Dental Disease Detection and Classification using Deep Learning Yolo8

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ABSTRACT

Dental diseases such as dental caries, periodontal disease, periapical lesions, and impacted teeth are among the most prevalent oral health problems worldwide. Early and accurate diagnosis is essential to prevent severe complications; however, manual examination of dental radiographs is time-consuming and subject to inter-observer variability. In existing systems, Convolutional Neural Networks (CNNs) are widely used for image-based dental disease classification, achieving reasonable accuracy but lacking precise localization of diseased regions.To address these limitations, this research proposes a YOLOv8-based deep learning framework for dental disease detection and localization using dental radiographic images. While CNN models focus on image-level classification, YOLOv8 performs real-time object detection, enabling both disease identification and spatial localization. Experimental analysis demonstrates that the proposed YOLOv8 model outperforms traditional CNN-based approaches in terms of detection accuracy, inference speed, and robustness, making it suitable for automated dental diagnostic assistance systems.

Keywords: Dental Disease Detection, Deep Learning, Convolutional Neural Network (CNN), YOLOv8, Medical Image Analysis, Dental Radiographs.

I. INTRODUCTION

Excess prepared food from restaurants often goes to waste due to lack of efficient, immediate channels to redistribute it to nearby users or charitable organizations. Restaurants usually lack a low-effort platform to publish short-lived surplus, and potential recipients lack a quick, reliable way to find and request such food. This project addresses the need for a lightweight, cloud-backed food sharing platform to connect supply and demand efficiently and safely.

Oral health plays a crucial role in overall human well-being, with dental diseases affecting a significant portion of the global population. Dental caries, gingivitis, periodontal diseases, and periapical lesions are commonly diagnosed through radiographic imaging such as bitewing, periapical, and panoramic X-rays. Accurate interpretation of these images requires clinical expertise, and misdiagnosis can lead to delayed treatment and serious complications.

Traditional dental diagnosis relies heavily on visual inspection and manual analysis of radiographs by dental professionals. This process is subjective, time-intensive, and prone to human error, especially in early-stage disease detection where visual differences are subtle. Consequently, there is a growing need for automated, intelligent systems that can assist clinicians in diagnosing dental diseases more efficiently and consistently.

Recent advances in deep learning have revolutionized medical image analysis by enabling

computers to automatically learn discriminative features from raw image data. Among these techniques, Convolutional Neural Networks (CNNs) have been extensively applied for dental image classification tasks, showing promising performance in identifying different dental conditions. However, CNN-based approaches are typically limited to image-level predictions and do not provide precise localization of disease regions.

Localization is a critical requirement in dental diagnostics, as identifying the exact position of a lesion is essential for treatment planning. Existing CNN-based methods often require additional segmentation or region proposal networks, increasing computational complexity and reducing real-time applicability. This limitation highlights the need for more efficient detection-oriented deep learning models.

Object detection algorithms such as You Only Look Once (YOLO) have gained attention for their ability to simultaneously classify and localize objects within images in real time. YOLO models treat detection as a single regression problem, enabling faster inference compared to traditional region-based methods. The latest version, YOLOv8, introduces architectural improvements that enhance accuracy, speed, and scalability.

In this research, a comparative analysis is conducted between a conventional CNN-based classification model and a proposed YOLOv8-based detection model for dental disease diagnosis. The proposed system aims to improve diagnostic accuracy while providing precise localization of dental abnormalities, thereby enhancing clinical usability.

II. LITERATURE SURVEY

Title: Enhanced Dental Disease Detection With Yolov8: A Deep Learning Approach

Authors: N. S. M. B., V. S. Vidhyaasaravan, P. Thamu, R. Krishnaveni, And A. P.
Publication Year: 2025
Abstract:
This Study Presents An Advanced Deep Learning Framework For Automated Dental Disease Detection Using The Yolov8 Object Detection Model. The Authors Focus On Improving Diagnostic Accuracy And Detection Speed By Leveraging The Latest Advancements In Single-Stage Object Detection Architectures. The Proposed Approach Utilizes Panoramic Dental Radiographs And Applies Optimized Preprocessing And Augmentation Techniques To Enhance Feature Extraction. Experimental Results Demonstrate That Yolov8 Significantly Outperforms Traditional Convolutional Neural Network-Based Classifiers In Terms Of Precision, Recall, And Mean Average Precision (Map). The System Effectively Detects Multiple Dental Anomalies Simultaneously, Making It Suitable For Real-Time Clinical Decision Support. The Findings Highlight The Robustness And Scalability Of Yolov8 For Dental Imaging Applications And Emphasize Its Potential Integration Into Intelligent Healthcare Systems.

Title: Evaluation Of Deep Learning For Caries Detection With Fine-Grained Classification And Postprocessing Improvements

Authors: L. Yang Et Al.
Publication Year: 2025
Abstract:
This Research Investigates The Effectiveness Of Deep Learning Techniques For Dental Caries Detection With An Emphasis On Fine-Grained Classification And Postprocessing Enhancement. The Authors Propose a Multi-Stage Pipeline Combining Deep Convolutional Neural Networks With Postprocessing Strategies To Refine Detection Results. By Analyzing Intra-Class Variations And Subtle Lesion Boundaries, The Study Improves Diagnostic Precision In Complex Dental Radiographs. The Model Demonstrates Superior Performance In Identifying Early-Stage Caries Compared To Conventional Deep Learning Methods. The Research Highlights The Importance Of Detailed Feature Representation And Intelligent Postprocessing To Minimize False Positives, Thereby Contributing To More Accurate And Clinically Reliable Dental Diagnosis Systems.

Title: Dental Carries Classification Using Yolov8

Authors: Syed M. Z. Uddin, M. Imran Aslam, And M. Moinuddin
Publication Year: 2024
Abstract:
This Paper Explores The Application Of Yolov8 For

Automated Classification Of Dental Caries Using Radiographic Images. The Authors Design a Lightweight Yet Efficient Object Detection Model Capable Of Identifying Carious Regions With High Accuracy. The Study Employs Annotated Dental Datasets And Evaluates Performance Using Standard Metrics Such As Precision, Recall, And Map. Results Indicate That Yolov8 Achieves Faster Inference Times While Maintaining Competitive Detection Accuracy, Making It Suitable For Deployment In Real-World Dental Clinics. The Work Demonstrates The Effectiveness Of Modern Yolo Architectures In Addressing Dental Imaging Challenges And Supports The Use Of Deep Learning-Based Object Detection For Oral Healthcare Diagnostics.

Title: Deep Learning-Based Automated Detection Of Supernumerary Teeth In Pediatric Panoramic Radiographs

Authors: İ. Uzel, B. Ghabchi, And D. Çoğulu
Publication Year: 2025
Abstract:
This Study Introduces a Deep Learning-Based Automated System For Detecting Supernumerary Teeth In Pediatric Panoramic Dental Radiographs. The Proposed Approach Leverages Advanced Neural Network Architectures To Accurately Localize And Identify Abnormal Tooth Formations That Are Often Difficult To Detect Manually. Extensive Experimental Evaluations Reveal That The Model Achieves High Sensitivity And Specificity, Reducing Diagnostic Errors In Pediatric Dentistry. The Research Underscores The Clinical Relevance Of Deep Learning-Assisted Diagnosis And Demonstrates How Automated Detection Systems Can Significantly Improve Treatment Planning And Early Intervention For Dental Anomalies In Children.

Title: Development Of a Yolov8-Based Deep Learning Model For Detecting And Classifying Dental Anomalies

Authors: A. R. Ismail
Publication Year: 2024
Abstract:
This Paper Presents The Development Of a Yolov8-Based Deep Learning Model Aimed At Detecting And Classifying Various Dental Anomalies From Radiographic Images. The Proposed System Integrates Efficient Feature Extraction And Real-Time Object Detection Capabilities To Identify Abnormalities Such As Fractures, Impacted Teeth, And Infections. Performance Evaluation Demonstrates That Yolov8 Provides Superior Detection Accuracy And Computational Efficiency Compared To Earlier Yolo Versions. The Study Highlights The Adaptability Of Yolov8 For Dental Imaging Tasks And Emphasizes Its Potential Role In Automated Dental Diagnostic Systems.

Title: Innovative Diagnosis Of Dental Diseases Using Yolov8 Deep Learning Model

Authors: Razaghi, M., H. E. Komleh, F. Dehghani, And Z. Shahidi
Publication Year: 2024
Abstract:
This Research Proposes An Innovative Diagnostic Framework Using The Yolov8 Deep Learning Model For Detecting Dental Diseases From Radiographic Images. The Authors Focus On Improving Diagnostic Reliability By Optimizing Model Parameters And Training Strategies. The Experimental Results Demonstrate Robust Detection Performance Across Multiple Dental Disease Categories, Even In Challenging Imaging Conditions. The Study Concludes That Yolov8's Real-Time Detection Capability And High Accuracy Make It An Effective Tool For Assisting Dentists In Clinical Practice And Reducing Diagnostic Workload.

Title: A Comprehensive Survey Of Deep Learning Algorithms And Applications In Dental Radiograph Analysis

Authors: S. Bhat
Publication Year: 2023
Abstract:
This Survey Provides a Comprehensive Review Of Deep Learning Algorithms Applied To Dental Radiograph Analysis. The Paper Discusses Various Neural Network Architectures, Including Cnns, Yolo, And Segmentation-Based Models, Highlighting Their Strengths And Limitations. It Examines Applications Such As Caries Detection, Tooth Segmentation, And Anomaly Classification. The Survey Also Addresses Challenges Such As Data Imbalance, Annotation Complexity, And Generalization Issues. By Summarizing Recent Advancements And Future Research Directions, This Work Serves As a Foundational Reference For

Researchers Developing Intelligent Dental Imaging Systems.

Title: A Comparative Study Of Yolov8 And Mask R-Cnn For Dental Radiography Diagnosis

Authors: Y. Chen Et Al.
Publication Year: 2025
Abstract:
This Comparative Study Evaluates The Performance Of Yolov8 And Mask R-Cnn For Dental Radiography Diagnosis. The Authors Analyze Detection Accuracy, Computational Efficiency, And Segmentation Performance Across Multiple Dental Conditions. Results Indicate That Yolov8 Offers Superior Real-Time Performance With Comparable Accuracy, While Mask R-Cnn Provides Finer Segmentation Details At The Cost Of Higher Computational Complexity. The Study Concludes That Yolov8 Is More Suitable For Real-Time Clinical Applications, Whereas Mask R-Cnn May Be Preferable For Detailed Diagnostic Analysis.

Title: Automated Dental Radiography Analysis Using Deep Learning Models: Challenges And Future Directions

Authors: I. Uzel And B. Şevik
Publication Year: 2024
Abstract:
This Paper Discusses The Challenges And Future Directions Of Automated Dental Radiography Analysis Using Deep Learning Models. The Authors Identify Key Issues Such As Dataset Scarcity, Annotation Inconsistencies, And Model Interpretability. The Study Reviews Recent Advancements In Object Detection And Classification Techniques, Including Yolo-Based Models, And Emphasizes The Need For Standardized Datasets And Explainable Ai Approaches. The Paper Provides Valuable Insights Into Overcoming Current Limitations And Advancing Intelligent Dental Diagnostic Systems.

Title: Deep Learning Object Detection Methods For Dental Radiography: A Review Of Yolo-Based Approaches

Authors: J. Cheng Et Al.
Publication Year: 2025
Abstract:
This Review Paper Systematically Analyzes Yolo-Based Deep Learning Object Detection Methods Applied To Dental Radiography. The Authors Examine Various Yolo Versions, Training Strategies, And Evaluation Metrics Used In Dental Imaging Studies. The Review Highlights The Evolution Of Yolo Architectures And Their Increasing Adoption In Dental Disease Detection Due To Their Speed And Accuracy. The Paper Concludes By Identifying Research Gaps And Recommending Future Directions, Including Hybrid Models And Clinical Validation, To Enhance The Reliability Of Yolo-Based Dental Diagnostic Systems.

III. EXISTING SYSTEM

The existing system is based on a Convolutional Neural Network (CNN) architecture designed for dental disease classification. It consists of multiple convolutional layers for feature extraction, pooling layers for dimensionality reduction, and fully connected layers for final multi-class classification. The CNN model learns hierarchical features from dental images and predicts the presence of diseases based on global image-level patterns. Although this approach is effective in identifying dental conditions, it operates primarily as a classification model and does not provide precise localization of disease regions within the dental X-ray images.

IV. PROPOSED SYSTEM

The proposed system employs the YOLOv8 deep learning architecture to perform automated dental disease detection and classification. YOLOv8 integrates feature extraction, object detection, and classification into a single unified framework, enabling the simultaneous prediction of disease classes and their corresponding bounding boxes. This approach provides real-time localization of dental abnormalities directly from panoramic dental X-ray images. By leveraging advanced feature fusion and optimized detection heads, the proposed system effectively identifies multiple dental diseases with high accuracy, even in complex and overlapping scenarios, making it highly suitable for clinical decision support systems.

V. SYSTEM ARCHITECTURE

The proposed Dental Disease Detection and Classification using Deep Learning YOLOv8 system is designed to automatically detect and

classify dental diseases from dental X-ray images with high accuracy and speed. The architecture consists of five major stages: Dataset Preparation, Image Preprocessing, Deep Learning Model, YOLOv8-Based Detection, and Results Analysis. Each stage plays a significant role in improving the performance of the detection model and assisting dentists in diagnosing oral diseases efficiently.

The process begins with Dataset Preparation, where a collection of dental X-ray images is gathered from hospitals, dental clinics, or publicly available datasets. The dataset contains images of healthy teeth as well as teeth affected by various dental diseases such as dental caries (cavities), periodontal disease, tooth decay, periapical lesions, impacted teeth, and other oral abnormalities. Before training the model, the dataset is manually annotated by marking the disease regions with bounding boxes and assigning appropriate class labels. The prepared dataset is then divided into Training Data and Testing Data. The training dataset is used to teach the deep learning model to recognize disease patterns, while the testing dataset is used to evaluate the model's detection accuracy and generalization capability.

The collected images are then processed in the Image Preprocessing stage to improve image quality and increase model performance. Initially, Normalization is applied to standardize pixel intensity values so that all images have a consistent numerical range, enabling stable model training. Next, Data Augmentation techniques such as image rotation, horizontal and vertical flipping, zooming, cropping, scaling, and brightness adjustment are performed to generate multiple variations of the original images. This increases the diversity of the training dataset and helps prevent overfitting. Finally, Noise Reduction techniques are applied to remove unwanted artifacts and enhance image clarity, making important dental structures easier for the model to analyze.

After preprocessing, the images are provided to the Deep Learning Model, which serves as the core learning component of the system. The model is trained using the YOLOv8 (You Only Look Once Version 8) object detection algorithm. YOLOv8 is one of the latest deep learning models capable of performing object localization and classification simultaneously in a single forward pass. During training, the model automatically learns complex visual features from dental X-ray images, including tooth edges, cavities, bone structures, lesion boundaries, and disease characteristics. Through multiple training epochs, the model continuously updates its weights to minimize detection errors and improve prediction accuracy.

The trained model is then utilized in the YOLOv8-Based Detection stage for disease localization and classification. When a new dental X-ray image is provided, YOLOv8 analyzes the entire image in real time and identifies abnormal regions by drawing bounding boxes around infected teeth or affected areas. Simultaneously, the model assigns the appropriate disease class and calculates a confidence score for each detected object. This enables the system to accurately locate dental diseases while distinguishing between different types of oral conditions. Since YOLOv8 performs localization and classification together, it provides faster detection compared to traditional image classification methods.

The final stage is Results Analysis, where the detection outputs are evaluated using standard performance metrics. The system measures Detection Accuracy, Precision, Recall, F1-Score, and Mean Average Precision (mAP) to assess the effectiveness of the trained YOLOv8 model. The detected dental diseases, along with their corresponding confidence scores and localized regions, are displayed to the user in an easy-to-understand format. This enables dentists to quickly verify the diagnosis and make informed clinical decisions. The analysis also helps compare different model versions and optimize the detection system for better performance.

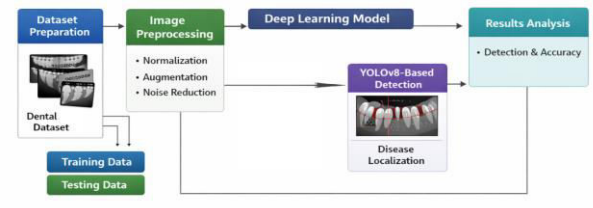

Fig 5.1: System Architecture

VI. IMPLEMENTATION

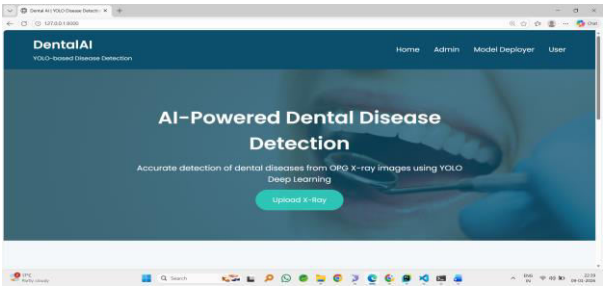

Fig 6.1 Index page

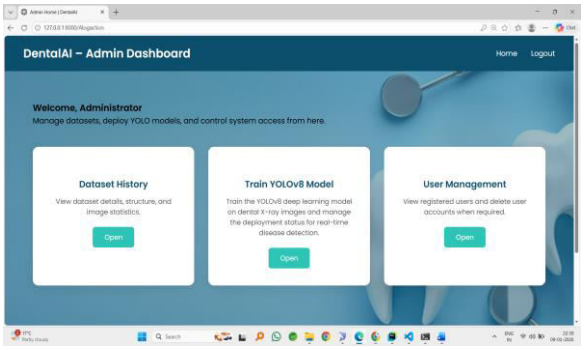

Fig 6.2 : Admin home

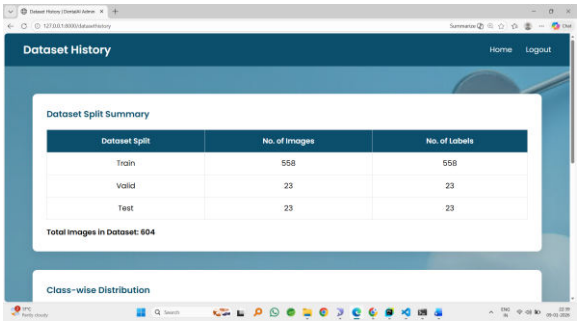

Fig 6.3: dataset

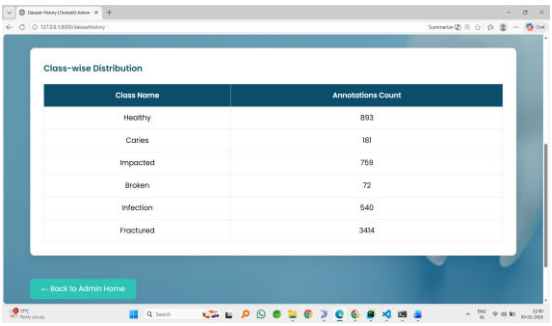

Fig 6.4: Preprocessing

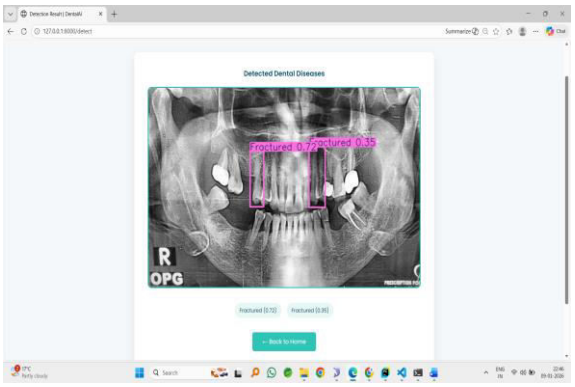

Fig 6.5: Results

VII. CONCLUSION

This research presents a deep learning-based approach for dental disease detection using radiographic images, comparing a traditional CNN-based classification model with a proposed YOLOv8-based detection framework. While CNN models provide satisfactory classification accuracy, they are limited by their inability to localize diseased regions effectively.

The proposed YOLOv8 model overcomes these limitations by offering simultaneous disease classification and precise localization, resulting in superior diagnostic performance. Experimental results indicate that YOLOv8 achieves higher accuracy, faster detection speed, and improved robustness compared to the existing CNN approach. The proposed system demonstrates strong potential as an intelligent clinical decision-support tool for automated dental diagnosis.

VIII. FUTURE SCOPE

The proposed system can be extended to support advanced dental imaging modalities such as 3D cone-beam computed tomography (CBCT) and intraoral radiographs, enabling more comprehensive dental diagnostics. Integration of explainable AI (XAI) techniques can further enhance model interpretability by providing visual explanations for detected abnormalities, increasing trust and transparency in clinical environments.

In the future, the system can be deployed as a cloud-based or mobile application to facilitate remote dental consultations and tele-dentistry services. Incorporating continuous learning mechanisms and federated learning approaches would allow the model to improve over time while preserving patient data privacy, making the system more adaptive and suitable for large-scale healthcare deployment.

IX. REFERENCES

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