MACHINE VISION TECHNIQUES FOR DETECTION OF OBJECTS

IE3100M System Design Project (Group 11) | Department of Industrial Systems Engineering and Management
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INTRODUCTION

Innowave Tech is a global technology and consulting company that provides a full suite of customised services in terms of industry digitalisation and intelligence transformation for customers. These include i4.0 Set-Up with Smart Sensors, Computer Vision, Customised AGVs and many other innovations.

PROBLEM DESCRIPTION

Waterbody leakages can pose significant risks to the semiconductor manufacturing process. As such, Innowave Tech aims to create an application that makes use of computer vision technology to automatically detect any form of water bodies, and the team was tasked to provide insights and recommendations to improve on their current liquid detection system.

DELIVERABLES

1. Prepare data to be ready to run on model; includes splitting and labelling of data
2. Train and test a model for water detection
3. Find ways to optimise the efficiency and effectiveness of the water detection model

METHODOLOGY

IMAGE PROCESSING

Dataset Splitting

Split the images into training, validating and testing datasets in the ratio of 70:20:10.

Image Annotation

Label images to prepare the sample dataset for training the liquid detection model. Water bodies in the dataset were labelled using the annotation tool 'LabelMe'.

Image Segmentation

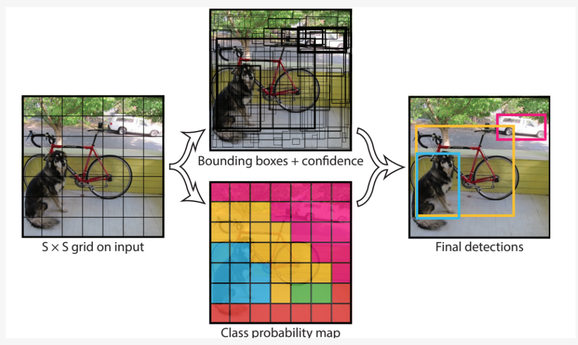
Perform semantic segmentation technique to extract regions of interest (the floor) from images for water detection. The team used the color contouring method to extract the yellow floor and blackout other areas.

Image Resolution Resizing

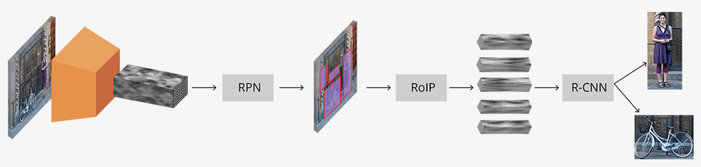
Resize images with different resolutions to create clearer image and improve performance.

DETECTION MODELS

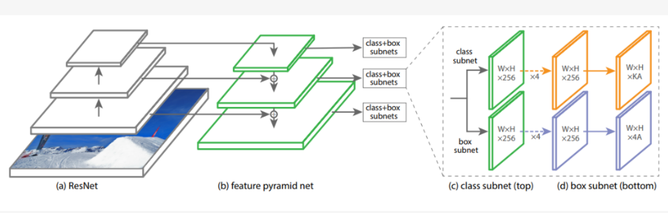
YOLOX



Faster RCNN



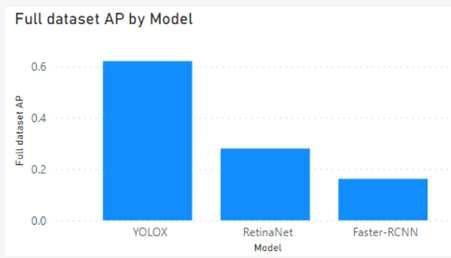
RetinaNet



OPTIMIZATION RESULTS

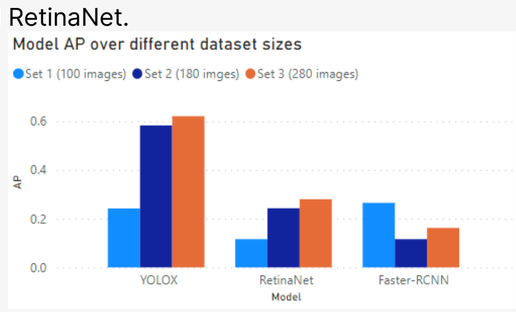
Performance of Different Models

Using the full dataset, YOLOX produced the best AP (62.1%) followed by RetinaNet (28%) and Faster-RCNN (16.2%).



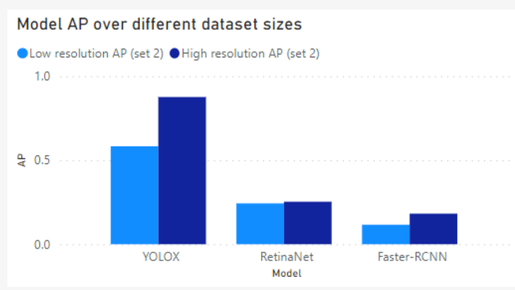
Varied Training Dataset Size

All models produced higher AP with a larger dataset. Faster-RCNN performed best in small dataset, but worse in larger datasets. Might mean it needs longer training time on larger datasets compared to YOLOX and RetinaNet.



Training Dataset Resolution

Increasing resolutions increased AP of all 3 models, likely due to water spills being easier to see in high resolution.



Extracted grounds

Extracting grounds increased prediction speed for all models when the training dataset is larger. However, this is not very significant, averaging at 2.3% inference time reduction. This might not be significant enough for implementation. Further tests with are needed to determine its applicability.

CONCLUSION

The YOLOX model is the most precise object detection model given the dataset provided by Innowave Tech. To optimize the performance of the model, we recommend the company to train the model with a large set of high-resolution images. Although the feature extraction method helps to narrow the areas for detection, it does not significantly reduce the inference time. Therefore, it might not be worth implementing in the system.

KEY SKILLSETS

- Project Management
- Stakeholder Management
- Systems Thinking & Problem Solving
- Python and Open CV
- Machine and Deep Learning