Lumbar Spine Degenerative Classification using Yolov11

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***Abstract*—baki chhe..**

***Index Terms*—baki chhe..**

I. Introduction

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II. Literature Review

The classification of degenerative changes of the lumber spine through deep learning is currently one of the most important topics of research because AI has the capability to improve disease diagnosis and simplify the workflow in clinical settings. This systematic review presents a thorough analysis of seven major studies in the area and looks into the methodologies, datasets, innovations, and clinical impacts of such research.

Lehnen et al. (2021) undertook an initial study on the application of convolutional neural networks (CNNs) for the identification of degenerative changes in MRIs of the lumbar spine. The feasibility study was quite limited in terms of the number and diversity of patients in the dataset. However, it was shown that using such methodology, degenerative conditions like disc degeneration and facet arthropathy could be successfully detected. The need for building larger, more diverse datasets and stronger architectures to address this clinical variability was emphasized.

Hallinan et al. (2021) developed a deep learning technique that can identify and classify central canal stenosis, lateral recess stenosis, and neuropathic foraminal stenosis through lumbar spine MRI. This work integrated multiple CNNs through ensemble learning to enhance the classification accuracy significantly. Furthermore, the utilization of a highly annotative dataset provided from the perspective of radiologists ensured the soundness of the research with respect to clinical validity. This study, therefore, underscores the potential of automated systems to aid radiologists in their involvement in complex diagnostic scenarios, thereby reducing subjectivity and interobserver variability.

The study of Mushtaq et al. (2022) was all about detecting deformities in lumbar spine through hybrid technique: edge-segmentation with deep learning techniques. Such anatomically relevant-algorithm localized vertebrae and detected other spines deformities such as scoliosis and spondylolisthesis. Applying spatial context was the new development from this form of-catching body's parts, which enhanced the fits segmentation accuracy of difficult cases. This is new concept evidence for how domain-specific knowledge were put to undertake in model design towards clinically relevant results.

Trinh et al. (2022) presented a deep learning architecture for identifying lumbar spondylolisthesis from X-ray images. This project was different from other studies that used MRI because it demonstrated the applicability of AI methods to different imaging modalities. Using a specific architecture for a specific modality at the same time enabled the model to overcome the peculiarities of X-ray imaging such as lower resolution and overlapping structures. Most notable is the emphasis placed on developing a lightweight architecture, the suitability of which is optimized for clinical deployment.

Nisar et al. (2024) have taken the research into entirely new territories by combining CNNs with transformers to detect and classify the lumbar intervertebral discs. The hybrid model here demonstrated state-of-the-art results on a large-scale dataset, proving the point that the architecture can capture both spatial and contextual features in one framework. This would not only improve the diagnostic paradigms but also establish the scalability of hybrid architectures for addressing complex medical imaging challenges.

In a related application, Payne et al. (2024) demonstrated a new hybrid methodology to detect the cervical spinal-occupying disease and cord compression using a vision transformer model and rules-based classification. Though this paper focuses on cervical spine imaging, it can draw ideas toward lumbar applications. The study showed the combination of data-driven and rules-based methods in providing high accuracy and interpretability, especially while recognizing the complex abnormality in the spinal region.

III. Methodology

This section describes....

A. Dataset Description

B. Data Pre-processing and Transformation:

C. Model Architecture:

D. Training Process

IV. Results and Discussion

The ability of the model to identify...

TABLE I
COMPARISON OF RESEARCH STUDIES ON MEDICAL IMAGE DATASETS

Study	Dataset Type	Size	Annotations
Lehnen et al. (2021)	MRI scans	Small-scale	Degenerative changes
Hallinan et al. (2021)	Lumbar spine MRI dataset	Medium-scale	Stenosis classifications
Mushtaq et al. (2022)	Lumbar spine dataset	Medium-scale	Vertebral deformities
Trinh et al. (2022)	X-ray images	Medium-scale	Spondylolisthesis
Ruchi et al. (2023)	Multiple MRI datasets	Large-scale	Disease classifications
Nisar et al. (2024)	MRI dataset	Large-scale	Disc classifications
Payne et al. (2024)	Cervical spine MRI	Large-scale	Stenosis and cord compression

TABLE II
STUDY METHODOLOGIES AND UNIQUE FEATURES

Study	Methodology	Unique Features
Lehnen et al. (2021)	CNN-based classification	Feasibility study with small dataset
Hallinan et al. (2021)	Ensemble learning	Radiologist annotations for robustness
Mushtaq et al. (2022)	Hybrid deep learning	Integration of spatial context
Trinh et al. (2022)	Custom CNN for X-ray	Modality-specific optimizations
Ruchi et al. (2023)	Enhanced CNN with ROI	Focused on signal-to-noise improvement
Nisar et al. (2024)	CNN-Transformer hybrid	State-of-the-art performance
Payne et al. (2024)	Vision transformer and rules-based classification	Combined data-driven and rules-based methods

A. Interpretation and Performance Analysis:

B. Comparison with Prior Work:

C. Challenges and Limitations:

D. Applications and Future Work:

CONCLUSION

REFERENCES