Automated Bone Fracture detection using YOLOv8

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***Abstract*—In medical diagnostics, detection of bone fracture is very crucial. It require time and accurate treatment of that injuries. Previous methods for bone fracture detection are X-ray in which analyzes the fracture by the help of radiations. It is time consuming and prone to human error. To address these limitations we used an automated approach for detection of bone fracture is yolov8. It is deep learning model for real time object detection. Its well suited for medical imagining because its architecture give more accuracy and speed. Our results show YOLOv8 achieve high accuracy and speed from the traditional methods. It is also more reliable. Since it is less time consuming and give the consistent results so it can be used in healthcare. It is possible that its efficiency can be enhance , minimize errors. This study shows the potential of deep learning model like YOLOv8 in diagnostics and medical imaging particularly in bone fracture detection**

***Index Terms*—Machine learning, cnn, deep learning, object detection, image classification**

I. Introduction

The detection of bone fracture is one of the important tasks in the medical field where accuracy plays a key role such as accurate identification of different fractures create significant impact in diagnosis. There are many traditional ways to bone fracture detection diagnosis such as X-ray, CT scan, MRI's [1]. These methods are good but heavily required manual expertise of doctors and this can lead to major err in the diagnosis. To improve the accuracy of diagnosis of bone fracture, there is an introduction of artificial intelligence techniques especially the deep learning for highly efficient results. YOLO (You Only Look Once) is the most popular algorithm for bone fracture detection due to its accurate detection of fracture in images. This advances YOLO model can be used in medical imaging as it does detection of object in a single regression problem such as a person height is predicted based on age which make this model highly efficient and accurate, irrespective of traditional models in which images are processed in multiple stages. In terms of bone fracture YOLO model can be trained with dataset of traditional methods like X-ray or CT scan where the location of fracture is marked which helps in identifying fracture in different part of body in short interval of time. Hence, this tool is valuable in minimizing the chances of missed fractures

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II. Related Work

A. Model

The deep learning algorithm has become more popular in detecting bone fractures because of its accuracy and speed compared to traditional methods of detecting fractures, which include x-rays, MRIs, and others. Many researchers have addressed how these models can detect fractures from x-ray images. There are advanced algorithms, such as convolutional neural networks paired with the Canny edge algorithm [2], that give highly accurate results and process data very quickly. These advanced algorithms help detect fractures in various areas, such as the wrist, skull, and vertebrae. The algorithms easily analyze medical images in a quicker and more efficient manner. The highly advanced model VERTE-X [6] has enhanced the detection of spinal cord fractures with its improved decision-making capabilities. The ensemble deep learning model improved the detection of distal radius fractures [5], with very high accuracy, outperforming radiology. The study of the Retina Net model pointed to challenges in detecting fractures near blood vessels and the eye socket [3]. Additionally, there is a highly accurate deep learning model for detecting skull fractures in children (Paediatric Skull Fracture), which allows for accurate diagnosis in emergency situations [9]. While deep learning models excel at diagnosing bone fractures from x-rays, they still face challenges in recognition, classification, detection, and locating fractures [1].

Despite these advancements, several challenges remain. One significant issue with deep learning models is that they function like "black boxes," meaning their decision-making process is not fully transparent, which makes it difficult for doctors [10] to trust and rely on them. Moreover, these models are not easily integrated into hospital settings due to the complexity of the data requirements. In the healthcare sector, where transparency is critical, it is important for doctors to understand why a particular diagnosis is made. In the future, it is essential to address these challenges by making models more interpretable and combining them with additional information, such as patient data and lab results, to improve their robustness and reliability. This would make these tools more accessible to doctors in their day-to-day work.

B. YOLO

The YOLO (You Only Look Once) model has made the great progress in the field of object detection at the time of its introduction. The first YOLO model was developed by Redmon et al which works as a single regression problem where one thing is dependent on some another thing [1]. With the time new versions came such as YOLOv3 and YOLOv5 with necessary improvements in them such as there was an integration of residual modules due to which its accuracy in detection increases and can be used in the complex environments[3]. Later there was a model called YOLO-LITE which was especially designed for while maintaining efficiency of the model[2].It was mainly designed for use on non-GPU devices. YOLO v8 is one of the latest version of YOLO which use optimised architecture for the advancement in the speed and efficiency of object detection. Yolov8 is particularly designed for challenging environments such as low light conditions. Yolo works on grid structure such as it divides into different grids and then study each part simultaneously . This reduces the chances of small errors. Irrespective of these evolution, continues efforts are being done by researchers to make this model applicable for real-world applications such as autonomous driving[4].The main aim of doing different kind of researches to make this model capable of detecting overlapping models.

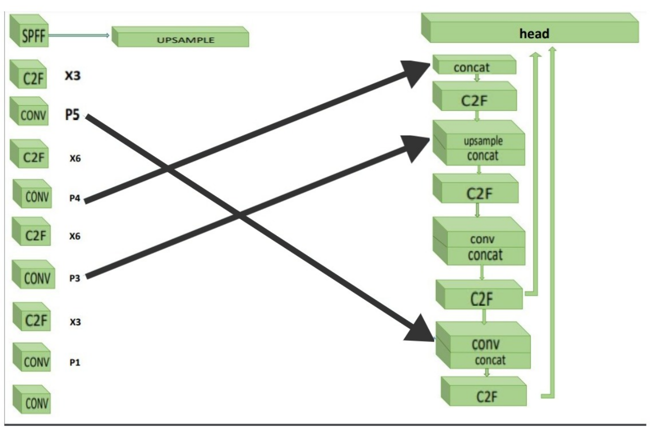

Fig. 1. YOLOv8 Architecture

III. PROPOSED MODEL

YOLO v8 is the latest version for the object detection and image segmentation that is well known for the speed and accuracy. It depends on the on the Yolo model which helps in performance optimization in real time. There are various updation in Yolo v8 which includes task flexibility , architecture improvement . It can adapt with different datasets. As yolo model use multiple neural network but yolo v8 works on single neural network so that it can predict the entire image . It also predicts bounding boxes and class labels simultaneously. Due to this reason it becomes better compared to multiple neural network. For better extraction, it use advance technologies like CSP(Cross Stage Partial) and PANet(Path Aggregation Network) due to which it gives more precise results. Main feature of YOLOv8 is that it is compatible with many deep learning frameworks like PyTorch and many others. It also provides user friendly interface for training and deployment. It also boasts scalability, with versions tailored for different hardware constraints (e.g., YOLOv8-nano for mobile devices). This model has option to pre-trained weights on domain-specific datasets due to which it is highly customizable. This helps to provide efficient performance across various industries like healthcare(i.e. detecting abnormalities in medical scan). It has a reliable real time efficiency hence it cam also be used in autonomous systems and crop monitoring.

IV. RESULTS

A. Material

1) Software and Hardware: Gpu(Goggle Colab environment)this enables the efficeint training and interface for deep learning model

2) Software and Tool: Yolov8 is implemented on the tensorflow framework.It is well known for its accuracy and speed

Other libraries that are used in this like cnn, deep learning etc

3) Evaluation Criteria: There are various factors for the evaluation ofe the results like F1-curve, Precision, map(50)

The f1 is the harmonic mean of precision and accuracy. A high f1 show there is good trade-off.

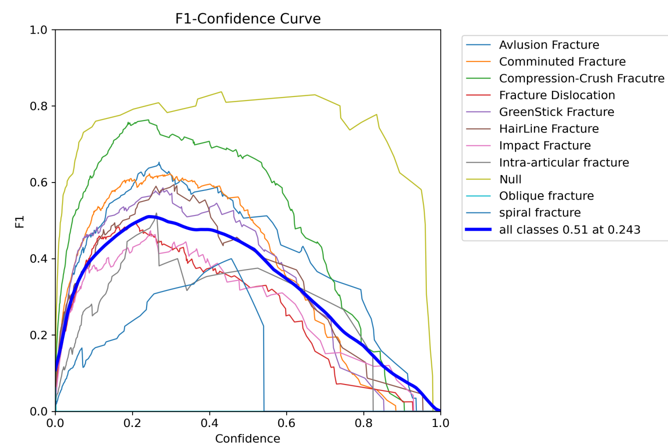

Fig. 2. F1-Confidence Curve

B. Analytics

1) YOLOv8 model: The YOLOv8 is a major advancement in detection of object and segmentation of image . It is just like a predecessors of YOLO versions. It is basically designes for its high efficiency, scalability, accuracy. It has done some architectural improvements for higher precision in detection thus it becomes suitable for real-time applications in various domains such as healthcare and retail. There are various modifiactions done in YOLOv8 that helps in improved detection in challenging time with limited data like it has a refined backbone network and enhanced anchore-free detection head. The key advantage of yolov8 is its adaptability. It supports range of pre-trained weightd that helps in fine-tuning in specific task, making it accessible to researchers. The yolov8 is compatible with modern deep learning concept which helps in integration into existing pipelines. It balances accuracy and speed in constrained environment. It also addresses biasness in trained data and ensure robustness against various attacks. The yolov8 becomes pivotal in evolution of detection of object. Its advancement ensure the machine learning to address real-worls challenges. It drives innovation across industries. It gives the strong foundation for the coming developersin fields like computer vision.

2) Model Training : The model is trained on the 100 epochs which takes approx 0.881 hours time for completion and after the completion the results are :

Class	Images	Instances	Box P	Box R	mAP50	mAP50-95
All	399	557	0.633	0.5	0.49	0.22
Avulsion fracture	46	57	0.651	0.639	0.592	0.180
Comminuted fracture	87	137	0.666	0.569	0.613	0.225
Compression fracture	63	82	0.754	0.748	0.742	0.353
Fracture dislocation	57	79	0.456	0.457	0.396	0.133
Greenstick fracture	37	66	0.622	0.53	0.546	0.191
Hairline fracture	31	44	0.655	0.523	0.54	0.206
Impact fracture	39	47	0.456	0.468	0.407	0.163
Intra-articular fracture	10	13	0.543	0.462	0.406	0.159
Null	21	22	0.755	0.864	0.842	0.696
Oblique fracture	1	2	1.0	0.0	0.0439	0.0319
Spiral fracture	6	8	0.4	0.25	0.264	0.068

TABLE I
RESULTS AFTER TRAINING DATASET

The model demonstrated strong performance in detecting bone fractures. Evaluation metrics included precision, recall, and F1-score. Figures 7 and 8 illustrate the F1 curve and precision curve, respectively, showcasing the model's effectiveness.

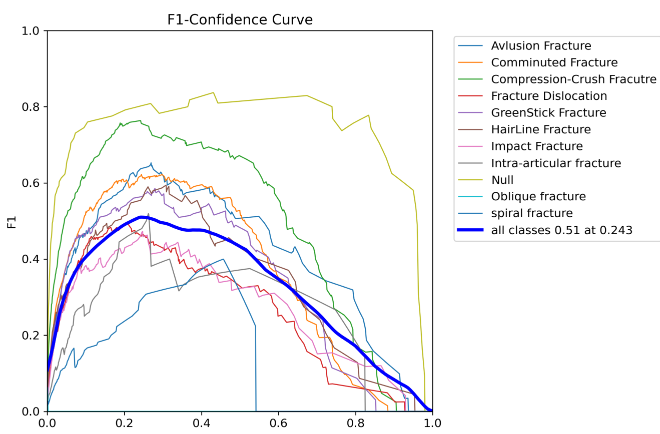

Fig. 3. F1-Confidence Curve

The model achieved a mAP50 score of 0.478.

YOLO v8 demonstrated strong performance in detecting bone fractures. The evaluation metrics include precision, recall, and F1-score. Figures 7 and 8 highlight the F1 curve and precision curve, respectively, showcasing the model's effectiveness. The model summary is as follows: - 261 layers - 8,364,640 parameters - 8,364,624 gradients - 19.3 GFlops

The model achieved a mAP50 score of 0.485.

The below table shows the results after training the dataset:

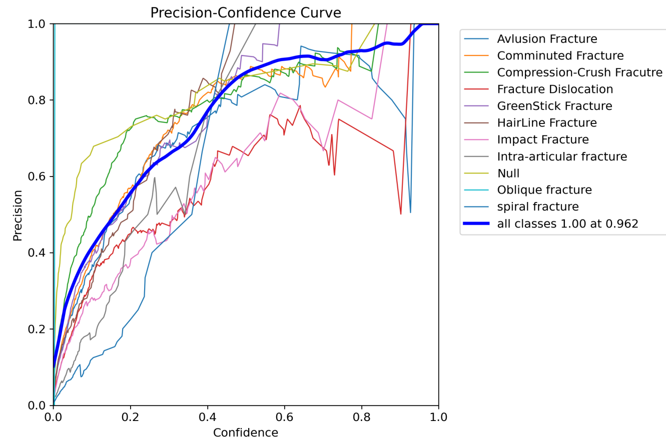

Fig. 4. Precision-Confidence Curve

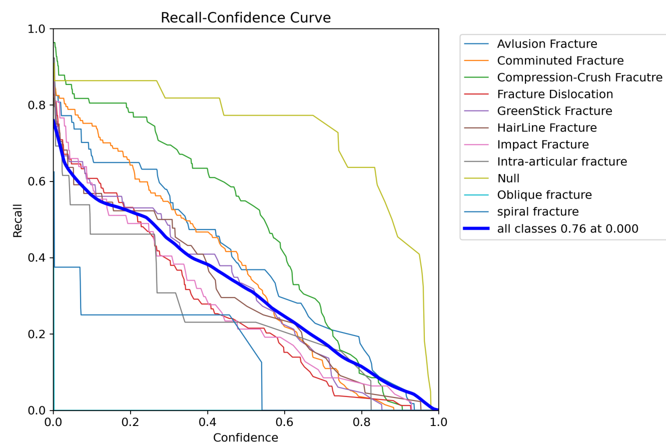

Fig. 5. Recall-Confidence Curve

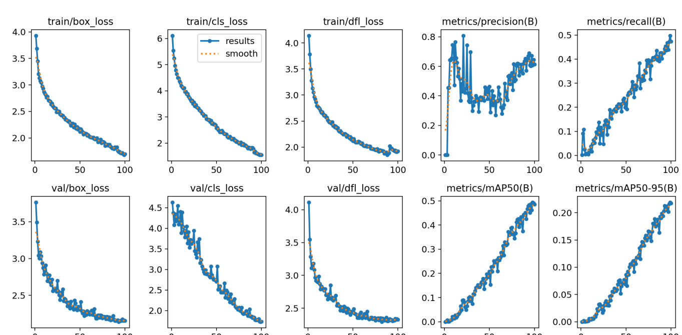

Fig. 6. Final Results

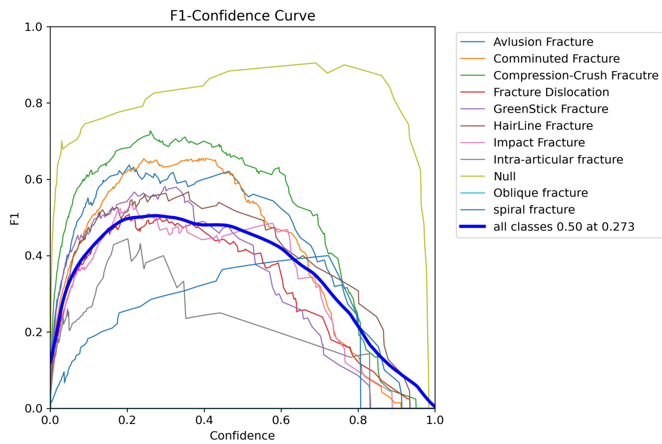

Fig. 7. F1-Confidence Curve

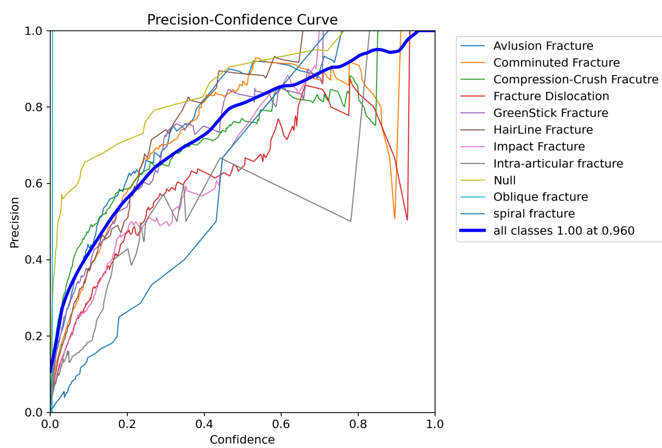

Fig. 8. Precision-Confidence Curve

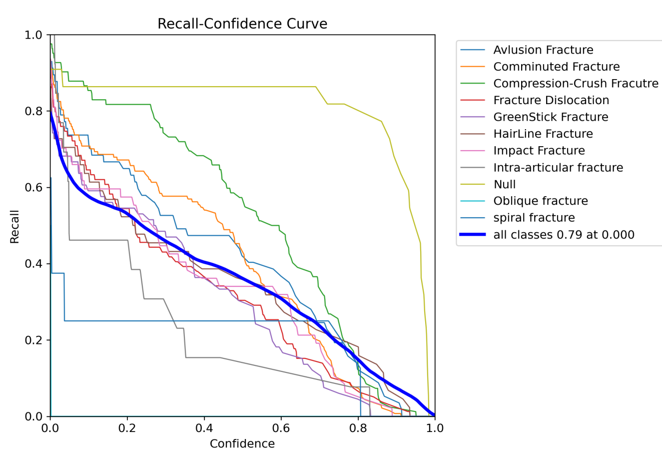

Fig. 9. Recall-Confidence Curve

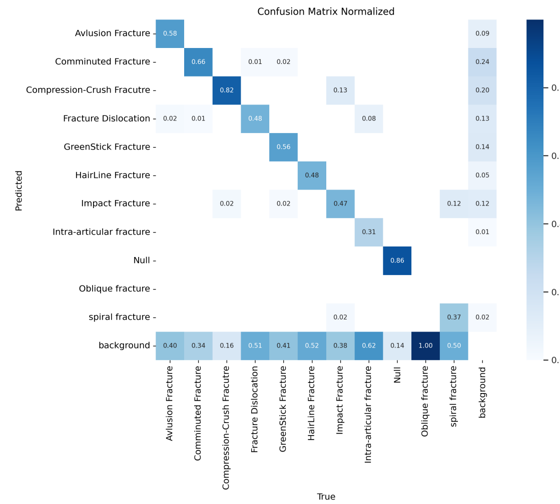

Fig. 10. Normalized Confusion Matrix

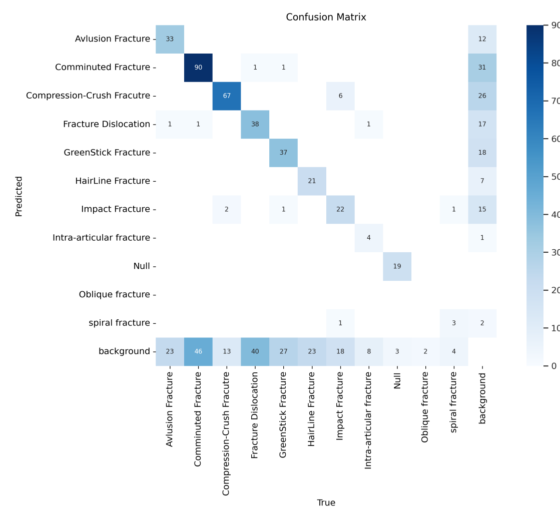

Fig. 11. Confusion Matrix

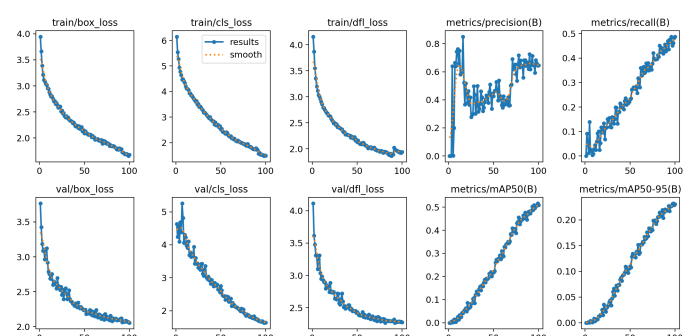

Fig. 12. Final Results

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TABLE II
RESULTS AFTER TRAINING DATASET

V. CONCLUSION

The YOLOv8 is a major advancement in detection of object and segmentation of image . It is just like a predecessors of YOLO versions. It is basically designes for its high efficiency, scalability, accuracy. It has done some architectural improvements for higher precision in detection thus it becomes suitable for real-time applications in various domains such as healthcare and retail. There are various modifiactions done in YOLOv8 that helps in improved detection in challenging time with limited data like it has a refined backbone network and enhanced anchore-free detection head. The key advantage of yolov8 is its adaptability. It supports range of pre-trained weightd that helps in fine-tuning in specific task, making it accessible to researchers. The yolov8 is compatible with modern deep learning concept which helps in integration into existing pipelines. It balances accuracy and speed in constrained environment. It also addresses biasness in trained data and ensure robustness against various attacks. The yolov8 becomes pivotal in evolution of detection of object. Its advancement ensure the machine learning to address real-worls challenges. It drives innovation across industries. It gives the strong foundation for the coming developersin fields like computer vision.

REFERENCES

[1] Z. Su, A. Adam, M. F. Nasrudin, M. Ayob, and G. Punganan, “Skeletal Fracture Detection with Deep Learning: A Comprehensive Review,” Diagnostics, vol. 13, no. 20. MDPI AG, p. 3245, Oct. 18, 2023. doi: 10.3390/diagnostics13203245.

[2] D. P. Yadav, A. Sharma, S. Athithan, A. Bhola, B. Sharma, and I. B. Dhaou, “Hybrid SFNet Model for Bone Fracture Detection and Classification Using ML/DL,” Sensors, vol. 22, no. 15. MDPI AG, p. 5823, Aug. 04, 2022. doi: 10.3390/s22155823.

[3] T. S. Jeong, G. T. Yee, K. G. Kim, Y. J. Kim, S. G. Lee, and W. K. Kim, “Automatically Diagnosing Skull Fractures Using an Object Detection Method and Deep Learning Algorithm in Plain Radiography Images,” Journal of Korean Neurosurgical Society, vol. 66, no. 1. Korean Neurosurgical Society, pp. 53–62, Jan. 01, 2023. doi: 10.3340/jkns.2022.0062.

[4] T. Meena and S. Roy, “Bone Fracture Detection Using Deep Supervised Learning from Radiological Images: A Paradigm Shift,” Diagnostics, vol. 12, no. 10. MDPI AG, p. 2420, Oct. 07, 2022. doi: 10.3390/diagnostics12102420.

[5] J. Zhang et al., “Deep learning assisted diagnosis system: improving the diagnostic accuracy of distal radius fractures,” Frontiers in Medicine, vol. 10. Frontiers Media SA, Aug. 17, 2023. doi: 10.3389/fmed.2023.1224489.

[6] N. Hong et al., “Deep-Learning-Based Detection of Vertebral Fracture and Osteoporosis Using Lateral Spine X-Ray Radiography,” Journal of Bone and Mineral Research, vol. 38, no. 6. Oxford University Press (OUP), pp. 887–895, Dec. 01, 2020. doi: 10.1002/jbmr.4814.

[7] V. S. Navale, “Bone Abnormalities Detection and Classification Using Deep Learning-Vgg16 Algorithm,” International Journal for Research in Applied Science and Engineering Technology, vol. 11, no. 7. International Journal for Research in Applied Science and Engineering Technology (IJRASET), pp. 122–129, Jul. 31, 2023. doi: 10.22214/ijraset.2023.54582.

[8] M. Motohashi et al., “A New Deep Learning Algorithm for Detecting Spinal Metastases on Computed Tomography Images,” Spine, vol. 49, no. 6. Ovid Technologies (Wolters Kluwer Health), pp. 390–397, Dec. 12, 2023. doi: 10.1097/brs.0000000000004889.

[9] J. W. Choi et al., “Deep Learning-Assisted Diagnosis of Pediatric Skull Fractures on Plain Radiographs,” Korean Journal of Radiology, vol. 23, no. 3. The Korean Society of Radiology, p. 343, 2022. doi: 10.3348/kjr.2021.0449.

[10] D. Mishra and A. K. Mishra, “Evolution of Artificial Intelligence in Bone Fracture Detection,” International Journal of Reliable and Quality E-Healthcare, vol. 11, no. 2. IGI Global, pp. 1–17, Jul. 29, 2022. doi: 10.4018/ijrqeh.299958.

[11] B. Pujitha, undefined., et al. ”Detection of Bone Fracture Using Deep Learning,” in 2024 International Conference on Emerging Systems and Intelligent Computing (ESIC), pp. 703-708, 2024.

[12] Sailaja Thota, undefined., et al. ”Deep Learning based Bone Fracture Detection,” in 2024 International Conference on Smart Systems for applications in Electrical Sciences (ICSSES), pp. 1-7, 2024.

[13] Rutvik Kapse, undefined., et al. ”Image Processing for Detecting Bone Fractures,” in 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), pp. 1297-1302, 2023.

[14] N. S. Sriveni, undefined., et al. ”Detecting Bone Fracture in Medical Images,” in Journal of Physics: Conference Series, vol. 1770, 2021.

[15] undefined. Tanushree Meena, undefined. S. Roy. ”Bone Fracture Detection Using Deep Supervised Learning from Radiological Images: A Paradigm Shift,” in Diagnostics, vol. 12, 2022.

[16] Rachel Y L Kuo, undefined., et al. ”Artificial Intelligence in Fracture Detection: A Systematic Review and Meta-Analysis.,” in Radiology, pp. 211785 , 2022.

[17] undefined. O. Bandyopadhyay, undefined. A. Biswas, undefined. B. Bhattacharya. ”Long-bone fracture detection in digital X-ray images based on digital-geometric techniques,” in Computer methods and programs in biomedicine, vol. 123, pp. 2-14 , 2016.

[18] Filza Akhlaq, undefined., et al. ”Diving Deep into Bone Anomalies on the FracAtlas Dataset Using Deep Learning and Explainable AI,” in 2024 International Conference on Engineering Computing Technologies (ICECT), pp. 1-6, 2024.

[19] undefined. Gerardo Meza, undefined. Deepak Ganta, undefined. Sergio Gonzalez Torres. ”Deep Learning Approach for Arm Fracture Detection Based on an Improved YOLOv8 Algorithm,” in Algorithms, 2024.

[20] Chun-Tse Chien, undefined., et al. ”YOLOv8-AM: YOLOv8 Based on Effective Attention Mechanisms for Pediatric Wrist Fracture Detection,” in Journal is required!, 2024.