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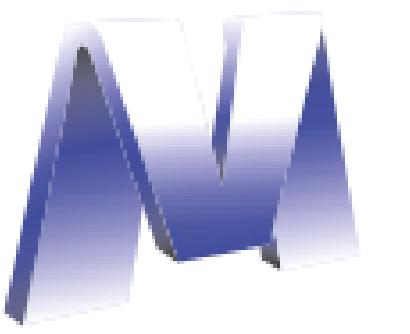
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Purpose

- Low back pain is a disease that attracts a lot of national attention, and one of the biggest causes of back pain is lumbar spinal stenosis (LSS).
- As a previous study, we developed a single pose-based convolutional neural network (SP-CNN) model that predicts the diagnosis of LSS with less time and cost burden using plain radiographs [1].
- In this study, we aimed to improve and generalize the predictive performance of the SP-CNN model using plain radiographs in extension, flexion, and neutral postures.

Overall flow diagram

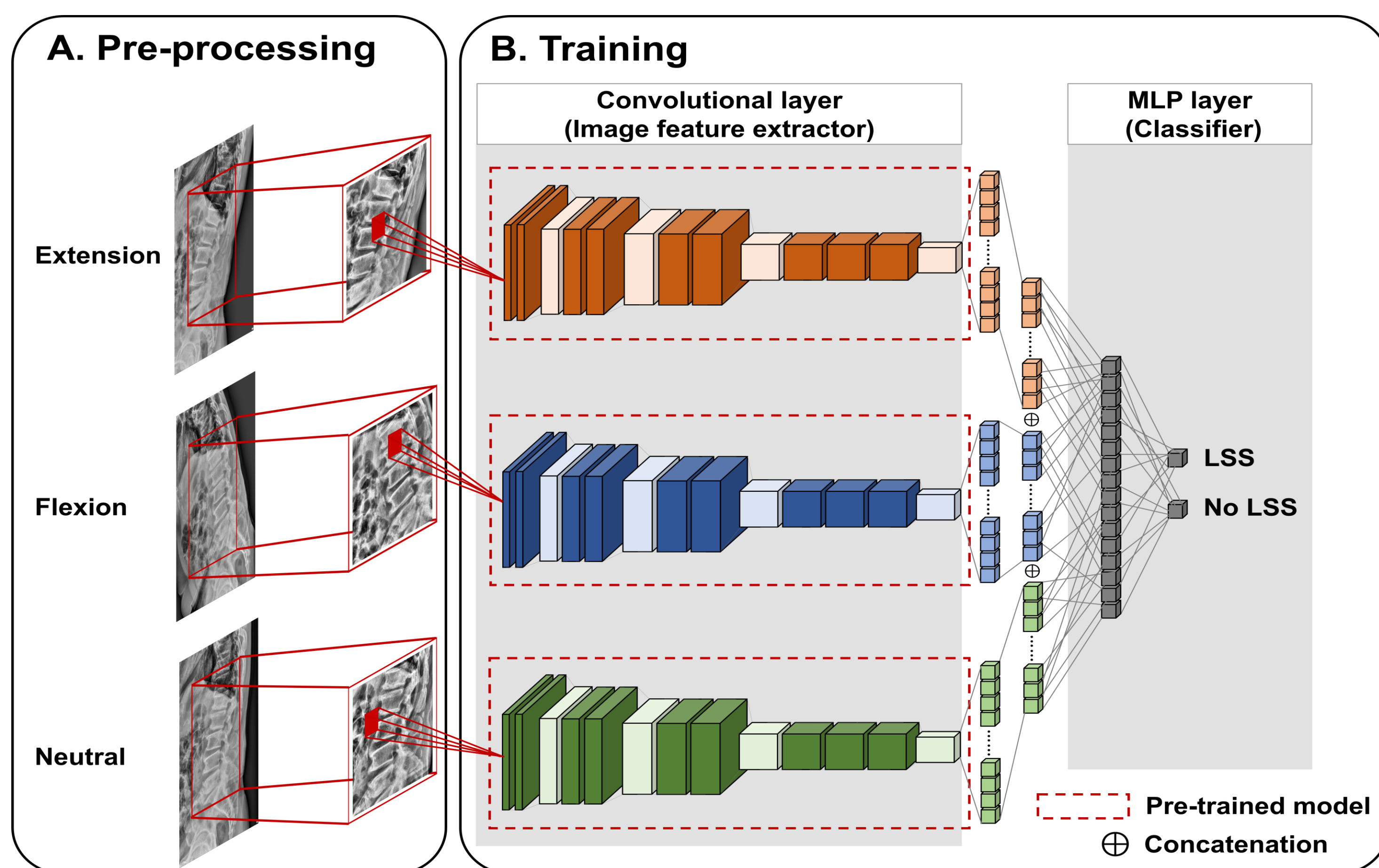


Figure 1. Workflow of the MP-CNN model to classify LSS. A is preprocessing part of input image, and B is the training part of the model.

Materials and Methods

- Patients who were diagnosed with severe LSS or no LSS confirmed by magnetic resonance imaging were enrolled in this study.
- Lateral radiographs of three postures were consecutively collected.
- Multi pose-based (MP-) CNN model was developed using extension, flexion, and neutral postures by leveraging the weights of three already developed SP-CNN models.
- Both the MP- and SP-CNN models utilized the ResNet50 algorithm [2], and the performance of the MP-CNN model was evaluated using an internal, extra internal and external validation set.

Results

- As shown in Table 1, MP-CNN model showed the highest performance among three SP-CNN models for all test sets.

Table 1. Comparison of AUROC between MP- and SP-CNN models on test set.

Test set	MP-CNN	SP-CNN (Neutral)	SP-CNN (Flexion)	SP-CNN (Extension)
Internal	0.914±0.005	0.896±0.007*	0.882±0.008*	0.893±0.004*
Internal extra	0.913±0.007	0.890±0.009*	0.896±0.011*	0.890±0.012*
External	0.795±0.015	0.769±0.024	0.773±0.029	0.742±0.018*

* p-value < 0.05

Results

- This misprediction may be occurred due to high iliac crest line on both neutral and flexion images, which was comparable to that seen on extension images.
- In contrast, MP-CNN model combined three postures and attenuated false positive and false negative lesions.

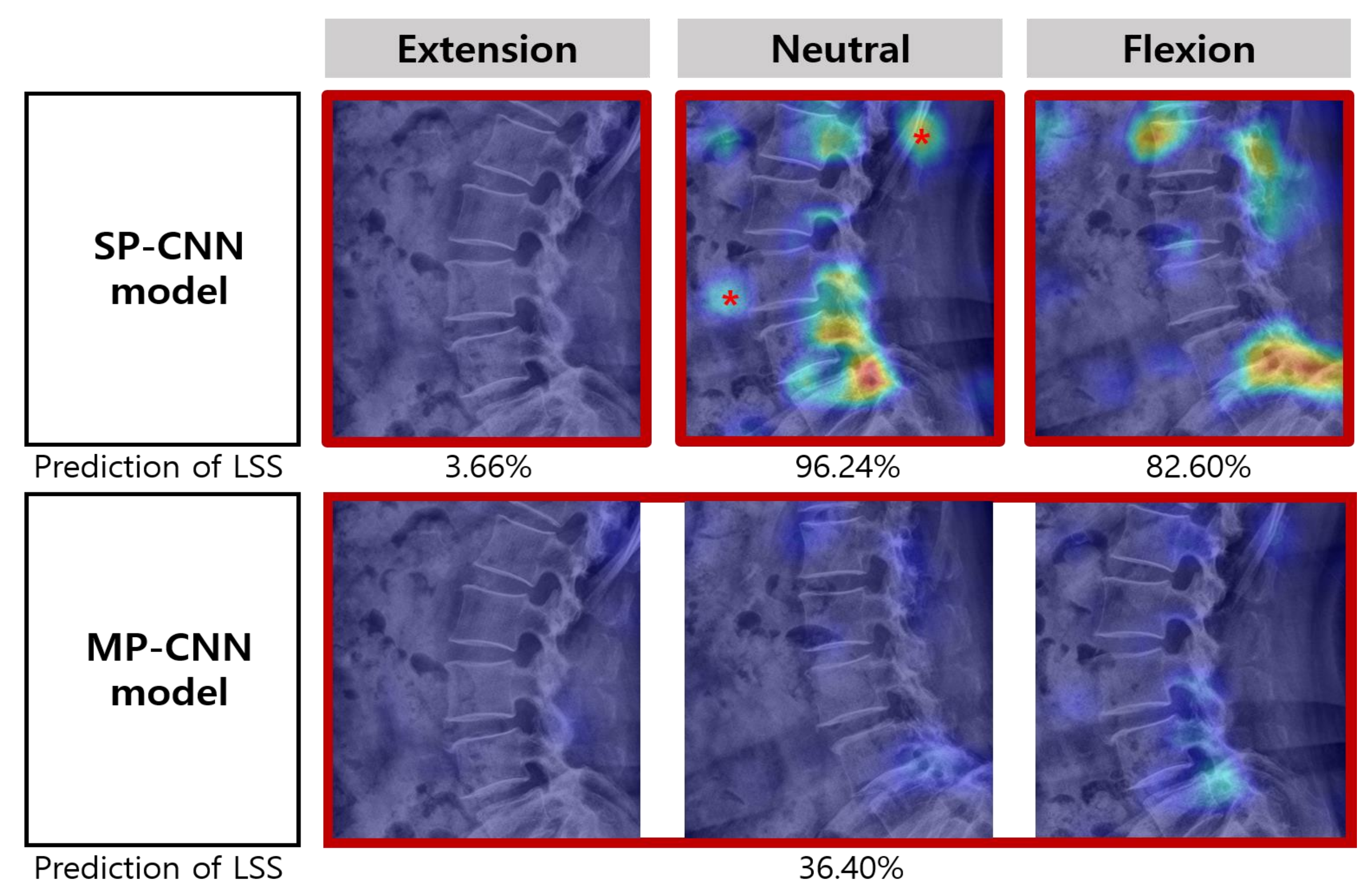


Figure 2. An example of heatmaps for an illustrative case that demonstrates a false positive in SP-CNN models for a 78-year-old female patient without LSS.

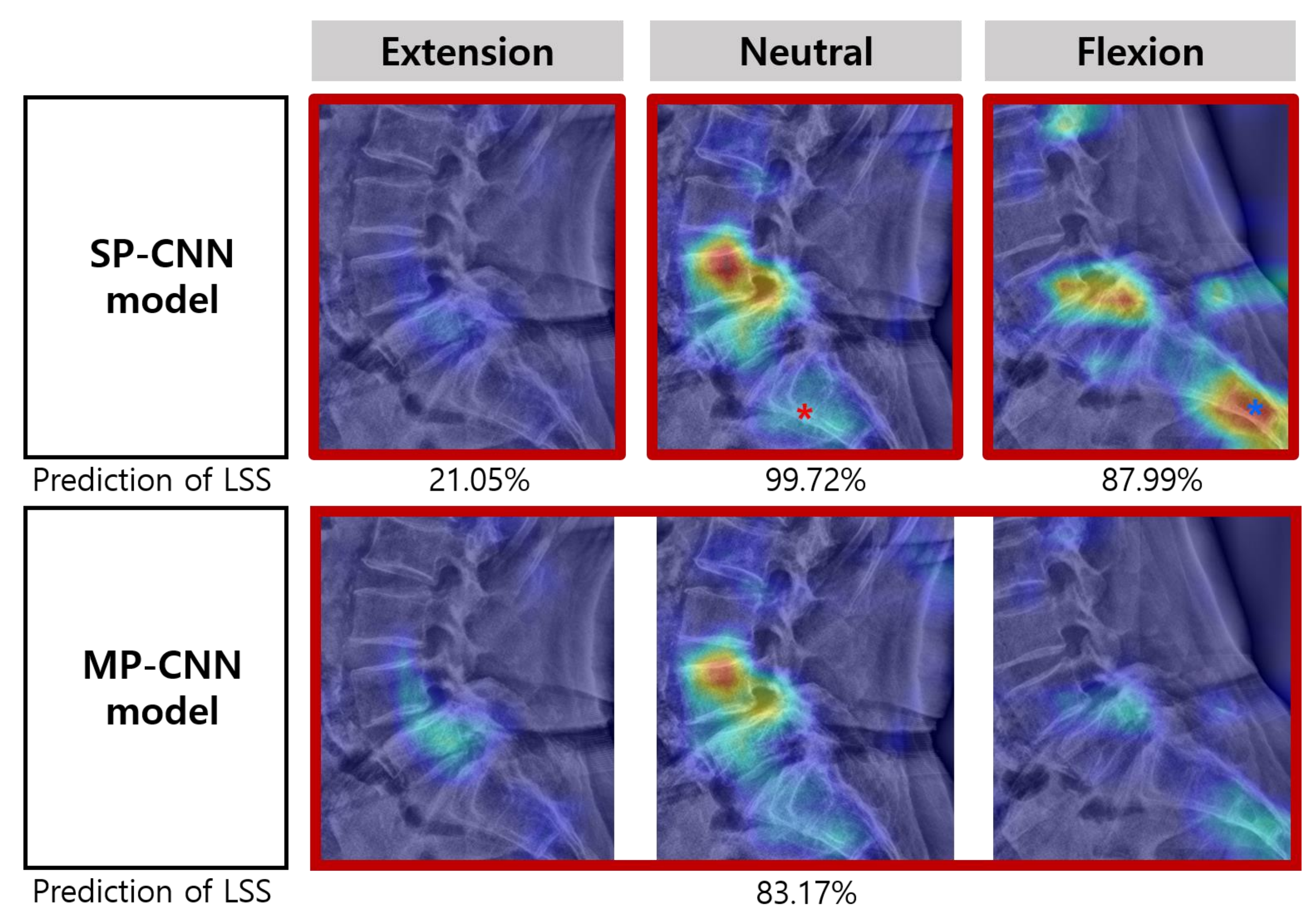


Figure 3. An example of heatmaps for an illustrative case that demonstrates extraction errors in SP-CNN models for a 71-year-old female patient with LSS.

Conclusions

- The MP-CNN model for predicting LSS using three postures of plain radiographs showed the highest performance in terms of AUROC for internal and external validations.
- The proposed model can be served as a useful screening tool for LSS with accurate localization and explainable rationale.

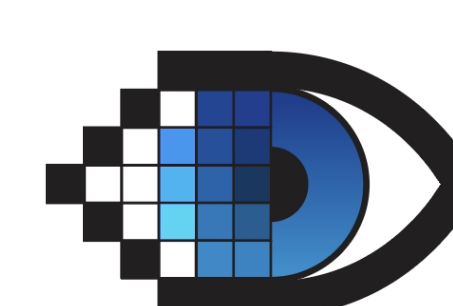
References

- [1] Kim, T., et al. Diagnostic triage in patients with central lumbar spinal stenosis using a deep learning system of radiographs. *Journal of Neurosurgery: Spine* 37.1 (2022).
- [2] He, K., Zhang, X., Ren, S., & Sun, J. Deep residual learning for image recognition. *Proceedings of the IEEE conference on computer vision and pattern recognition* (2016).

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