International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 571-577 www.ijaem.net ISSN: 2395-5252

A Survey on Cervical Spine Fracture Detection Using Yolo

Mr. K Kishan[1], Aileni Anilkumar[2], Honey Babu[3], S Sai Teja[4]
Assistant Professor, Department of CSE (Artificial Intelligence &Machine Learning)[1]
IVB.Tech Students, Department of CSE (Artificial Intelligence & Machine Learning)[2,3,4]
ACE Engineering College, Hyderabad, Telangana,India

Date of Submission: 15-03-2024 Date of Acceptance: 30-03-2024

ABSTRACT: Accurate detection of cervical spine fractures is crucial for ensuring timely and effective medical intervention. This abstract outline a pioneering method for cervical spine fracture detection, employing a fusion of the YOLO (You Only Look Once) object detection framework and a tailor-made CNN-LSTM model. The implementation of deep learning techniques serves as the cornerstone of this approach, with the primary goal of automating and refining the precision of fracture identification in both cervical spine X-rays and CT scans. Through the strategic utilization of meticulously annotated datasets, we embark on the fine-tuning of the YOLO framework. This process ensures a heightened ability to recognize and precisely localize fracture regions within the complex landscape of medical images. The integration of YOLO, renowned for its efficiency in object detection, and a customized CNN-LSTM model, known for handling sequential data, results in a synergistic system that excels in fracture identification with advanced accuracy.
Keywords: YOLO (You Only Look Once), Deep learning techniques, CNN, CNN-LSTM, X-rays, CT scans, Detection, Cervical Spine Fracture.

I.INTRODUCTION

The cervical chine, which consists of seven parts (C1-C7) of the upper chine, twelve parts (T1-T12), five midriff portions (L1-L5), five holy sections (S1-L5), and a caudal section, makes up the human spine, which is essential for standing erect. Fractures to the cervical spine (CS) can result in severe injury, a high chance of palsy, and a protracted sickness with a high death rate. CS injury diagnosis should be completed quickly and without incarceration. Imaging-based CS screening is the initial stage in evaluating polytraumatized patients. A common and affordable technique for identifying bone fractures in the hand, wrist, hipsterism, pelvis, and CS is X-ray imaging. Less than 3 million cases of CS injuries occur annually in North America, and less than 1 million cases with blunt trauma in the United States. Rapid-fire assessment and management can lower morbidity and mortality in CS injury patients. Doctors are now able to make more thorough diagnoses thanks to the widespread usage of image processing techniques with medical imaging technology like CT. Areas that are hard to view because of other organs can be examined using glamorous resonance imaging. However, the utilisation of additional CT scans is complicated by the fact that conventional cervical spinal radiographs are insufficient to thoroughly assess the cervical chine after significant trauma. Up to 53 out of every 100 cervical chine fractures may go undetected by standard 3-view radiography, which also yields perfectly normal results in more than 8 occurrences of bony cervical chine injuries. Research has been done on artificial intelligence (AI), which is a crucial technology for interpreting radiographic images.

II. LITERATURE REVIEW

The research centered on a thorough investigation into the effectiveness of various methodologieswithin the domain. By scrutinizing pertinent research papers, the aim was to assess a multitude ofapproaches and techniques employed in these areas. This process sought to reveal the nuancedintricaciesandadvancements within the field.

Soaad M. Naguib et al [1]The paper titled "Classification of CS Fracture and Dislocation Using Refined Pre-Trained Deep Model and Saliency Map" presents an approach for the accurate classification of CS (Cervicothoracic) fracture and dislocation using deep learning techniques. The authors utilize two well-known deep learning architectures, namely AlexNet and GoogleNet, as part of their methodology.This is

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 571-577 www.ijaem.net ISSN: 2395-5252

particularly important in medical imaging, where the use of X-ray images is common for diagnosing skeletal injuries.The authors trained their deep learning models on a dataset comprising 2009 X-ray images. This dataset likely includes a variety of CS fracture and dislocation cases to ensure that the models are exposed to diverse examples and can generalize well to unseen cases.The performance evaluation of their proposed approach indicates promising results. The reported accuracy of the system is 93.54%, and the precision is 89.33%. These metrics suggest that the deep learning models developed in this study are effective in accurately classifying CS fractures and dislocations. Accuracy measures the overall correctness of the classification.Furthermore, the mention of a "refined pre-trained deep model" suggests that the authors might have fine-tuned or adapted a pre-existing deep learning model for the specific task of CS fracture and dislocation classification. Additionally, the incorporation of a saliency map suggests an effort to interpret and visualize the regions in the X-ray images that contribute most to the model's decision-making.The accuracy and precision for this method is 93.54%, 89.33%.

J.E. Small et al [2]The paper titled "CT CS Fracture Detection Using a CNN" focuses on the detection of Cervicothoracic (CT) fractures using a Convolutional Neural Network (CNN). In this approach, the authors analyze a dataset comprising a total of 665 investigations. The primary methodology employed in this study is CNN, a popular deep learning architecture commonly used for image classification tasks.The primary objective of the paper is to develop a computer-based system capable of detecting CT fractures from CT scan images. The choice of using a CNN indicates that the authors leveraged the power of deep learning to automatically learn features andpatterns in the input data, in this case, CT images.However, the paper notes a couple of drawbacks in their approach. First, there is no user interface mentioned, suggesting that the system might lack a user-friendly interface for interacting with the developed model. This limitation could impact the ease of use and adoption by healthcare professionals or end-users.Another drawback mentioned is the reported low accuracy of the approach, specifically stated as 92%. While 92% accuracy may still be relatively high, it is considered low in the context of medical imaging tasks where high accuracy is crucial for reliable diagnosis.

Hojjat Salehinejad et al [3]The paper titled "Deep Sequential Learning for CS Fracture Detection on Computed Tomography Imaging" explores the use of deep sequential learning techniques for the detection of Cervicothoracic (CS) fractures in Computed Tomography (CT) imaging.The inclusion of a sizable dataset is crucial for training deep learning models effectively and ensuring their generalization to new, unseen data.The reported results indicate an accuracy of 70.92% for the balanced test dataset and 79.18% for the imbalanced test dataset. The use of both balanced and imbalanced test datasets suggests that the model's performance is evaluated under different scenarios, accounting for potential class imbalances in real-world applications. It's worth noting that the reported accuracy values, while not exceptionally high, may be considered reasonable, depending on the complexity of the task and the difficulty of detecting CS fractures in CT imaging. The challenges associated with medical image analysis, including the presence of noise and variability in patient anatomy, can make achieving very high accuracy a challenging task.

Raphael MartusMarcon et al [4] The title enhancement in Fractures of the CS was given by the authors for this approach. The methodology used here is diagnosis, classification. They divided the CS into upper CS and lower CS. They archived the exact diagnosis and classification of a lesion.

Sebastian Hartmann et al[5]The paper titled "Analysis of the Literature on CS Fractures in Ankylosing Spinal Disorders" focuses on the examination of existing literature to analyze cervical spine (CS) fractures in individuals with Ankylosing Spinal Disorders (ASDs).The primary methodology employed in this study is an extensive search on PubMed, a widely used database of biomedical literature. This suggests that the authors conducted a thorough review of existing research articles, reviews, case reports, and other relevant literature related to cervical spine fractures in individuals with ankylosing spinal disorders.The key objective of the paper appears to be a comprehensive analysis of the literature to gain insights into the characteristics, diagnostic challenges, and clinical outcomes associated with cervical spine fractures in the context of ankylosing spinal disorders. One of the notable findings mentioned in the brief overview is that delayed analysis of cervical fractures in individuals with ankylosing spinal disorders contributed to initially misinterpreted clinical symptoms. This observation suggests that there may be specific challenges or nuances in the diagnosis and interpretation of cervical spine fractures in the context of ankylosing spinal disorders, potentially leading to delayed recognition and appropriate management.

Arunnit Boonrod et al[6]The paper titled "Diagnostic accuracy of deep learning for evaluation of C-spine injury from lateral neck radiographs" focuses on the diagnostic accuracy of deep learning techniques, particularly using the You Only Look Once (YOLO) architecture, for assessing cervical spine (C-spine) injuries from lateral neck radiographs.The methodology chosen for this approach involves the use of YOLO, including versions 2, 3, and 4. YOLO is a popular object detection algorithm that can be trained to identify and locate objects within images. The authors applied their deep learning model to a dataset consisting of 229 lateral neck radiographs obtained from 625 patients. This dataset likely includes a variety of cases related to C-spine injuries, and it is essential for training and evaluating the deep learning model's performance. The reported diagnostic accuracy values for the deep learning model are 80%, 72%, and 75%. These accuracy figures represent the model's ability to correctly identify and classify C-spine injuries in the lateral neck radiographs. It's worth noting that deep learning models in medical imaging tasks often face challenges due to variations in anatomy, image quality, and the complexity of detecting specific abnormalities.

Dong-Min Sonet al [7]The paper titled "Automatic Detection of Mandibular Fractures in Panoramic Radiographs Using Deep Learning" presents an approach for the automatic detection of mandibular fractures in panoramic radiographs using deep learning techniques.The primary methodology employed in this study involves the use of a deep learning system, specifically implementing the You Only Look Once (YOLO) architecture. YOLO is an object detection algorithm that can efficiently identify and locate objects within an image. In this case, the authors leverage YOLO for the automatic detection of mandibular fractures in panoramic radiographs.

Alexey Zakharov et al [8]The paper titled "Interpretable Vertebral Fracture Quantification Via Anchor-Free Landmarks Localization" introduces a novel approach for quantifying vertebral fractures with a focus on interpretability. Employing a new soft-argmax method, the authors utilize anchor-free landmarks localization, indicating the identification of key points without predefined anchors. Aims to enhance transparency and understanding of the model's decision-making process, particularly crucial in medical applications. The results, obtained through 5-fold cross-validation, showcase the method's potential effectiveness in vertebral fracture quantification. The contribution lies not only in accuracy but also in providing insights into the specific features influencing the model's predictions. This research represents a valuable step towards interpretable and clinically applicable vertebral fracture assessment in the domain of medical imaging and computer-aided diagnosis.

Kong SH et al[9]The paper titled "Development of a Spine X-Ray-Based Fracture Prediction Model Using a Deep Learning Algorithm**"**. The methodology incorporates Convolutional Neural Networks (CNN) and DeepSurv, demonstrating a fusion of image-based and clinical information for enhanced predictive accuracy. By training the model on both X-ray images and relevant clinical data, the approach signifies a comprehensive strategy to capture diverse factors influencing fracture prediction. The inclusion of DeepSurv suggests a consideration of time-related aspects, indicating a survival analysis approach to fracture prediction. The reported accuracy of 74.4% showcases the model's moderate success in predicting fractures, aligning with the challenges associated with predicting complex medical outcomes. This research contributes to the evolving intersection of medical imaging and predictive modeling, offering a potential tool for early identification of individuals at risk for spine fractures based on a holistic integration of radiological and clinical information. Further exploration and refinement of this model could potentially enhance its utility in clinical practice for proactive fracture risk assessment.

G. Sha et al [10]The paper titled "Detection of Spinal Fracture Lesions based on Improved Yolov2 addresses the detection of spinal fracture lesions using a combination of Convolutional Neural Networks (CNN) and an improved version of the YOLOv2 (You Only Look Once) algorithm. The methodology involves training the model on a dataset of CT scan images, emphasizing the significance of advanced imaging techniques in spinal fracture diagnosis. The use of YOLOv2, a state-of-the-art object detection algorithm, highlights the effectiveness of real-time processing for identifying fracture lesions within the complex CT scan images. The authors propose enhancements to YOLOv2, possibly tailored to improve accuracy and efficiency in detecting spinal fractures.The reported accuracy of 86.63% suggests a high level of success in the automated detection of spinal fracture lesions using their proposed method. This research contributes to the domain of medical imaging and computer-aided diagnosis, offering a potentially valuable tool for clinicians to expedite and enhance the accuracy of spinal fracture identification through automated analysis

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 571-577 www.ijaem.net ISSN: 2395-5252

of CT scans. The utilization of deep learning techniques, particularly the combination of CNN and YOLO, showcases the ongoing efforts to harness advanced technologies for more effective and efficient medical image analysis.

Table 1: The comparison of literature reviews

Paper	Year	Technique/Methodology	Pros	Cons
1.	2023	Classification of Cervical Spine Fracture and Dislocation Using Refined Pre-Trained Deep Model and Saliency Map	Introduces a refined pre-trained deep model and utilizes saliency maps for cervical spine fracture classification	Lack of detailed information makes it challenging to assess specific strengths and weaknesses.
2.	2021	CT Cervical Spine Fracture Detection Using a Convolutional Neural Network	Utilizes a Convolutional Neural Network for CT cervical spine fracture detection, potentially improving accuracy and efficiency.	No user interface and low accuracy.
3.	2020	Deep Sequential Learning for Cervical Spine Fracture Detection on Computed Tomography Imaging	Introduces a deep sequential learning approach for cervical spine fracture detection on CT imaging, potentially enhancing diagnostic accuracy.	The validations and bidirectional approach are not accurate and have less accuracy.
4.	2013	Fractures of the cervical spine	Provides insights into fractures of the cervical spine, potentially contributing to a better understanding of the clinical aspects and management.	Accurate location of fractures is not displayed which led to serious issues.
5.	2017	Analysis of the Literature on Cervical Spine Fractures in Ankylosing Spinal Disorders	Offers an analysis of the literature on cervical spine fractures in ankylosing spinal disorders, potentially providing valuable insights for clinicians and researchers.	Delayed diagnosis of cervical fractures. Inadequate imaging techniques.
6.	2022	Diagnostic accuracy of deep learning for evaluation of C-spine injury from lateral neck radiographs	Investigates the diagnostic accuracy of deep learning for evaluating cervical spine injuries from lateral neck radiographs, potentially	The findings may not be as broadly applicable as they could be due to the modest size of the dataset.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 571-577 www.ijaem.net ISSN: 2395-5252

			contributing to advancements in diagnostic methods.	
7.	2021	Automatic Detection of Mandibular Fractures in Panoramic Radiographs Using Deep Learning	Introduces automatic detection of mandibular fractures in panoramic radiographs using deep learning, potentially enhancing diagnostic efficiency.	The dataset is fairly small, which may limit the generalizability of the findings. The study did not evaluate the impact of the system on clinical decision-making or patient outcomes.
8.	2022	Interpretable vertebral fracture quantification via anchor-free landmarks localization	Proposes interpretable vertebral fracture quantification through anchor-free landmarks localization, potentially improving accuracy and interpretability.	The algorithm is only able to detect and quantify vertebral body compression fractures. It is important to develop algorithms that can detect and quantify other types of vertebral fractures.
9.	2022	Development of a Spine X-Ray-Based Fracture Prediction Model Using a Deep Learning Algorithm	Develops a spine X-ray-based fracture prediction model using a deep learning algorithm, potentially contributing to improved fracture risk assessment.	The dataset is kind of fragile, which may confine the generalizability of the holdings. The study did not evaluate the performance of the model on real-world data, such as X-ray images obtained from emergency departments or trauma centers.
10.	2020	Detection of Spinal Fracture Lesions based on Improved Yolov2	Introduces a method for detecting spinal fracture lesions based on an improved YOLOv2, potentially enhancing accuracy in lesion detection.	The study did not evaluate the performance of the model on real-world data, such as spine CT images obtained from hospitals.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 03 Mar. 2024, pp: 571-577 www.ijaem.net ISSN: 2395-5252

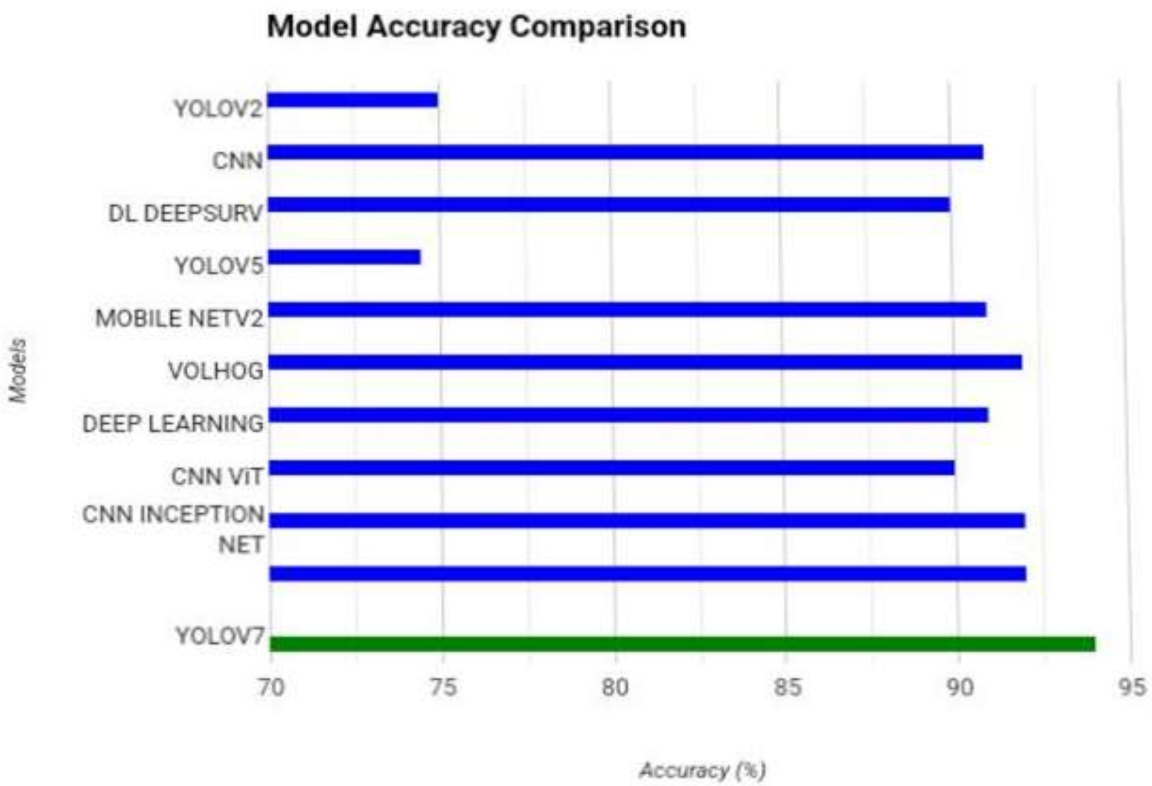

Fig 1: Accuracy for different methodologies

III.CONCLUSION

The RSNA 2022 CS Fracture Detection project stands as a testament to the collaborative synergy and technological innovation within the medical imaging domain. This ambitious endeavor united RSNA, ASNR and ASSR, harmonizing their efforts to explore the integration of artificial intelligence into the intricate process of detecting and localizing CS fractures. At the core of this project lies a meticulously curated dataset, comprising around 3,000 CT studies gathered from twelve diverse sites across six continents.This extensive dataset serves as a treasure trove of information, meticulously annotated by spine radiology specialists affiliated with ASNR and ASSR. Their expert-level annotations provide intricate insights into the presence, vertebral level and specific location of CS fractures within the studies. The richness of this dataset, covering a diverse range of cases, ensures its representativeness, establishing it as a valuable resource for the development and evaluation of machine learning models.

IV. ACKNOWLEDGEMENT

We would like to thank our guide **Mr. K KISHAN** for his continuous support and guidance Assistant Professor, Department of CSE (Artificial Intelligence & Machine Learning), and **Mr. SHASHANK TIWARI,** Assistant Professor, Project Coordinator and we profoundly thank **Dr. KAVITHA SOPPARI**, head of the Department CSE(Artificial Intelligence & Machine Learning) for her guidance and continuous support.

REFERENCES

[1]. Soaad M. Naguib, Hanaa M. Hamza, Khalid M. Hosny, Mohammad K. Saleh and Mohamed A. Kassem**.** “Classification of Cervical Spine Fracture and Dislocation Using Refined Pre-Trained Deep Model and Saliency Map”, Diagnostics (Basel), vol. 13, no. 7, pp. 1273, 2023 Apr, doi: 10.3390 / diagnostics 13071273.

[2]. J.E. Small, P. Osler, A.B. Paul and M. Kunsta, "CT Cervical Spine Fracture Detection Using a Convolutional Neural Network", AJNR Am J Neuroradiol, vol. 42, no. 7, pp. 1341-1347, 2021 Jul, doi: 10.3174/ajnr.A7094.

[3]. Hojjat Salehinejad, Edward Ho, Hui-Ming Lin, Priscila Crivellaro, Oleksandra Samorodova, Monica Tafur Arciniegas, Zamir Merali, Suradech Suthiphosuwan, Aditya Bharatha,

Kristen Yeom, Muhammad Mamdani, Jefferson Wilson, Errol Colak, "Deep Sequential Learning for Cervical Spine Fracture Detection on Computed Tomography Imaging", Oct 2020, doi: https://doi.org/10.48550/arXiv. 2010.13336.

[4]. Raphael MartusMarcon, Alexandre FogaçaCristante, William Jacobsen Teixeira, Douglas Kenji Narasaki, ReginaldoPerilo Oliveira, Tarcísio Eloy Pessoa de Barros Filho, "Fractures of the cervical spine", vol. 68, no.11, pp. 1455-1461, Jan. 2013, doi: 10.6061/clinics/2013(11)12.

[5]. Sebastian Hartmann, AnjaTschugg, ChristophWipplinger, Claudius Thomé, "Analysis of the Literature on Cervical Spine Fractures in Ankylosing Spinal Disorders", in Medical University of Innsbruck, vol. 7, no. 5, pp. 469-481, Aug. 2017, doi: 10.1177/2192568217700108.

[6]. Arunnit Boonrod, Artit Boonrod, Atthaphon Meethawolgul a, Prin Twinprai, "Diagnostic accuracy of deep learning for evaluation of C-spine injury from lateral neck radiographs", vol. 8, no. 8, pp. 2405-8440, August 2022, doi: https://doi.org/10.1016/j.heliyon.2022.e10372.

[7]. Dong-Min Son, Yeong-Ah Yoon, Hyuk-Ju Kwon, Chang-Hyeon An and Sung-Hak Lee, "Automatic Detection of Mandibular Fractures in Panoramic Radiographs Using Deep Learning", vol. 11, no. 6, pp. 933, May 2021, doi: https://doi.org/10.3390/diagnostics11060933.

[8]. Alexey Zakharov, Maxim Pisov, AlimBukharaev, Alexey Petraikin, Sergey Morozov, Victor Gombolevskiy, Mikhail Belyaev, "Interpretable vertebral fracture quantification via anchor-free landmarks localization", Medical Image Analysis, vol. 83, pp. 1361-8415, doi: https://doi.org/10.1016/ j.media.2022.102646.

[9]. Kong SH, Lee JW, Bae BU, Sung JK, Jung KH, Kim JH, Shin CS, "Development of a Spine X-Ray-Based Fracture Prediction Model Using a Deep Learning Algorithm", EndocrinolMetab (Seoul), vol. 37, no. 4, pp. 674-683, 2022 Aug, doi: 10.3803/EnM.2022.1461.

[10]. G. Sha, J. Wu and B. Yu, "Detection of Spinal Fracture Lesions based on Improved Yolov2," 2020 IEEE International Conference on Artificial Intelligence and Computer Applications (ICAICA), pp. 235-238, 2020, doi: 10.1109/ICAICA50127.2020.9182582.