High-speed parallel processing bio-microscope based on integral imaging

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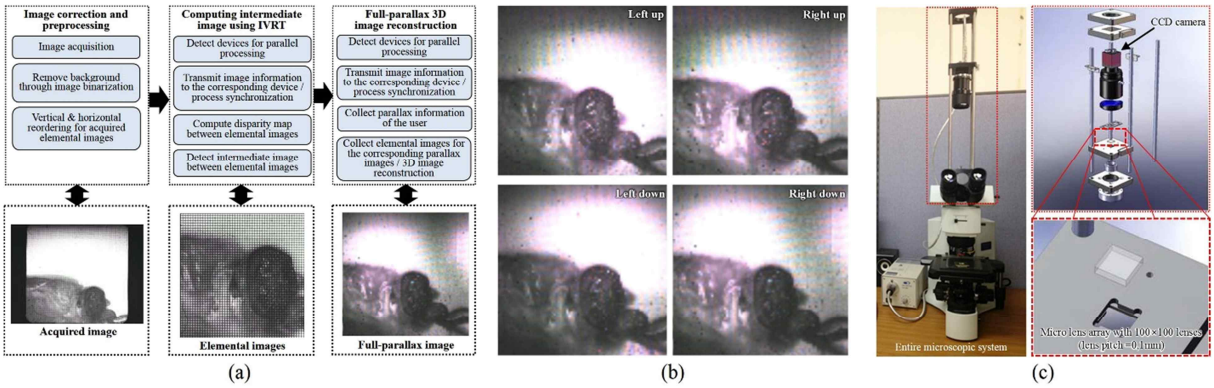

Figure 1: *(a) Flowchart of the proposed high-speed parallel processing algorithm and processed images extraction of the insect for corresponding parts, (b) reconstructed full-parallax 3D images of the insect from 4 viewing directions, and (c) the entire structure of the demonstration system.*

1. Introduction

Recently, fluorescence and confocal type bio-microscopes have been widely used in variety of fields, including hospitals and research institutes in the observation and inspection for the cells, blood and skin tissues. The most challenging issues of these bio-microscopes are resolution improvement and real-time observation. Another issue is how to acquire and display three-dimensional (3D) information of the observation samples. In the real-time observation, 3D image generating time is needed for the constant optical slices. Lim et al.[Lim et. al, 2009] proposed bio-microscope which generating the 3D information of object; however could not provide in real-time. In this study, we proposed an improved 3D bio-microscope which is applied real-time generating 3D information of the observation sample using Open-computer-language (OpenCL) parallel processing and optical reconstruction using integral imaging technique with simultaneously improved resolution.

2. Our approach

As shown in Figure 1(a), there are main three parts in our developing algorithm: preprocessing (preprocessing and calibration for the elemental images sets acquired by the microscope), computing (detects in intermediate images for the every elemental images by using intermediate view reconstruction technique (IVRT)) and reconstruction (reconstructs resolution enhanced full-parallax 3D image using generated intermediate images) parts. We created completive software which implemented in every part, using OpenCL of general-purpose- computing on graphics processing unit (GPGPU) to reconstruct full-parallax 3D image on the observer's wanted depth through parallel processing. OpenCL parallel processing method is developed as one of the important real-time detection and display method for the computer-generated integral imaging technique recently. Algorithm procedure goes following: first, distinguish the acquired images from background using binarization method. Here, sub-images obtained from the image information of corresponding binarized area. Image correction process goes for each center of the generated elemental images where Hough transform used to calculate center of the elemental images. Figure 1(b) shows the reconstructed full-parallax 3D images from four corners. To improve the viewing quality of the reconstructed 3D images, intermediate values for every pixel of two elemental images are detected, by using disparity map which shows the difference between two images. Here, OpenCL is used for real-time disparity map detection. Accessibility of acquired elemental images are approached to the number of GPGPU, therefore it can be implemented in same processing time for each thread, regardless acquired elemental images. In the physical experiment, proposed method consisted in high-speed (7-8ms/125-142fps), about 42-48 times faster when compared with CPU-based method (330ms/3fps). The demonstration structure of proposed 3D microscope is shown in Fig. 1(c).

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References

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