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Fully automatic cervical vertebrae segmentation framework for X-ray images

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Abstract

The cervical spine is a highly flexible anatomy and therefore vulnerable to injuries. Unfortunately, a large number of injuries in lateral cervical X-ray images remain undiagnosed due to human errors. Computer-aided injury detection has the potential to reduce the risk of misdiagnosis. Towards building an automatic injury detection system, in this paper, we propose a deep learning based fully automatic framework for segmentation of cervical vertebrae in X-ray images. The framework first localizes the spinal region in the image using a deep fully convolutional neural network. Then vertebrae centers are localized using a novel deep probabilistic spatial regression network. Finally, a novel shape-aware deep segmentation network is used to segment the vertebrae in the image. The framework can take an X-ray image and produce a vertebrae segmentation result without any manual intervention. Each block of the fully automatic framework has been trained on a set of 124 X-ray images and tested on another 172 images, all collected from real-life hospital emergency rooms. A Dice similarity coefficient of 0.84 and a shape error of 1.69 mm have been achieved.

Keywords: Segmentation, Deep Learning, FCN, UNet, Localization, Cervical vertebrae, X-ray.

1. Introduction

The cervical spine consists of seven vertebrae, labelled C1 to C7. These vertebrae support the head and protect the spinal column in the neck region.

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