X-Ray Baggage Object Detection Using Neural Networks for Safety Purpose

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Introduction

- X-rays have been employed to assist in object detection for airport security purpose. X-ray machines usually scans the content of baggage used by travelers to detect if there are any anomalies contained.
- Images that are generated by the x-ray machines are carefully checked by officers onsite to ensure the travelers do have any prohibited items in their baggage. The entire inspection process usually takes 5-15 seconds, depending on the quality of the X-ray image produced as well as the years of expertise and knowledge of security officer.
- Convolutional Neural Network (CNN), an emerging concept comes under the umbrella of Artificial Intelligence and Deep Learning is the subject of interest that will can increase the efficiency of object detection via X-ray images whilst eliminating the discrepancies of human inspection.

Problem Statement

The conventional way of x-ray baggage object detection has relatively low accuracy, i.e., only 50%, due to fatigue issues experienced by the airport security officers that perform checking the baggage. Sometimes, it is also difficult for officer to identify suspicious objects stored in baggage due to the poor-quality images produced by X-ray machine.

Objectives

- To deploy an innovative solution to address airport security issue by leveraging the benefits of deep learning method.
- To develop a threat object detection model using CNN.
- To analyze the effect of key parameters on the proposed framework and compared its performance with state-of-art methods

Methods

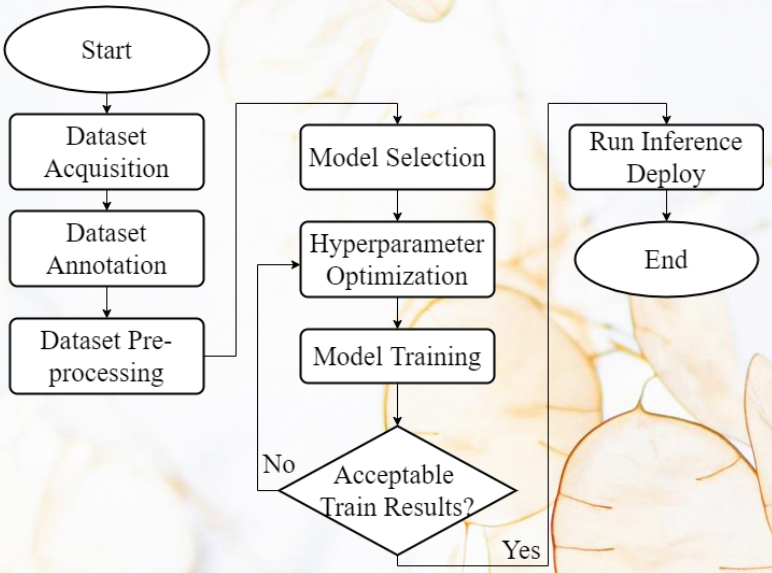


Fig 1: Holistic steps to build the model

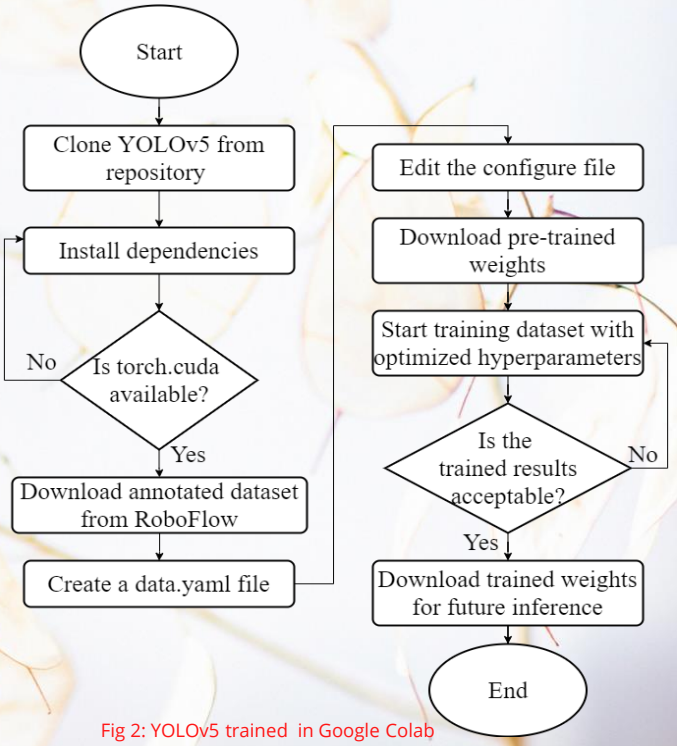


Fig 2: YOLOv5 trained in Google Colab

Results

Table 1: Comparison between proposed algorithm with other algorithms

	Recall	Precision	F1- score	mAP@0.5	mAP@0.5:0.95
YOLOv5	***84.6***	***90.4***	***87.4***	***90.0***	***66.67***
YOLOv3	73.7	75.6	74.3	76.8	-
MobileNetSSD v2	38.0	44.0	40.8	28.1	-

Fig 3: Sample Prediction by YOLOv5

Fig 4: Graph of Precision, Recall, mAP and all the types of losses.

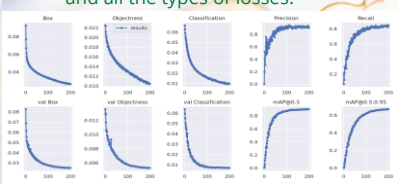


Fig 5: Confusion matrix of YOLOv5

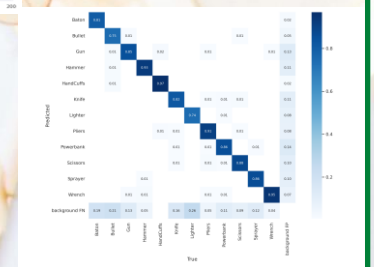
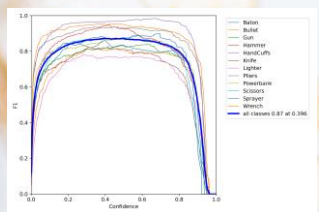


Fig 6: F1-score of YOLOv5



Novelty

- Hyperparameters are optimized by stochastic decent gradient descent.
- The proposed model uses the dense prediction, Cross Spatial Network, and Path Aggregate Network (PANet) for its head, backbone, and neck respectively.

Contribution of the study to the society

- The accuracy of x-ray baggage object detection has been improved tremendously to ensure better airport security.
- Criminal issues such as drug trafficking will be reduced drastically due to the promising ability of proposed model to identify anomalies.
- The traffic rate at airport baggage customs can be reduced drastically due to the enhanced inspection efficiency.
- Attainment of Sustainable Development Goals (SDG) mission and vision, particularly for goals 9 and 11 to improve the quality and security of human life.

Conclusion

- The proposed model has mAP of 90.0%, precision of 90.4%, recall of 89.6%, and f1-score of 87.4%. The proposed model can achieve at least 83.0% of accuracy level with the inference time of 0.008s, hence it is suitable for real-time application to address airport security issue.