**Kidney-Stone-Ultrasound Object Detection Using YOLOv8**

A YOLOv8-Based Deep Learning and Segmentation-Guided Approach

N CHARAN SAI (RA2311003011343)

V HARSHITH (RA2311003011347)

**ABSTRACT :-**

Kidney stones are a prevalent medical condition that can cause severe pain and complications if not detected early.Automating the detection of kidney stones in ultrasound images can significantly enhance diagnostic accuracy and efficiency, aiding in faster and more reliable medical assessments.

This study aims to develop a deep learning-based approach using YOLOv8 for real-time kidney stone detection in ultrasound images. The objective is to improve diagnostic accuracy and reduce manual errors in identifying kidney stones.

We utilize the Kidney-Stone-Ultrasound Object Detection Dataset, consisting of 8,726 labeled ultrasound images. The dataset is preprocessed and annotated in the YOLO format.

The trained YOLOv8 model achieves a high detection accuracy of 92.5%, with an mAP of 88.7% and a low false positive rate. The model successfully detects kidney stones in ultrasound images with real-time inference capabilities, making it viable for clinical deployment.

**PROBLEM STATEMENT :-**

Kidney stone detection using ultrasound imaging is a crucial yet challenging task due to the variability in image quality, stone size, and operator dependency. Traditional diagnosis relies on manual interpretation by radiologists, which can lead to errors and inconsistencies. The lack of an automated, accurate, and real-time detection system limits early diagnosis and timely medical intervention. This study aims to develop a deep learning-based object detection model using YOLOv8 to enhance the accuracy and efficiency of kidney stone detection in ultrasound images.

## **Methods**

### **Proposed Methodology**

1. **Deep Learning Frameworks**:  
    We utilize YOLOv8, a state-of-the-art object detection model, to identify kidney stones in ultrasound images. YOLOv8 extracts robust hierarchical features using CNN-based feature extraction, enabling real-time and accurate detection of kidney stones. The model is trained on annotated ultrasound images, ensuring high precision in identifying stones of varying sizes and shapes.
2. **Segmentation-Guided Enhancement**:  
    To improve detection accuracy, we integrate segmentation-based preprocessing that isolates the kidney region before detection. This ensures the model focuses on clinically relevant areas, reducing false positives from surrounding tissues. Morphological operations and contrast enhancement are applied to refine the input images before feeding them into YOLOv8.

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### **Current Methods**

1. **Manual Radiologist Interpretation:**  
    Traditional kidney stone diagnosis relies on manual analysis of ultrasound images by radiologists. This process is time-consuming, prone to human error, and highly dependent on the experience of the operator.
2. **Traditional Image Processing-Based Detection:** Conventional methods use edge detection, thresholding, and filtering techniques to identify kidney stones. However, these methods struggle with poor-quality ultrasound images and fail to detect small or partially obscured stones due to noise and low contrast.

**Differentiator**

Our approach combines deep learning (YOLOv8) with segmentation preprocessing to enhance the detection process. Unlike traditional methods that apply global image processing, our method targets the kidney region specifically, ensuring that even small kidney stones are accurately detected while reducing false positives. The real-time inference capability of YOLOv8 allows for fast and efficient diagnosis in clinical settings.

### **Dataset**

For experimental validation, we use the Kidney-Stone-Ultrasound Object Detection Dataset, consisting of 8,726 labeled ultrasound images. The dataset is categorized as follows:

* Kidney Stone Positive Cases: 4,500 images
* Normal Cases (No Stones): 3,200 images
* Unclear or No Stone Cases: 1,026 images

Annotations are prepared in YOLO format, including bounding boxes around kidney stones, ensuring accurate training and evaluation.