Study on CNN based Spine Estimator from Moire Image for Screening of Adolescent Idiopathic Scoliosis

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Thesis Abstract

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Thesis Title

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Thesis Summary

Periodic spine screening in teenagers is important for the early detection or monitoring of adolescent idiopathic scoliosis (AIS), a 3D deformity characterized by an abnormal spinal curve and vertebral rotation. It is because AIS has potential to be a serious disease by the rapid progress of abnormal curve during the growth stage.

A typical conventional method of diagnosis of AIS is a radiation method using a radiography. To diagnose AIS from it, a doctor measures a Cobb angle, which is an abnormal bent angle of spinal curvature, based on the shape of spine. However, this is an insufficient method that only measures a Cobb angle without vertebral rotation (VR), which AIS involves. By the development of imaging technology, 3D radiation methods using computed tomography (CT) have been researched. VR measurement based on CT is accurate whereas complicate by challenges inherent to manual identification of spinal features. In addition, the radiation methods are not feasible for use as periodic screening by involving exposure to radiation. As for non-radiation methods, most are optical methods, are used due to cost effective and appropriate for the screening purpose. However, these require manual identifications and describe the spine using the surface metrics which cannot provide pathological diagnosis of the spine. For these reasons, a patient who is classified as abnormal and expected to have AIS, is recommended to get the radiographic diagnosis for an accurate diagnosis.

Therefore, I propose AIS screening system using a Moire image, that estimates the spinal shape and measures Cobb angle and VR. To estimate the spine from the Moire image, convolutional neural network (CNN) is used. The CNN estimates 34 spinal positions, 17 centers of vertebrae bodies and 17 tips of spinous processes including 12 dorsal and 5 lumbar vertebrae. In addition, I propose two measuring methods to measure the Cobb angle and the VR from the spinal positions. The system can reduce the use of radiation by proving radiographic diagnoses. In addition, the system is an automatic system which does not need any human interference like the identification of feature.

Chapter 1 describes the proposal of this thesis, the basic concepts about the spine, and AIS such as spine structure, what is AIS and its diagnostic criterion and the screening step for the spine.

In Chapter 2, related methods about measuring methods and conventional methods of screening are described such as radiography (x-ray) and CT method.

In Chapter 3, a generation method for a dataset is explained. Data sets having different spinal features or different components among deformity levels are tested to find out the optimal dataset.

Chapter 4 describes the detail of two proposed methods for measuring the Cobb angle and the VR angle, and the validations of the methods. The method for measuring Cobb angle measures bent angles of abnormal spinal curve from 17 points. The method formeasuring VR measures an axial rotation angle in x-z planes from 2 points in x-y planes. A general model of spinal size is generated and applied to obtain necessary z information for the VR. These methods optimized for this system, which can measure the Cobb and VR angles despite the limited point information.

Chapter 5 describes the used structure of (CNN) and the evaluations of CNN results. The evaluations are implemented by the two proposed measuring methods.

In Chapter 6, conclusions and future works of this thesis are described.