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ɔject Classification in Multi-View X-Ray Images Using R-CNNs

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Lynceus: Detecting Organics in Carry-on Luggage

The Lynceus project team is engaged in the mission of national security by working with Customs and Border Protection (CBP) to better detect threat items at ports of entry. By leveraging state-of-the-art computational and statistical techniques, including machine learning, we hope to develop methods that improve CBP's ability to detect organic items in personal affects.

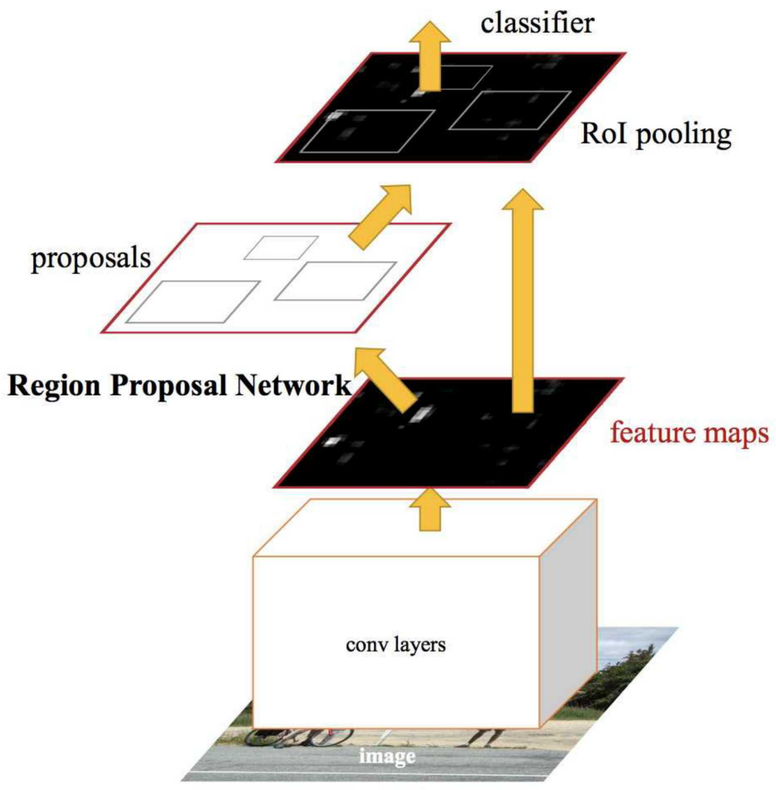
Data:

- Data collection using a Rapiscan 620DV screening system located onsite at SNL-NM
- Utilizing other Rapiscan data from both onsite and external sources
- Several types of image data available: dual-view, dual-energy X-ray scans and processed products

Example Scans from the Lynceus Dataset

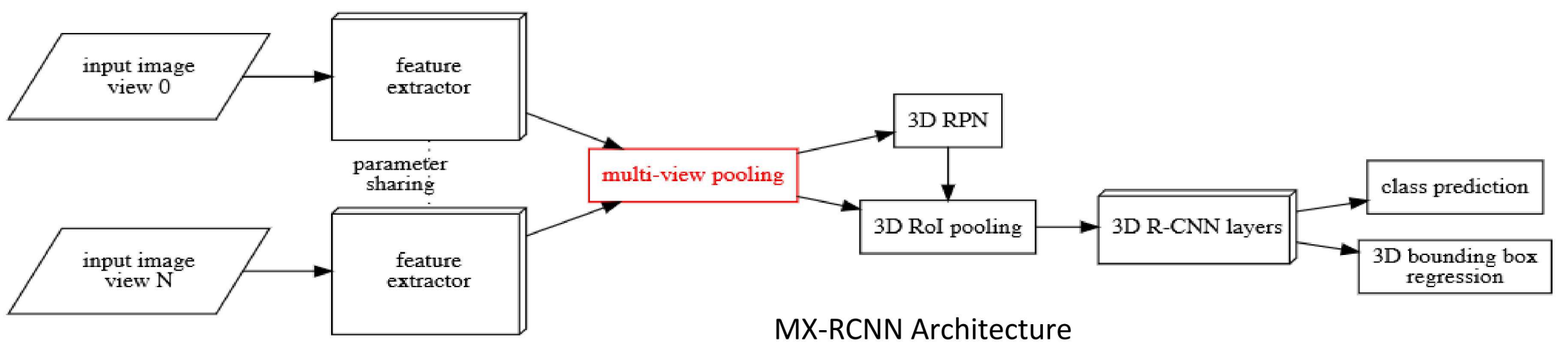
Method:

I am developing an object detection pipeline for our dataset built with state-of-the-art convolutional neural network (CNN)-based algorithms. In particular, I am utilizing the *Multi-view X-ray R-CNN* (MX-RCNN) architecture defined by Jan-Martin O. Steitz et al., which is based on the widely successful Region-based CNN (R-CNN) methods for object detection.



Faster R-CNN Architecture

MX-RCNN is based on Faster R-CNN, which is an entirely convolutional architecture that can be trained end-to-end using gradient descent. MX-RCNN modifies this architecture to utilize the multiple views provided by baggage scanners by pooling the feature maps of the individual 2D views into a single 3D *feature volume.* This is done in a novel way that preserves the benefits of X-ray imaging and utilizes scanner geometry.



MX-RCNN Architecture

Results:

During the course of my summer internship I have successfully implemented a geometry-naive version of multi-view pooling that works with dual-view data, I have developed a MX-RCNN network using Keras, I have collected thousands of x-ray scan images, and I have built a full image classification pipeline for Rapiscan 620DV data. This pipeline utilizes a CNN that is essentially a partly-3D version of ResNet-50, which mirrors the architecture of MX-RCNN only without the R-CNN top. I am currently training this alongside a standard 2D ResNet-50 in order to compare performance, working towards a geometry-aware multi-view pooling layer, preparing data for object detection algorithms, and implementing a pipeline for object detection using MX-RCNN.

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References:
Steitz, J.-M.O. et al. *Multi-view X-ray R-CNN.* 2018. Available from: https://arxiv.org/pdf/1810.02344.pdf

Ren, S., He, K., Girshick, R., Sun, J., 2015. *Faster r-cnn: Towards real-time object detection with region proposal networks*. Advances in neural information processing systems. pp. 91-99. Available from: https://arxiv.org/pdf/1506.01497.pdf