

Multi-View Detection of Prohibited Items in X-ray Images with Class Imbalance Handling

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1. Overview

X-ray technology is commonly used across security screening, medical imaging, industrial inspection, and quality control applications. This project aims to develop a deep learning system to detect prohibited items in X-ray baggage images. Using public X-ray datasets, the model will classify whether an image contains suspicious items, locate them with bounding boxes, and optionally segment them at the pixel level.

2. Problem Definition

- **Classification:** Identify if a bag contains prohibited items (knife, gun, liquid).
- **Detection:** Localize items with bounding boxes.
- **Optional Segmentation:** Pixel-level outlines of items.
- **Stretch Goal:** Implement few-shot or zero-shot detection

Challenges include overlapping objects, low contrast, and irregular shapes in X-ray images.

3. Datasets

- **LDXray:** Dual-view X-ray images ([Kaggle](#))
- **GDXray / PIDRay / SIXray:** Annotated images of baggage ([Kaggle](#))
- **DvXray** (32,000 dual-view, ~20GB) ([GitHub](#))

4. Methodology

- **Classification:** ResNet / EfficientNet → likelihood of prohibited items.
- **Detection:** YOLOv8 / Faster R-CNN → bounding boxes.
- **Optional Segmentation:** Mask R-CNN / U-Net → pixel-level masks.
- **Extensions:** Multi-view inputs, Grad-CAM heatmaps, lightweight real-time models.
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5. Evaluation Metrics

- **Classification:** Accuracy, F1-score
- **Detection:** mAP, IoU
- **Segmentation (if applied):** Dice coefficient, IoU
- **Abnormality Detection:** ROC-AUC, PR-AUC, FNR, FPR for rare objects.

6. Timeline

- **Weeks 1–2:** Dataset exploration and preprocessing
- **Weeks 3–4:** Baseline classification & detection
- **Weeks 5–6:** Multi-output model & fine-tuning
- **Week 7:** Evaluation & visualization
- **Week 8:** Final report & presentation

7. Expected Outcomes

- YOLOv8 model detecting and localizing prohibited items, including rare objects.
- Optional pixel-level segmentation and anomaly detection.
- Grad-CAM visualizations and ablation studies for model interpretability.
- Stretch goals: Few-shot/zero-shot detection, INT8 quantization, instance segmentation.