OPEN

PRS GLOBAL OPEN VIEWPOINT

Overhead Multiview Camera System for Recording Open Surgery

Hiroki Kajita, MD*; Yoshifumi Takatsume, PhD†; Tomohiro Shimizu, BS‡; Hideo Saito, PhD§; Kazuo Kishi, MD, PhD*

Video recording of surgical procedures is an important tool for surgical education, real-time consultation, process improvement, research, workflow coordination, and error analysis.[1] Camera configurations reported for video recording open surgery include head mounted, fixed or tripod positioning, overhead positioning, videographer mounted, and body mounted on the surgeon; however, each of them has some limitations such as poor video quality, inadequate battery life, light overexposure, obstruction by surgical team members, and excessive motion.[2] As for the overhead mounted position, especially when integrated into a sterile light handle, this camera is at high risk of occlusion by the heads of surgical team members, effectively rendering the video unusable.[2]

To solve this problem, we invented overhead multiview camera system integrated into operating room light.[3,4] We installed multiple cameras attached to the position corresponding to the multiple lights comprising the operating room light (Fig. 1). Thereby, as long as the surgical field is illuminated, our camera system creates a situation in which at least one camera shoots the surgical field (Fig. 2). With this camera system, surgeons can confirm that surgery is being recorded when the surgical field is illuminated. This frees the operative team from bothersome camera operations and allows them to focus on procedures. (**See Video 1 [online],** which shows a demonstration of the handling of the overhead multiview camera system integrated in a mobile stand type operating room light.)

Also, our system automatically switches the viewpoint just when obstruction is detected; thus, optimal view without becoming obstructed is achieved **(see figure, Supplemental Digital Content 1,** which shows an example of automatic viewpoint selecting of the multiview camera system, http://links.lww.com/PRSGO/B356). The method of camera switching is described in the previous report.[4,5]

We have tested the camera system in 12 cases for open surgeries performed in the Department of Plastic and Reconstructive Surgery, Keio University Hospital. (Video recording of the patients was approved by the Keio University School of Medicine Ethics Committee, and written informed consent was obtained from all patients or parents.) In all cases, no complications nor the disturbances to the surgeries were noticed related to the recording with the camera system. The videos were captured from the start to the end of the surgeries without missing. Through the output video file, all the procedures could be looked back again and again, at free speed; since cameras do not move during recording, the procedures can be recognized even if fast-forwarded as high as sixty times speed. (**See Video 2 [online],** which shows a demonstration of automatic viewpoint switching of the overhead multiview camera system used for multiple z-plasty procedure for a congenital constriction band on the left forearm.)

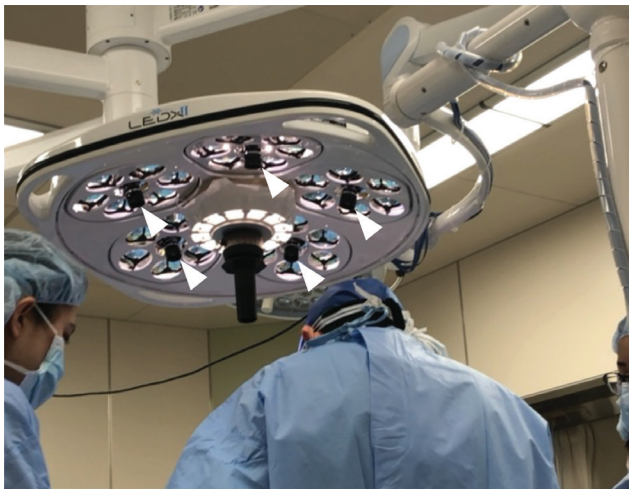

Fig. 1. The overhead multiview camera system integrated into a mobile stand type operating room light. The center LED of each light module was replaced with CCD camera (arrowheads), creating a situation in which at least one camera shoots the surgical field when light from any of the LEDs reaches surgical field.

*From the *Department of Plastic and Reconstructive Surgery, Keio University School of Medicine, Tokyo, Japan; †Department of Anatomy, Keio University School of Medicine, Tokyo, Japan; ‡Graduate School of Science and Technology, Keio University, Yokohama, Japan; and §Department of Information and Computer Science, Keio University Faculty of Science and Technology, Yokohama, Japan.*

This research was funded by AMED research expenses (task number: JP18he1902002h0001), JST CREST (JPMJCR14E1, JPMJCR14E3), and Saitama Prefecture Leading-edge Industry Design Project.

Received for publication February 7, 2020; accepted February 12, 2020.

Presented in part at the 2019 Annual Meeting of the American Society of Plastic Surgeons, September 22, 2019, Chicago, Ill., and The IEEE International Symposium on Mixed and Augmented Reality 2019, October 15, 2019, Beijing, China.

Plast Reconstr Surg Glob Open 2020;8:e2765; doi: 10.1097/GOX.0000000000002765; Published online 23 April 2020.)

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

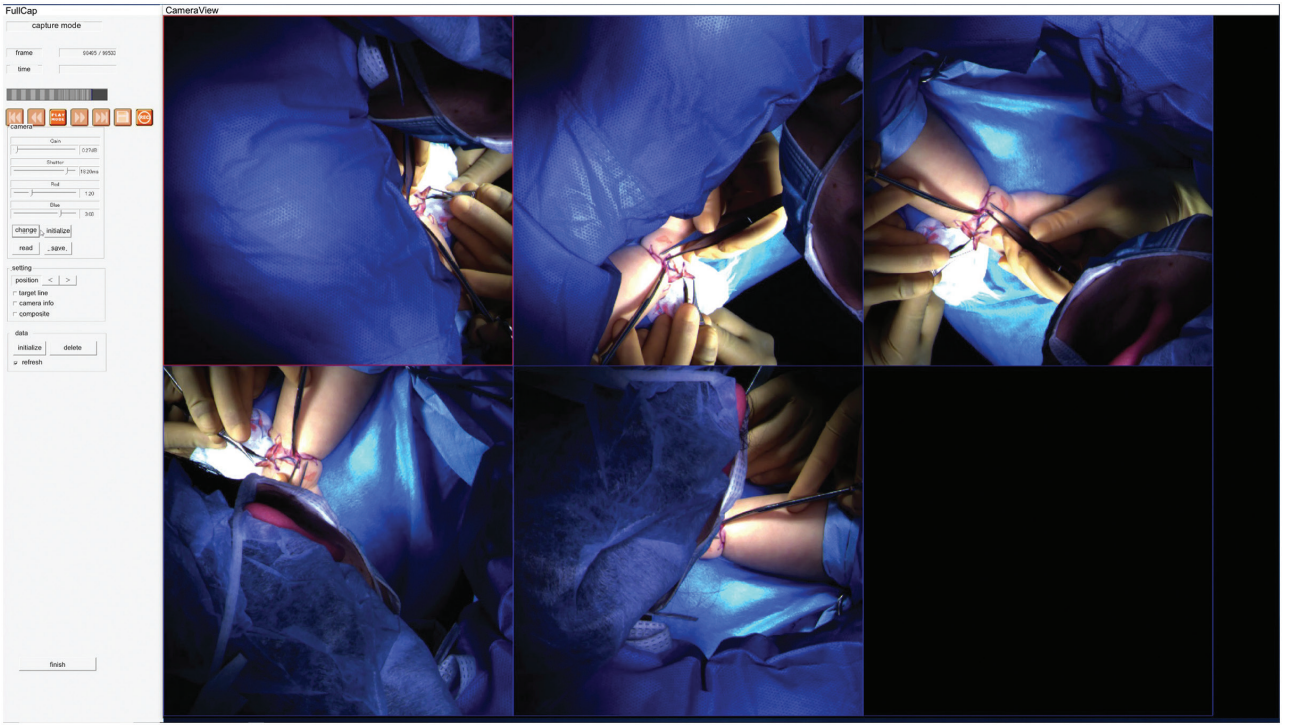

Fig. 2. An example of the screen of multiview camera system application. Videos from 5 viewpoints are seen simultaneously. Some cameras capture the surgical field well, whereas the others do not because of the occlusion by the body of surgical team members. CCD, charge coupled device; LED, light emitting diode.

Although the overhead multiview camera system has several advantages compared to the standard camera configurations, the most distinguishable point is that surgeons do not have to change routine practice in operation room; when they use the light handle as usual, the camera system automatically captures the surgical field. For further implementation, there are some difficulties in camera control of zoom, focus, and exposure, and in the assembling of cables or total cost, which will be resolved in the near future.

In conclusion, the overhead multiview camera system is a promising technology for automatic recording of open surgery.

Hiroki Kajita, MD
Department of Plastic and Reconstructive Surgery
Keio University School of Medicine
35 Shinanomachi, Shinjuku-ku
Tokyo 160-8582, Japan
E-mail: jmrbx767@keio.jp

ACKNOWLEDGMENTS

The authors thank Dr. Yoshiaki Sakamoto and Dr. Yuri Asano for performing the surgery and approval of the recording. This research is in accordance with the ethical standards of tKeio University School of Medicine Ethics Committee, and with the Helsinki Declaration of 1975, as revised in 1983.

REFERENCES

1. Xiao Y, Schimpff S, Mackenzie C, et al. Video technology to advance safety in the operating room and perioperative environment. *Surg Innov.* 2007;14:52–61.
2. Saun TJ, Zuo KJ, Grantcharov TP. Video technologies for recording open surgery: a systematic review. *Surg Innov.* 2019;26:599–612.
3. Kajita H, Takatsume Y, Oishi K, et al. Development of multi-camera mounted surgical lamp that realizes complete automatic recording of plastic surgery videos without cameraman. Paper Presented at: 2019 Annual Meeting of the American Society of Plastic Surgeons; September 22, 2019; Chicago, Ill. Available at: https://asps.confex.com/asps/2019am/meetingapp.cgi/Paper/38752. Accessed February 8, 2020.
4. Shimizu T, Oishi K, Saito H, et al. Automatic viewpoint switching for multi-view surgical videos. In: 2019 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct). 2019; 89-90. Paper Presented at: The IEEE International Symposium on Mixed and Augmented Reality 2019; October 15, 2019; Beijing, China. Available at: http://hvrl.ics.keio.ac.jp/paper/pdf/international_Conference/2019/ISMAR2019_Shimizu.pdf. Accessed February 8, 2020.
5. YouTube. [ISMAR2019] Automatic viewpoint switching for multi-view surgical videos. Available at https://www.youtube.com/watch?v=6vgse4Jv0B8. Accessed February 8, 2020.