Deep Learning Enables Instance Edge Detection of Vertebral Bodies on X-ray Images

by

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Abstract

Osteoporosis is the most prevalent metabolic bone disease, where vertebral fracture is the most typical sign of osteoporosis. Most of the clinical diagnosis were done manually with reports of under-diagnosis due to heavy work-load. Therefore, there is a need for an automatic and objective shape measurement of vertebrae. In this study, we have used There are 120 thoracic and 120 lumbar vertebral X-ray images, with professional edge annotation provided by medical doctors, where the training to validating ratio was 2:1. We proposed and implemented a novel framework, Automatic Instance-edge Detection Network (AID-Net) to perform instance edge detection of vertebral bodies on X-ray images by deep learning algorithms. Mask R-CNN was adopted as the basis of our framework, learnt from instance edge labelled by medical experts. Since X-ray image formed by only one projection plane of penetration, superior and inferior end plate of vertebral bodies will be ‘bubble’ shape instead of single line. Therefore, differ from typical regional-of-interest based segmentation task, we aimed to find the accurate edges locations of the vertebral bodies. Therefore, Holistically-nested Edge Detection, state-of-the-art of supervised edge detection, was employed rather than other simple segmentation network. Also, focal loss is employed during training instead of conventional binary cross entropy due to imbalance label ratio between edge and background. The accuracy of the edge detection is evaluated with dice coefficient and Hausdorff distance. The dice coefficient of our framework on each edge of vertebral body is more than 0.7, and with less than 6 pixels error in terms of Hausdorff distance. Also, our framework performs vertebral edge detection fully automatically, without any human interaction is needed. Our proposed algorithm is the first instance edge detection method of vertebrae on X-ray images, which achieved automatic and objective measurement. With this fully automatic approach, this method can easily be adopted by existing vertebral disease diagnosis systems.

Date: 13 Aug 2019 (Tuesday)
Time: 3:00 pm
Venue: LT-H (Lifts 27-28)

Examination Committee:
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All are welcome!

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