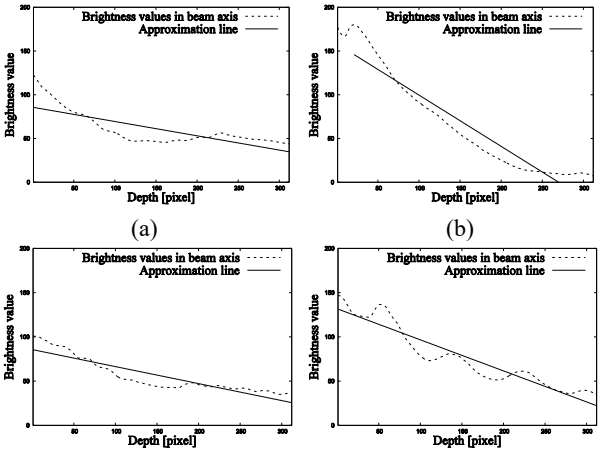
3. Result and discussion

An example of the brightness values in beam axis and its approximation line are shown in **Fig. 2**. Brightness value at the large intestine wall is relatively high, and the value decreases with distance from the wall. The coefficients of attenuation slope are different each other because of content in the intestine, as shown in **Fig. 3**. It is shown that the hard type has approximately 2.5 times huger attenuation than those of others.



(a) (b) (c) (d)

Fig. 1 Ultrasound images visualizing inside of large intestine. (a)normal, (b)hard, (c)loose, (d)gas.



(a) (b) (c) (d)

Fig. 2 Brightness values in beam axis (solid line) and its approximation line (dash line). (a)normal, (b)hard, (c)loose, (d)gas.

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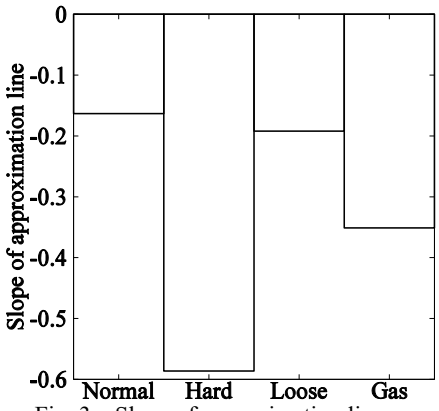

Fig. 3 Slope of approximation line.

The each ACF using 80 lines in beam axis is shown in **Fig. 4**. The peak is called as main lobe, and the following peak is called as side lobe. We focused on that the intensity of side lobe varies according to types. The intensity of side lobe in each type is shown in **Fig. 5**. It is shown that the gas type has approximately 1.5 times larger intensity than those of others.

Classification of images using slopes and intensity are conducted. The values of the slopes and the intensity from 4 type images are plotted, as shown in **Fig. 6**. In this graph, the distance between normal and the loose types are so close, and some points are overlapped. Therefore, it seems to be hard to clearly divide normal and loose types. On the other hand, plots of gas are relatively far away from other types. Although the distribution of the intensity in hard type is so wide, the slopes are nearly constant. Based on the above results, it seems to be easy to distinguish gas type and hard type from others. However, note that brightness values are dependent on machine setting.

4. Conclusion

In this study, we proposed a method that estimates the state of stools and gases accumulated in the large intestine according to type, and showed the feasibility. As a future work, we will utilize the features with machine learning, and design classifier for classifying stools and gases.

References

1. K. Ichikawa, Y. Oshima, T. Kadoi: Journal of Japan Society of Nursing Diagnosis **13(1)**, (2008) 28-37 [in Japanese].

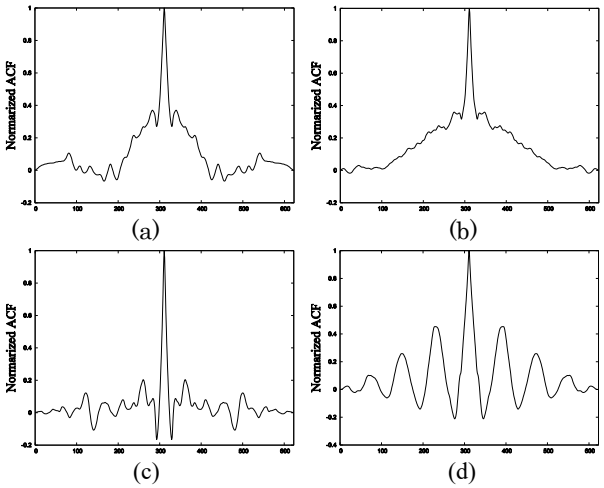

Fig. 4 ACF in beam axis.
(a)normal, (b)hard, (c)loose, (d) gas.

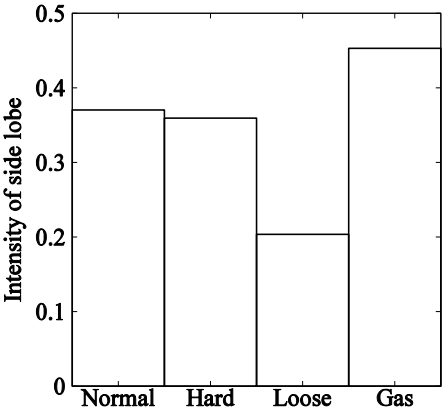

Fig. 5 Intensity of side lobe.

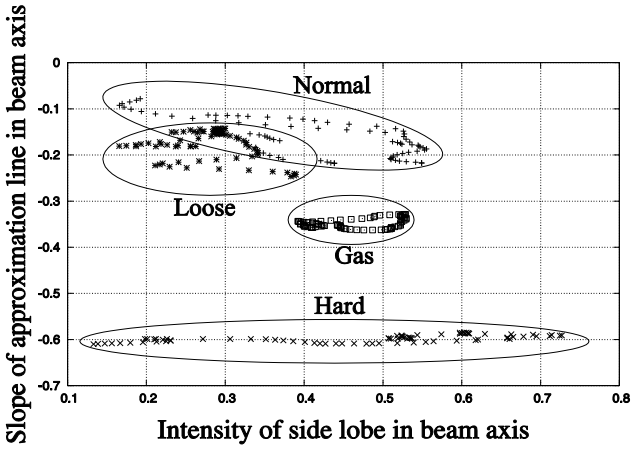

Fig. 6 Distribution of feature points.