



Spinal Cord Vertebrae Identification and Segmentation using Machine Learning Classification Approach

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Abstract:

The nervous system is a vital body phenomenon. Taking one of its major organs, the spinal cord, and describing its significance are a crucial task. The damage in the major hub of the information transmission network can disturb the functionality of any other vital organ. proposed identification and segmentation for vertebrae of spinal cord from CT scan dataset using convolutional neural network, K-means algorithm and K-NN algorithm. The process of identification and segmentation is divided into two phases. In the first phase a deep learning based convolution neural network is used for providing segmentation of the whole spine and the second phase has the localization and identification of vertebrae.

Keywords: Spinal Cord, KNN Classification, Deep Learning, Machine Learning.

Introduction:

The central nervous system is the most important processing unit in human anatomy. It manages and controls all the essential organs from head to toe, naming eye blinking, breathing, heart pumping and movement of motion including bending and twisting. The central nervous system has two major organs; the supreme one is the brain, and the subsequent is the spinal cord. The starting point of the spine is the brain stem. The spinal cord is a delicate vertical tube-like pipe with a firm texture that contains a bunch of nerves and tissues.

The spine nerves along with sensory signals transmit information signals to other parts of the body. They are the main

communication system of the human body, as it connects each organ and its response to the brain. The brain, being the processing unit, gets and supplies all the information with the help of the spinal cord. The spine helps in mobility of the body.

1. Vertebrae:

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx as shown in figure. Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. The vertebrae in each region have unique features that help them perform their main functions.

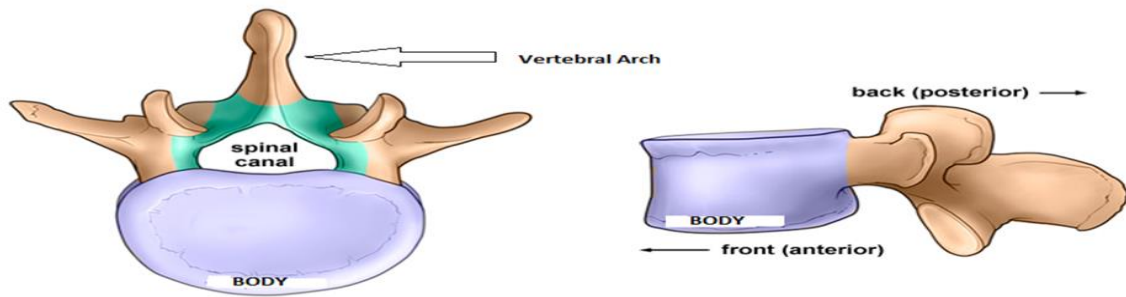


Fig.1 . Spinal Cord Vertebrae Cross Section

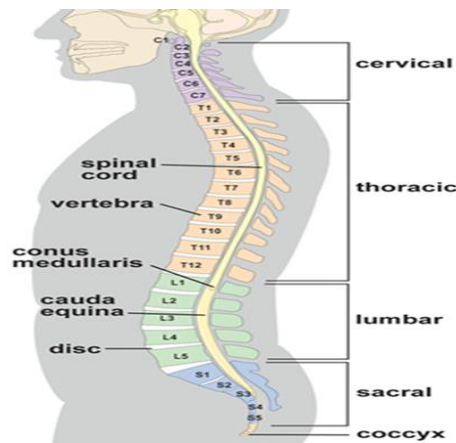


Fig.2 Spinal Chord

2. Spinal Posture Deformities:

The common symptoms that indicate spine problems include weakness, senses loss, sweating, swelling, numbness, bladder control, reflex action, paralysis, and back ache. Taking these symptoms into account, the clinical specialist can identify the affected. Causes behind these issues can be the infection, trauma injury, vascular blockage, bone fracture and tumor.

The deformity of the spine is split into three categories such as

1. Scoliosis: One of the sideways curvature deformities of the spine that occurs commonly during the growth and erupts just before puberty is called scoliosis. Most of the time, cases of scoliosis are mild but with the passage of time, spine scoliosis deformities get severe as a child grows. The severity of scoliosis can lead to disability. Extreme curvature disorders reduce the space within the chest that causes

breathing problems as it affects the functionality of the lungs and heart. Chronic back pain and uneven shoulders, hips and waist are the common symptoms of this case.

2. Kyphosis: Kyphosis is the overelaborated round-back from the cervical region. In simple words, it is a vertebrae wedge-shaped deformity from neck to shoulder. Kyphosis can occur at any age, even in infants, but it is mostly common in older women. There are three types of kyphosis: postural, Scheuermann and congenital

3. Lordosis: If the lower lumbar pelvic curve, which is above the buttocks, arches too far inwards, it is called Lordosis. Lordosis can cause excess pressure on the structure of the spine causing severe pain and discomfort, and it can also affect the subject's movement.

Need of Artificial Intelligence in Spine Research:

One issue with the traditional diagnostic process in spine research is poor interpretation and intervention during patient monitoring who suffers spinal disorders. Consider two patients may have identical imaging studies but they exhibit different symptoms and functional abilities. It will be difficult for physicians to do interpretation and intervention planning. The traditional approach struggles to accurately apply the wealth of collected patient data to do patient care. To have more precise interpretation and to offer better treatment, artificial intelligence inspired applications are becoming so popular. Machine learning algorithms are capable of seemingly stochastic datasets that are challenging for physicians to interpret.

Proposed Methodology:

The proposed work consists of study and implementation of robust and efficient deep learning framework for analysis of spinal medical data.

Objective of Proposed Work:

- Study, analyze and compare various existing machine learning algorithms
- Study, analyze and compare various postero- anterio (PA) and lateral radiographs using machine learning

techniques: Two radiographs CT scan and MRIs will be use for the proposed work. Techniques from supervised and unsupervised machine learning will be implemented for analyzing these radiographs. Evaluation of performance parameters and comparison of results of each technique will be presented

- Implementation of an efficient deep learning based framework for spine research using various machine learning libraries, models and computer programming language
- Evaluation of various parameters related to implemented technique

Result and Discussion:

The aim of the proposed work is to implement an efficient deep learning framework for analysis of spine related medical data. Framework will be implemented for 2D postero-anterior and lateral radiographs such as CT- scan and MRIs. Various parameters like confusion matrix, accuracy, precision, specificity, etc. related to the proposed deep learning model will be evaluated. Quality measures such as Dice Similarity Coefficient (DSC), Recall and Precision values are used to compute similarity between the prediction and the ground truth data.

Epochs	DSC	Recall	Precision
100	85.07	94.25	77.65
200	88.20	93.46	83.61
300	88.29	93.87	83.78



Fig. 3 Segmentation of Spinal Chord



Fig. 4 Identification of Vertebrae using Machine learning Classification

Conclusion:

The proposed implementation of Machine learning classifiers techniques in identification and classification of spinal cord has been studied. For the implementation CT Scan dataset is used and results are generated. It is found that the CNN and KNN model works satisfactorily to identify and segment the vertebrae of the spinal cord.

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