Towards an Affordable Deep Learning System: Automated Intervertebral Disc Detection in Xray Images

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Abstract

In this work we propose approach towards automatically evaluating biomechanical parameters in spine radiographic images using automatic disc detection techniques, framework as shown in Figure 1, to make efficient and accurate decisions on patient care. To this end, we trained Support Vector Machine (SVM) classifiers on different layers of Deep Convolutional Neural Network (DCNN) features. Our experimental results show the potential of using very small training data to yield satisfactory classification performance with accuracy up to 97.2% using only 15 training data.

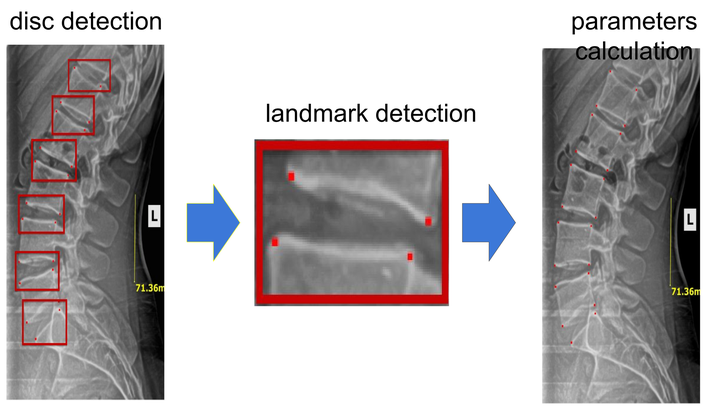

Figure 1: System framework

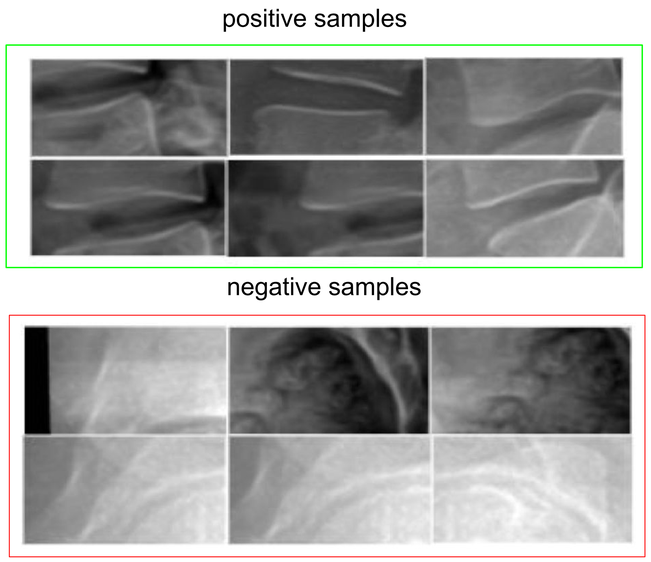

Figure 2: Sample image patches

Methods

We use deep convolutional neural network pre-trained on natural images as our feature extractor. Image samples, as shown in Figure 2, are fed into pretrained network then we extract features from different layers of DCNN. Using these features, we train multiple SVM classifiers, whose output is the label of the corresponding image patch. Positive sample contains visible disc, negative sample does not include visible disc. Figure 3 shows our proposed method.

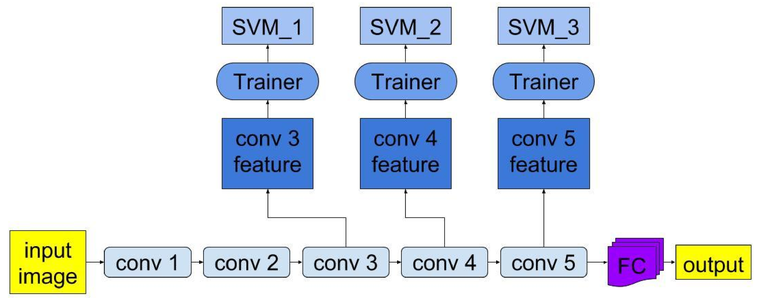

Figure 3: Proposed method

Results

Dataset: training data set contains 15 lateral lumbar X-Ray images, testing data set contains 2 lateral lumbar X-ray images.

Metrics:

$$accuracy(y, \hat{y}) = \frac{1}{n_{samples}} \sum_{i=0}^{n_{samples}-1} 1(\hat{y}_i = y_i)$$

Results:

Table 1. Detection results compared between different convolution layers.

Configuration	True Positive	True Negative	False Positive	False Negative	Overall Accuracy
conv3+SVM	0.785	0.986	0.214	0.014	0.970
conv4+SVM	0.790	0.987	0.210	0.013	0.972
conv5+SVM	0.741	0.984	0.258	0.015	0.966