Title:

Response to “Comments on ‘Novel real-time tumor-contouring method using deep learning to prevent mistracking in X-ray fluoroscopy’”

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To the editor,

We would like to respond to the comments of Drs. Mori and Endo [1] on our research paper [2].

First, we wish to discuss their suggestion on the requirement for using actual fluoroscopic images in the test stage. The necessity to validate our method using clinical fluoroscopic imaging was already mentioned in the Abstract, Discussion, and Conclusion sections [2]. The sentences in the Discussion section include the following: “We understand that our results were obtained from preliminary simulated fluoroscopic images, and we must validate this method using real clinical fluoroscopy. The anticipated primary difficulty is the different image qualities between the DRRs and the clinical fluoroscopy images. However, we expect that this problem can be solved by improving the DRR quality to be similar to the quality of clinical fluoroscopy images, or by creating a wide contrast variation in the training images for the input dataset of deep learning” [2]. The last sentence might be too optimistic; however, this was because we had already confirmed a successful result using clinical fluoroscopic imaging. Our next report will demonstrate the feasibility of our method using clinical fluoroscopic imaging.

We also wish to discuss their concern that the superior results were obtained as a result of overfitting, because training images were similar to the test images. We demonstrated the advantages of our method using geometric and simulated fluoroscopic models [2]. In the geometric model, the probability of matching a training image to a test image was almost zero. Therefore, it was proven that

the good tracking results were not caused by overfitting. In the simulated fluoroscopic model, we already mentioned that the possibility of matching a training image to a test image was 1 in 400. This low value does not directly mean that there was overfitting, because deep learning can be considered a statistical parameter optimization method. This is completely different from a template matching method using a dictionary file [3]. In addition, in deep learning, “data augmentation” in and of itself is well known to be one of the techniques for reducing overfitting. Famous data augmentation methods are affine transformation and adding noise to training images. Although a uniform noise is generally used, some reports selected a randomly arranged nonuniform pattern and demonstrated improvements in accuracy [4, 5]. Our data augmentation method is similar to that in these reports because the overlapped bone structure can be regarded as a nonuniform pattern. Our superior results were therefore not caused by overfitting, contrary to their concern.

Other minor questions: It was not surprising that the amplitude of the tracking error was less than the pixel size of the simulation image because the tumor position was calculated as the centroid by many pixels, which identified the tumor region using our image segmentation method. This was simply a statistical effect. It was also not surprising that our tracking error was less than that of other methods because other methods included some additional errors such as the identification of a ground truth position of tumors manually.

Finally, we wish to discuss their suggestion that we need to change the title of our report based on their concern that the title could mislead RPT readers into believing that our study was performed with actual fluoroscopic images. This suggestion cannot be accepted. The appropriateness of the title was already judged by an editor and referees. In the Abstract [2], we clearly stated, “Our results from a simulated fluoroscopy model showed ...” and “Further studies using clinical fluoroscopy are highly anticipated.” Moreover, in our paper [2], the subsection titles in the Methods and Results have highlighted the use of “Simulated fluoroscopy model.” We therefore think that their concern is unfounded. This is also supported by the fact that an article, which was submitted before their comment, cited our paper correctly as “They validated their method on simulated fluoroscopic images” [6].

Compliance with ethical standard

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical statement

This article does not contain any studies performed on human participants and animals.

Reference

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