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ULTRA

Real-time Hose Wear Analysis

Introduction

General requirement

- 360° camera hose out surface coverage.
- Scanning of hoses between 0.02 m to 0.2 m in diameter.
- Automatic detect and label cuts, scratches, tears, abrasion.
- Whole system works in real time.
- Automatic image/video stitching.
- Detections noted on side of and/or overlaid on a saved image/video.

General method

- Machine learning
  - Model training & inference
- OpenCV
  - Video processing
- Graphic User Interface (GUI)
- Solidworks
  - Fixture hardware

Platform Selections

- TensorFlow 2.3.0
- NVIDIA CUDA
- Tkinker
- OpenCV 4.1.1
- TensorRT

Device choices:

NVIDIA Jetson Xavier NX

2 ELP USB webcam

IMX 219-120 CSI camera

Testing

Model evaluation

- mAP = 84.2% at IoU = 0.5
- Inference speed = 190 images/sec

Two detection options

- Real-time detection
- Record video + Video detectoin

Memory Issues

- GPU: 91% & RAM 5.6G / 8.0G
- Too much work load on memory

Video Design:

- 320 x 240 pixels for each camera
- 320 x 720 pixels fit for screen size

GUI Design:

- Interface size : 1024 x 600 pixels
- Functions: Detection initiations, User manual, settings, and exit

Software Architecture

Object detector creation:

Selected model:
SSD MobileNet V2

1. Data collection and processing:
   LabelImg, Training & Testing data distribution
2. Hyperparameter tuning:
   Data argumentation, batch size & leaarning rate
3. TF-TRT optimization:
   Precision mode FP16
4. Inference program:
   Model deploy -> Camera invoke -> Input data process -> Detection results visualization

Hardware Design

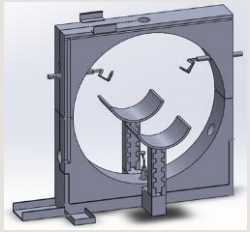
3D model design:

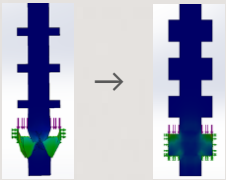
Main Components:
Fixture & hose supporter

Material:
ABS plastic

Hose suppurter:
Deformation avoid
thickness: 2cm

Back option:
- Foam board
- Wood
- Foam mat





Project planning

Total design period:
8 months

Total budget cost:
$1089

References

Sandler. M, Howard. A, Zhu. M, Zhmoginov. A, Chen. L, (2018), MobileNetV2: Inverted Residuals and Linear Bottlenecks. The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2018, pp. 4510-4520. https://arxiv.org/pdf/1801.04381v4.pdf