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Improving Radiograph Analysis Throughput using Object Detection

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Keywords

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Abstract

SIGN Fracture Care International partners with surgeons in low-resource hospitals worldwide to provide access to effective orthopedic care. SIGN reaches across 52 countries and interacts with over 5,000 surgeons, but expanding their care has led to an overwhelming amount of medical data; SIGN's Online Surgical Database (SOSD) contains over 500,000 images spanning two decades and is continuing to grow. We apply machine learning tools to the SOSD to improve the throughput of radiograph analysis to assist SIGN in further expanding their reach and effectively helping surgeons and patients. We also outline a plan for future work on improving surgical outcomes using additional analyses and metadata about patients before and after surgery.

In our initial work, we used object detection methods to detect surgical implants in radiographs. From the SOSD, we generated a training set containing 2,510 radiographs with screws, nails, and plates labeled by bounding boxes. We then applied transfer learning using the Faster R-CNN architecture pretrained on the COCO dataset. Training a single model to recognize all three classes of implants gave a low average precision (AP) for the plate class, likely due to the low number of plates in our training set and the large variety of surgical plates used by SIGN-partnered surgeons. Applying standard image augmentation techniques to increase the plate count did not appreciably increase the AP of plate detection. We, therefore, trained a separate model to detect plates by redrawing the bounding boxes to account for correlations between screws and plates. This strategy increased the AP of plate detection by 75.3 percentage points. The AP of each class was 78% for screws, 93% for nails, and 89% for plates, while the sensitivity was 90% for screws, 85% for nails, and 78% for plates.