

Enhanced Weapon Detection System Based on Faster RCNN

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Proposed Preprocessing and Enhancements

The Data Set

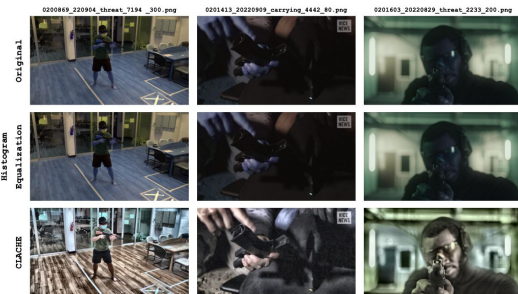
Number of classes = 1 - Weapon
Trained on: 1840 ground truth boxes
Tested on: 1978 Samples

Preprocessing in FasterRCNN framework

- 1) Apply **Scaling Factor**: image **resized** so that minimum dimension is 600 pixels, as recommended by Faster R-CNN
- 2) **Standardization** with supplied means and standard deviations
- 3) **Augment** training data: horizontally flip the data with 50% probability
- 4) **Label** training and test data images with ground truth boxes with their corresponding classes

Proposed Enhancements

- 1) **Contrast Limited Adaptive Histogram Equalization (CLAHE)**



CLAHE filter is an enhancement from the regular Histogram Equalization to help **increase contrast** of images in low or uneven lightings.

- 2) **Bilateral Filtering**



Bilateral filtering **smoothens** the image and **reduces noise**, while preserving edges.

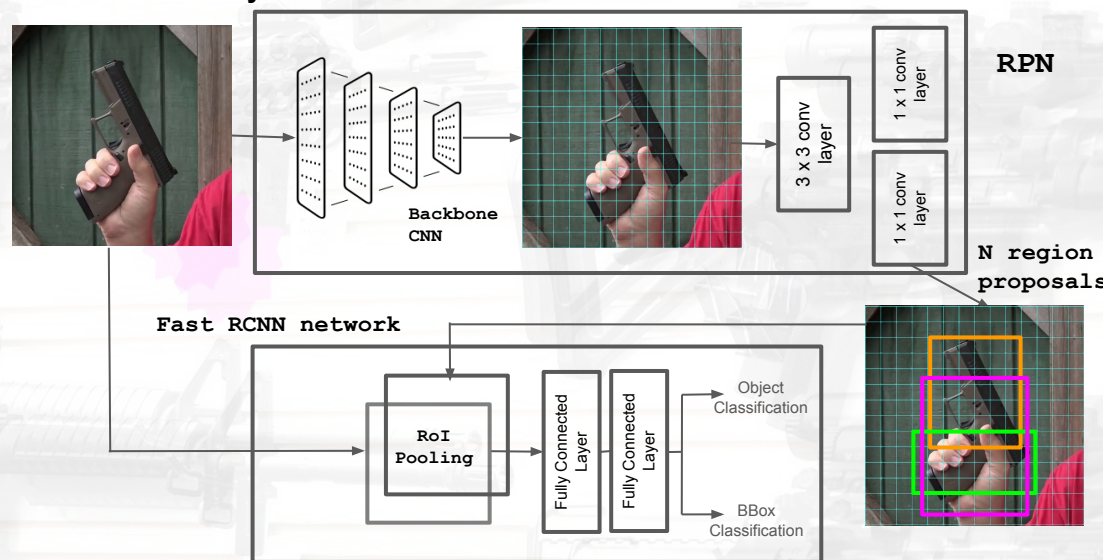
Faster RCNN (Region-Based Convolutional Neural Network)

Faster Region-Based Convolutional Neural Network is an improvement over predecessors, comprising of:

- 1) **Backbone CNN**: processes input images to extract hierarchical features (e.g. VGG16, ResNet)
- 2) **Region Proposal Network (RPN)**: predicts bounding box proposals (Regions of Interest) and scores proposals; trained end-to-end with rest of network

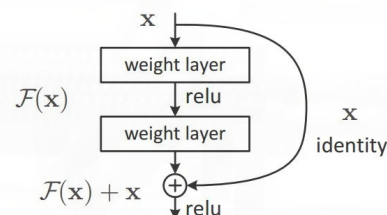
(Right) e.g. of Architecture: **VGG-16** designed to reduce number of params in convolutional layers

Faster RCNN Layout



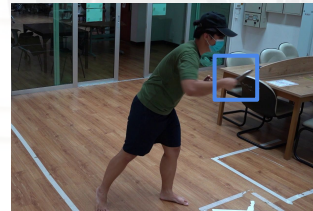
Our Proposed Modifications to Faster RCNN

Mod #1: Replace backbone CNN with ResNet



Skip connections by identity mapping Addresses Vanishing Gradient Problem

Mod #2 Vary the anchor box sizes from $[128^2, 256^2, 512^2]$ to $[64^2, 128^2, 256^2]$



Small weapons are better identified with reduced anchor box sizes

Mod #3 Increase no. of conv layers in RPN + Introduce Batch Normalisation

Results and Discussion

	Accuracy	Precision	Recall	F1
VGG16	0.49	0.44	0.96	0.60
Resnet 152	0.65	0.54	0.86	0.66
Resnet 152 Anchors	0.67	0.55	0.89	0.68
Resnet 152 Anchors Filters	0.67	0.55	0.90	0.68
Resnet 152 Anchors RPN Layers Filters	0.75	0.84	0.47	0.60

The Final Model - Anchors + Filters

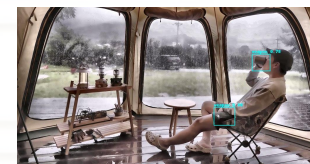
	Positive	Negative
True	704	619
False	580	75



Output Images

Example of True Positive

Example of False Positive



Possible Future Enhancement

The false positives reported could be due to dark/blur being mistakenly recognised as weapons. To avoid this, we can increase the number and quality of input data.

Additional rounds of fine-tuning epochs with smaller learning rates could be run to further increase accuracy of prediction.

References

Trazy. 2023. FasterRCNN Github.
<https://github.com/trzy/FasterRCNN.git>

Ren, S., He, K., Girshick, R., & Sun, J. (2017). Faster R-CNN: Towards real-time object detection with region proposal networks. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(6), 1137-1149.
<https://doi.org/10.1109/tpami.2016.2577031>