

OPTICAL AXIS TRACKING OF MICROORGANISM USING HIGH SPEED VISION

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1. INTRODUCTION

In observation of fast moving microorganism, object's speed is observed much faster than its real speed due to high magnification of microscope. Hence, it is very difficult to continuously observe and retain the object inside microscope's field of view unless we have a tracking system, for instance, the system reported by Berg[1]. Using a high-speed vision system [2], Oku et al.[3] developed an object-size-independent tracking system that allowed two-dimensional tracking of microorganism. In order to advance Oku's system to a three-dimensional tracking system, we add a new optical axis tracking to the conventional system and propose the optical axis tracking method by using the feature of focus measure and Becke line[4]. Becke line is the pattern appears on fresnel refraction nearby the edge of phase object and usually used to determine the refraction factor of mineral substances. The bright pattern of Becke line shift toward the medium with higher refraction factor when focus is brought away from the phase object. Using Becke line feature, we can detect the focus position whether its below or above the phase object.

2. OPTICAL AXIS TRACKING

To perform optical axis tracking, piezo-controlled objective lens is used to move microscope focus along optical axis. Image taken from microscope is captured by high-speed vision system, where 3x3 laplacian filter is applied and followed by summation and threshold process to calculate its focus measure which is used to evaluate focal plane. The advantage of using high-speed vision system is that it is allowed image acquisition and focus measure calculation to be performed within 1[ms]. Figure 1 and 2 show focus measure map and tracking using focus measure respectively. To allow more efficient tracking, Becke line pattern feature is used to detect whether the object is below or above the focus. Figure 3 shows the procedure to detect becke line using high-speed vision system.

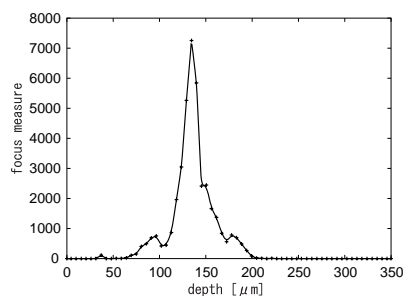


Figure 1: Focus measure

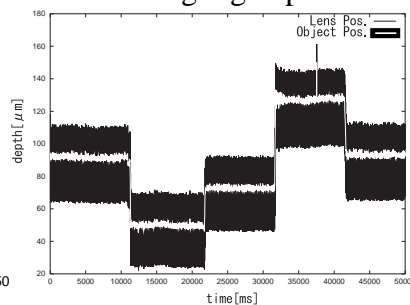


Figure 2: Tracking

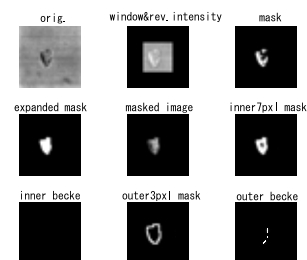


Figure 3: Becke line detection

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