MOTION-BLUR-LESS MICROSCOPIC IMAGING WITHOUT THERMAL EFFECT

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Motion blur deteriorates spatial resolution of taken image especially for moving objects in optical shape monitoring. Conventionally, intensive illumination used for avoiding motion blur with short exposure time. However, intensive illumination causes thermal effect and photobleaching on subjects [1]. For instance, test object gets damage and expands when it gets intensive illumination, and accuracy of monitoring degrades.

In this research, we propose motion-blur-less shape monitoring method [2] to compensate motion for longer exposure time and less intensity of illumination in microscopic environment. The system is constructed with galvanometer mirror and camera to capture moving ceramic targets having 40 μm holes at the speed of 20 mm/s on the stage. As the galvanometer mirror moves in synchronization with the motion of the stage, the motion-blur is compensated. Originally 60 μm sized motion blur is occurred on the image (See Fig.1 (a)), however, our proposed method improved image as shown in Fig.1 (b). The spatial resolution was improved at 30 times. Therefore, our proposed method enables to reduce intensity of illumination one thirtieth.

To validate the thermal effect of the illumination, we constructed a system with thermal imaging device and LED light system under the subject. As shown in Fig. 2, according to the thermal images after 5 min lighting, the temperature of the subject changed from 26.0˚C to 26.2˚C by our proposed method (a), while it changed from 26.3 ˚C to 31.9˚C by conventional method (b). We confirmed that the difference of temperature due to different intensity of illumination and consider this method can suppress photobleaching on biological target.

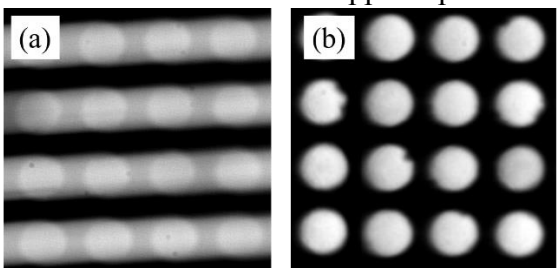

Figure 1: Motion-blur compensation during motion at a speed of 20mm/s

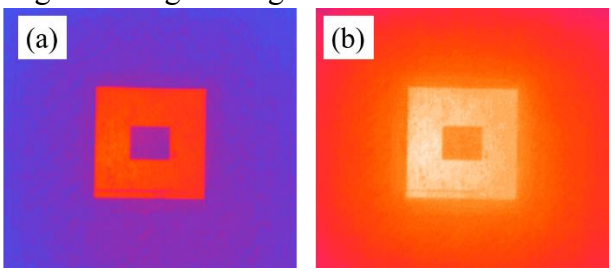

Figure 2: Thermal effect on subject which has micro holes(Inside square)

[1] S. Kalies et al., "Mechanisms of high-order photobleaching and its relationship to intracellular ablation," Biomed. Opt. Express **2**, 805-816 (2011).
[2] T. Hayakawa et al., "Real-time high-speed motion blur compensation system based on back-and-forth motion control of galvanometer mirror," *Opt. Express* **23**, 31648-31661 (2015).