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Eye-tracking fluoroscopy system: a new artificial intelligence-based system to communicate activate watching of the monitor during endoscopy

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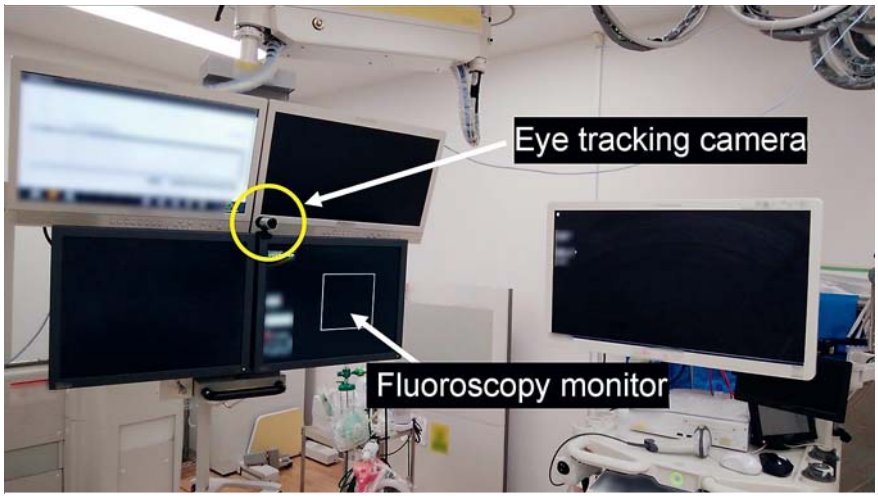
Minimizing radiation exposure time is one of the three principles of radiation safety. However, fluoroscopy is often used unnecessarily when endoscopists are not looking at the fluoroscopy monitor. Unnecessary radiation exposure is due to the complexity of fluoroscopic endoscopy procedures, wherein multiple operators independently view different parts of multiple monitors. These procedures usually need an endoscopist for endoscope maneuvers and one or more assistants for other devices; therefore, a radiologic technologist, who manages radiation exposure, cannot always monitor the line of sight of all operators at once. As limited tools are available to reduce endoscopic radiation exposure time [1], we developed a new eye-tracking fluoroscopy system that informs the radiologic technologist when the operators' line of sight is directed toward the monitor. It can track the operators' line of sight and flash a "watching" alert on the detection monitor once a line of sight to the fluoroscopy monitor is detected. This system, jointly developed with NEC Corporation (Tokyo, Japan), was designed to detect remote gaze of operators simultaneously using artificial intelligence (AI)-based face-recognition technology. Radiologic technologists can use this system by attaching an external camera to the fluoroscopy monitor (▶ **Fig. 1**) and connecting the camera to the detection monitor and the AI software.



▶ **Fig. 1** The eye-tracking camera located in the center of multiple monitors, with the fluoroscopy monitor at the lower right.

▶ **Fig. 2** Detection of direct lines of sight to the fluoroscopy monitor displayed on the detection monitor.

The system could detect the operators' line of sight to the fluoroscopy monitor with high accuracy. This was demonstrated in an experimental study by three personnel wearing radiation safety glasses and personal protective equipment, who raised their hands only when gazing at the fluoroscopy monitor (▶ **Fig. 2**). The line of sight detected included both deliberate and unconscious gaze by operators. The system worked in real time during endoscopic procedures (▶ **Fig. 3**). Radiation exposure could thus be minimized by detecting line of sight during actual endoscopy (▶ **Video 1**).

This AI-based eye-tracking system is a promising tool to reduce radiation exposure time of patients and operators during fluoroscopic endoscopy procedures.

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Competing interests

The authors would like to declare that the system used in this study was provided by NEC Corporation (Tokyo, Japan).

▶ **Fig. 3** The eye-tracking fluoroscopy system during actual endoscopy.

Video 1 Eye-tracking fluoroscopy system for reducing radiation exposure time during endoscopy.

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