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Evaluating the Educational Effectiveness of Surface Radioactive Contamination Survey Techniques

S. Hosokawa[1,*], A. Nakamura[2], H. Ose[2], M. Osanai[1], R. Mori[1], K. Okuda[1], T. Tsujiguchi[3], T. Tomisawa[4] and Y. Takahashi[1]

[1] Department of Radiation Science.
[2] Department of Radiological Technology.
[3] Education Center for Disaster and Radiation Emergency Medicine.
[4] Department of Nursing Science, Hirosaki University, 66-1, Honcho, Hirosaki, Aomori, 036-8564, Japan.

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Abstract – In this study, we evaluated the educational effectiveness of training by reviewing recorded data on contamination survey techniques and real-time display feedback. An optical flow (OF) sensor and a distance sensor were used to measure the speed and distance, respectively. The sensors were mounted on a radiation measuring device, and the contamination survey techniques of the 12 participants were recorded. The recorded data and real-time technique feedback was used to conduct training, after which the participants performed contamination surveys once more. Speed and distance both significantly decreased after training, with speed dropping from 4.70 to 3.45 cm s^{-1} and distance decreasing from 1.16 to 0.90 cm. Additionally, variations during surveys showed a significant reduction.

Keywords: optical flow / education / radioactive contamination survey

1 Introduction

Surface contamination surveys are typically performed by workers using Geiger–Müller survey meters. To reliably detect contamination, it is important to bring the probe close to the surface and scan slowly and carefully. Previous studies have demonstrated that when the probe is moved more slowly, differences in distance have a smaller impact on detection (Yamanishi and Sugiura, 2009). It has also been demonstrated that for low-energy beta-emitting radionuclides, such as C-14, maintaining a 5 mm gap between the detector and the source makes it sufficiently possible to detect contamination levels around the regulatory standard of 40 Bq / cm^2 for controlled areas, which is based on Japanese regulations (Abe et al., 2010). If the appropriate techniques are employed, contamination surveys can be conducted with sufficient sensitivity. As for previous research focusing on training contamination surveys, Onuma *et al.* (2012) developed a PC software program that simulated probe operations via mouse movements to highlight differences in the scanning techniques of novices and experts. Tomisawa *et al.* (2023) conducted contamination survey training in a virtual reality environment and reported that its educational effect was equivalent to that of in-person training. Nonetheless, non-negligible discrepancies between simulations and real-world settings exist, and the training often remains a one-time exercise. In this study, we examined a method that enables continuous training and is applicable to daily operations and verified its educational effectiveness.

2 Materials and methods

2.1 Acquisition of correction factors for speed estimation

For speed estimation, we employed an optical flow (OF) sensor (ThoneFlow-3901UY). We connected the OF sensor and a distance sensor (VL6180X) to a microcontroller board (ESP32 DW3000). The distance from the scanning surface was varied from 1 to 10 cm, and at each distance, the movement speed of the microcontroller board was varied from 1 to 10 cm s^{-1}, resulting in 100 different conditions. From the relationship between distance and output, we derived correction factors that were applied to the outputs to obtain distance-independent values.

2.2 Evaluation of the educational effect

Based on the above considerations, we attached the OF sensor to an appropriate position on the radiation measurement

*Corresponding author: shosokawa@hirosaki-u.ac.jp

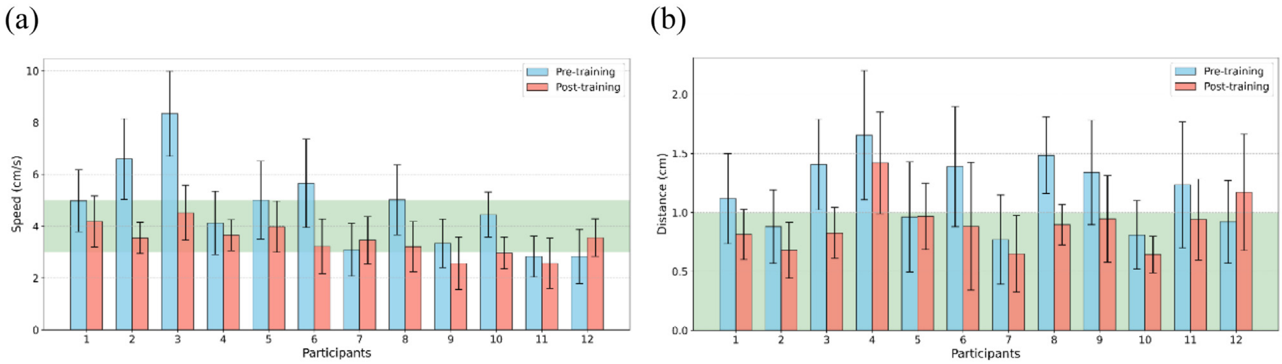

Figure 1. Changes in technique before and after training (the shaded area indicates the recommended proper technique) (a) Speed (b) Distance.

device (RaySafe X2). We recruited 12 senior students majoring in Radiological Technology. Each participant was instructed to perform surface contamination surveys of a 70 × 100 cm table covered with filter paper, once before training and once after. During these days, the participants were instructed regarding the proper technique, specifically maintaining a scanning speed of 3–5 cm s^{-1} and a probe-to-surface distance of approximately 1 cm. Before their second survey, the participants were shown a recorded data of their first technique. They then underwent training, during which their scanning speed and distance were displayed in real time. To determine whether the training significantly improved the technique, we used either a t-test or the Wilcoxon signed-rank test. $P < 0.05$ was considered statistically significant.

3 Results

At distances of ≥2 cm, the relationship between the OF sensor output and the distance was approximately an inverse. The corrected values obtained using the approximation equation derived from the 3–10 cm range exhibited a linear relationship with distance. This enabled the conversion of the OF sensor output into speed.

Figure 1 presents the results of each participant's contamination survey technique. The standard deviations, representing the variation during survey, are overlaid on the bar graphs. After training, the participants' average scanning speed decreased from 4.70 to 3.45 cm s^{-1}($p = 0.0091$), and their average distance decreased from 1.16 to 0.90 cm ($p = 0.0034$). In addition, the variability (as revealed by the standard deviation) during surveys was significantly reduced after training: speed variation decreased from 1.23 to 0.876 ($p = 0.0034$), and distance variation decreased from 4.10 to 3.14 ($p = 0.0066$).

4 Discussion

Since the OF sensor output is theoretically expected to inversely correlate with distance ($y = ax^{-1}$), the 3–10 cm range produced results that were closer to the theoretical value of $b = -1$ in the power-function $y = ax^b$ than the 2–10 cm range, with the 4–10 cm range showing further improvement. However, as distance increases, the signal strength diminishes and the signal-to-noise ratio decreases.

After establishing an environment for recording speed and distance, we evaluated the contamination survey techniques of the 12 participants. Although participants exhibited significant improvements in technique following training, they were already close to the proper technique before the training began. Because the participants were students unfamiliar with contamination survey techniques, we provided prior explanations of the proper methods. By selecting experienced workers who do not require preliminary explanations, it would be possible to more realistically assess the training effect.

Moreover, the variation in the survey technique during the contamination surveys showed a significant reduction post training, suggesting that the stability of their technique improved.

5 Conclusion

By examining a technique for recording the probe movement speed and the distance from the scanning surface, we found that combining a distance sensor with an OF sensor made it possible to achieve this goal. Furthermore, providing these values during training sessions helped participants employ proper techniques and achieve reduced variation during contamination surveys, resulting in more stable performances.

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Conflicts of interest

The authors declare no conflicts of interest.

Data availability statement

The research data associated with this article is included within the article.

Ethics approval

This study was approved by the Ethics Committee of Hirosaki University (Approval Number: HS-2024-075).

Informed consent

Informed consent was obtained from all participants involved in this study.

Author contribution statement

S. Hosokawa conducted the overall research and wrote the manuscript. A. Nakamura and H. Ose assisted in data acquisition and experimental setup. M. Osanai, R. Mori, and K. Okuda performed data analysis. T. Tsujiguchi and T. Tomisawa provided advice on the research. Y. Takahashi supervised the research process.

References

Yamanishi H. and Sugiura N. (2009) Variation of Detection Ability with Scanning Method on Surface Survey of Radiological Density, *Jpn. J. Health Phys*. 44 (3), 304–312.

Abe T., Kawazu I., Umata T. and Norimura T. (2010) Detection of Surface Contamination by Low-Energy Beta-Emitting Nuclides Using Direct Measurement Method with GM Survey Meter, *Jpn. J. Radiat. Saf. Manag*. 9 (1), 47–53.

Onuma I., Kobayashi M., Umehara T. and Shimizu I. (2012) Use of a Surface Contamination Survey Simulation Program and its Effects, *Jpn. J. Health Phys*. 47 (3), 194–197.

Tomisawa T., Hosokawa S., Kudo H., Osanai M., Ota K., In N., et al. 2023. Are online simulations for radiation emergency medical preparedness less effective in teaching than face-to-face simulations? *Disaster Med. Public Health Prep*. 17: e520.

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