AI-based Kidney Stone Detection using CT Imaging

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MSDSM02 - Image Processing for Societal Applications
IIT Ropar

2025–26

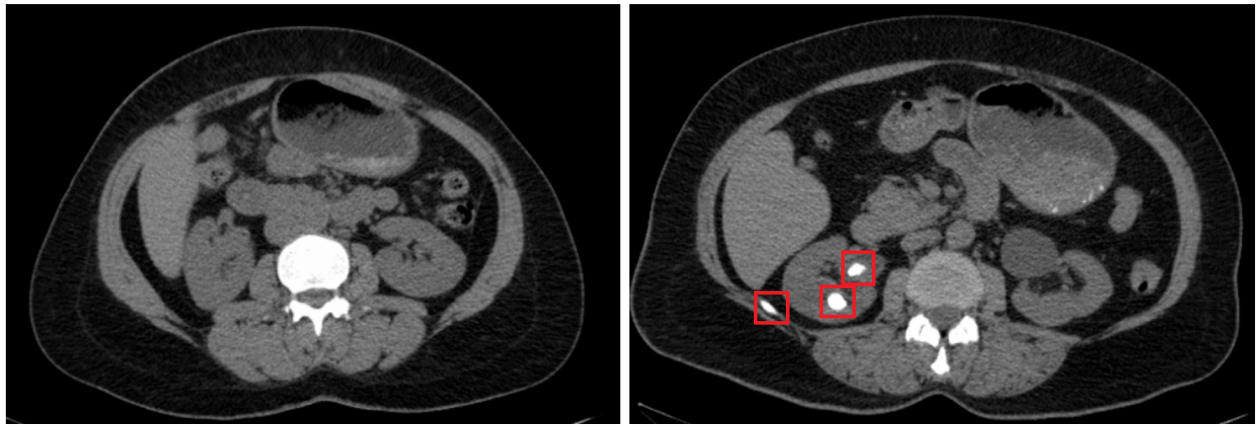
Problem Statement & Motivation

Problem:

Develop an AI-based system to automatically detect and localize kidney stones from CT scan images.

Motivation:

- Manual CT interpretation is slow and error-prone.
- AI models can automate detection, improving speed and accuracy.
- Enables early diagnosis and reduces clinical workload.



(a)CT Scan of person without kidney stone *(b)CT Scan of a person with kidney stone*

Figure: Sample Input (CT Scan- Without stone) and Output (Localized Kidney

Dataset Description

- **Source:** Mendeley Axial CT Imaging Dataset (2025)
- **Authors:** Peshraw A. Abdalla, Bander S. Mahmood, Nawzad R. Hama
- 3,364 original CT images + 35,457 augmented images
- **Augmentation:** Rotation, scaling, contrast adjustment, flipping
- **Categories:** With Stone / Without Stone
- **Split:** 80% training, 20% testing
- **Preprocessing:** Resize to 224×224, normalize pixel values to [0,1]

Proposed Methodology – Overview

Two-Stage Deep Learning Pipeline:

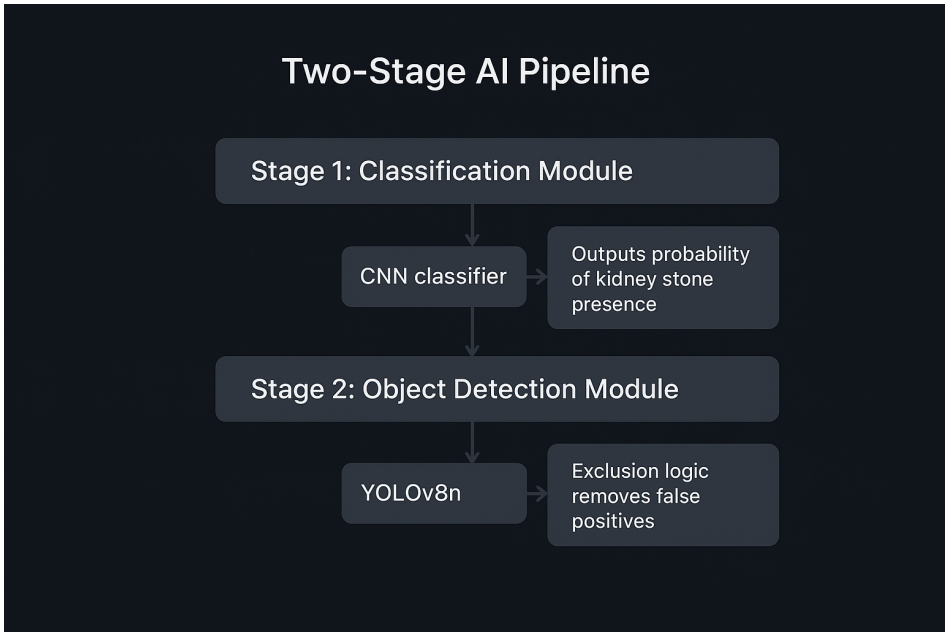


Figure: Proposed Two-Stage AI Pipeline for Kidney Stone Detection

Tools Used: Python, TensorFlow/Keras, OpenCV, NumPy, YOLOv8, scikit-image

CNN Classification Results

- Achieved classification accuracy of **86%**.
- Validation accuracy stabilized around **0.80** after 2 epochs.
- Validation loss decreased to $\sim$0.44 after 6 epochs.
- Threshold = 0.3 to enhance sensitivity (detect borderline cases).

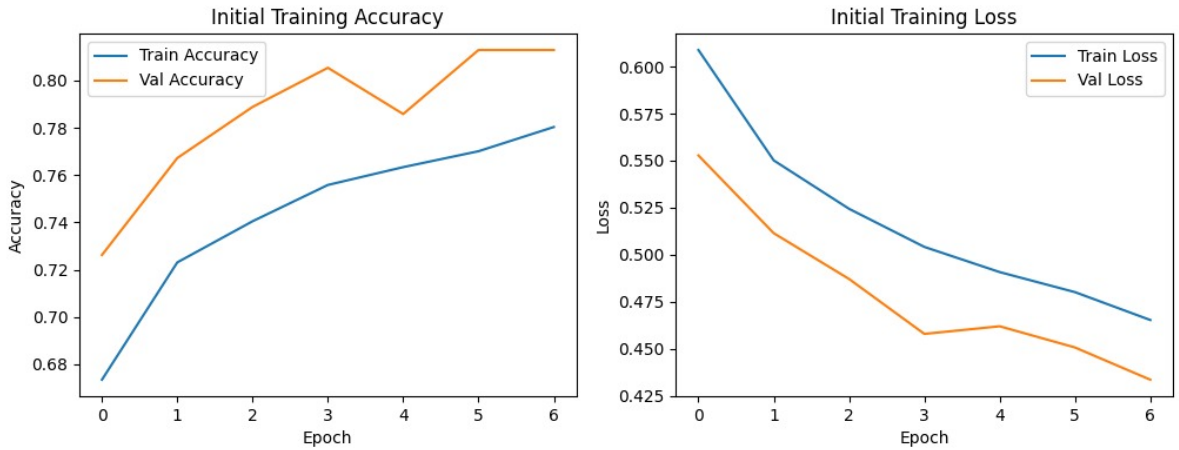


Figure: CNN Model Accuracy and Loss Curves

YOLOv8 Detection Results

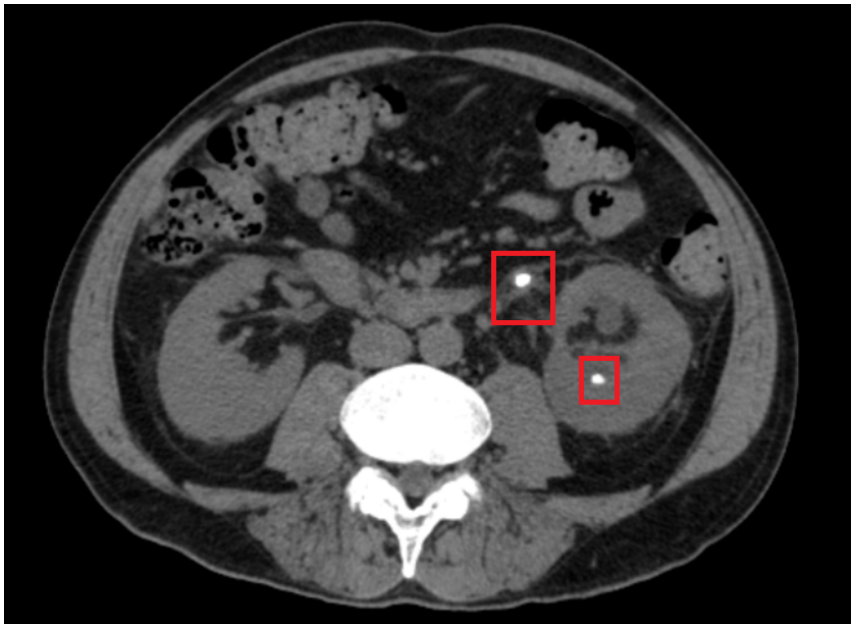
- Confidence threshold $= 0.7$
- Bounding boxes accurately localized kidney stones.
- Exclusion filter reduced false positives near the spinal region.

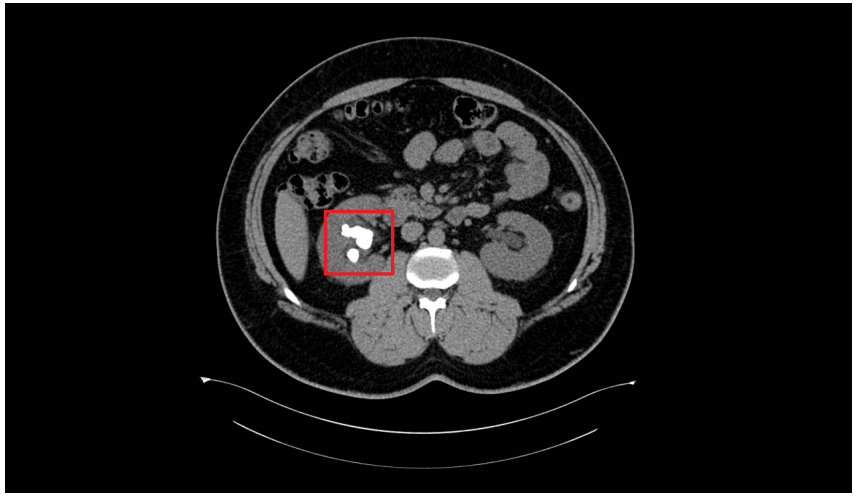
Evaluation Metrics

Detection Metrics:

- **mAP (mean Average Precision):** 0.85
- Mean Average Precision (mAP)
- Confidence Score Threshold = 0.7

Result





Results Summary

Model	Accuracy (%)	mAP (YOLOv8)
CNN Classifier	86.0	-
YOLOv8 Detector	-	0.85

Table: Quantitative Performance Summary

- The hybrid CNN + YOLO pipeline improved efficiency.
- Reduced false positives and improved localization accuracy.

Discussion & Challenges

Strengths:

- Efficient and sensitive screening via CNN.
- Accurate bounding-box detection with YOLOv8.
- Interpretable and clinically meaningful visual outputs.

Challenges:

- Limited dataset size.
- False positives in dense spinal regions.
- Difficulty detecting small stones with low contrast.

Conclusion & Future Work

Summary:

- Built a two-stage AI system for kidney stone detection and localization.
- Combined CNN classification and YOLOv8 object detection.
- Achieved high accuracy and real-world feasibility.

Future Directions:

- Expand dataset with multi-center 3D CT scans.
- Use attention-based architectures for finer localization.
- Integrate system into hospital PACS for clinical use.

Thank You!

Questions?