Gaussian Mixture Model-based EM Algorithm for Instrument Occlusion in Tool Detection from Imagery of Laparoscopic Robot-Assisted Surgery

D.H. Lee[1], J. S. Choi[2], and H. C. Kim[3]

[1]Interdisciplinary Program, Bioengineering Major, Graduate School, Seoul National University, Seoul, Korea
[2]Center for Biomedical Engineering, Asan Medical Center, Seoul, Korea
[3]Department of Biomedical Engineering, College of Medicine and Institute of Medical and Biological Engineering, Medical Research Center, Seoul National University, Seoul, Korea

E-mail: hckim@snu.ac.kr

Abstract— **An expectation-maximization algorithm using a Gaussian mixture model was proposed as an efficient method to separate occluded instruments. The proposed methods distinguish occluded surgical instruments in an image of laparoscopic robot-assisted surgery, and it was found that the method can efficiently separate each surgical instrument.**

Keywords— **Occlusion, Surgical Instrument Tracking**

I. INTRODUCTION

The use of surgical robot systems for laparoscopic surgery has been increasing, but there are problems including narrow view that hinders the detection of an emergency situation caused by unintended tool movement[1]. To solve this issue, instrument tracking and then using their relative position information in an imagery of surgery is being tried to provide preventive caution, but separating occluded instruments is known to be difficult. An expectation-maximization algorithm using a Gaussian mixture model was proposed as an efficient method to separate occluded instruments.

II. METHODS

The distribution of pixels of the target image is assumed as a Gaussian mixture model, and we applied the *EM* algorithm

A. Gaussian Mixture Model (GMM)

GMM explains given sets of data, and it is defined by setting the number of elements which follow the Gaussian distribution.

$$p(x|\theta) = \sum_{i=0}^{M} \alpha_i p(x|\mu_i, \Sigma_i) \quad (1)$$

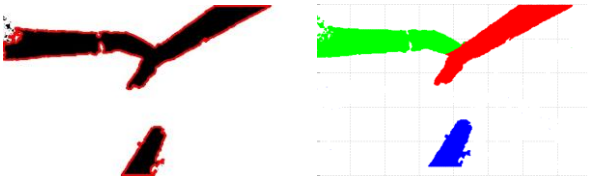
Then, the initial parameter is defined randomly.

B. Expectation and Maximization (EM) Algorithm

The *EM* algorithm is an iterative method for finding maximum likelihood or maximum a posteriori (MAP) estimates of parameters in statistical models. *EM* iteration alternates between performing an expectation (E)step, and a maximization(M)step[2].

III. RESULTS

As shown in Fig. 1,



(a) **(b)**

Fig.1.Separation of the occluded instruments using (a) conventional segmentation method, (b) the proposed method image

IV. CONCLUSION

The proposed method using a *GMM*-based *EM* algorithm for distinguishing occluded instruments in the image of laparoscopic robot-assisted surgery shows a better performance than a conventional segmentation method.

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