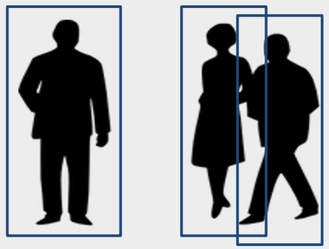
Edge Computing을 이용한 딥러닝 기반 마케팅 타겟 검출 및 분석 시스템



지능기전공학부 Catch U 김연우 곽수지 신우정 이채원

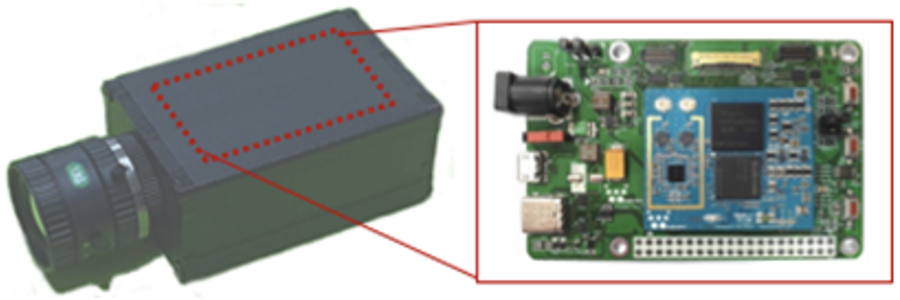
CONTENTS

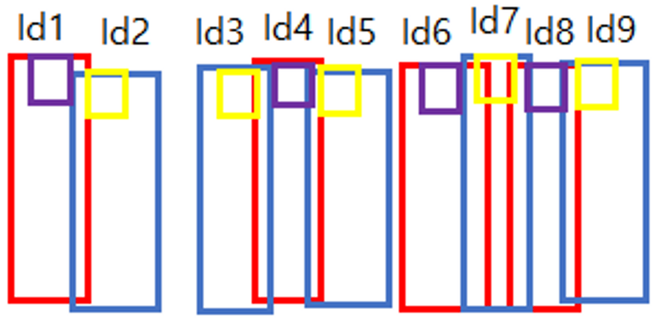
01 개요

Overview

Workflow

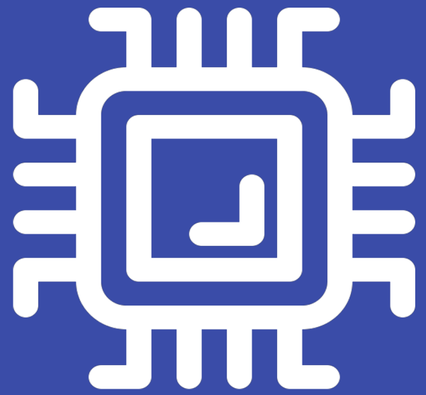
Overview





보행자(남):5
보행자(여):4
광고 응시자(남):3
광고 응시자(남):2

프로젝트 최종목표



영상 기반 딥러닝
검출 시스템을 **경량화**하여
고성능 컴퓨팅 **필요 없이**
임베디드 기기에서 사용 가능한
모델 제공

Edge Computing을 위한 모델 경량화

시간별 통행량 및 광고 응시자 비율을 시각적인 자료로 제공하여 **광고 효과** 및 **마케팅 기초 자료** 제공

시각화 플랫폼

Workflow

YOLO v3

Channel-wise Pruning

Quantization

Object Detection

Kalman Filter

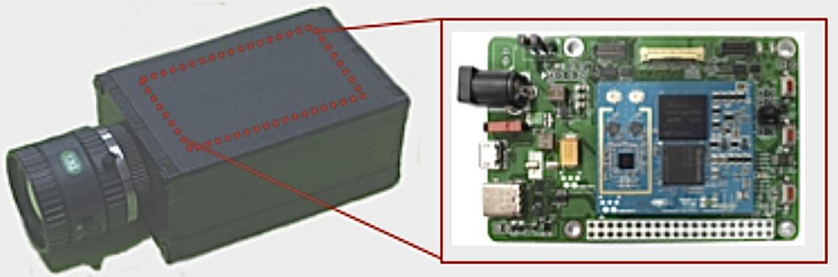
Hungarian Algorithm

Object Tracking

Counting Algorithm

Object Counting

Embedding



QCS605

Web

02 기술 상세

Object Detection

Object Tracking

Embedding

Web service

Detection

YOLO v3

Channel-wise Pruning

Quantization

Object Detection

Kalman Filter

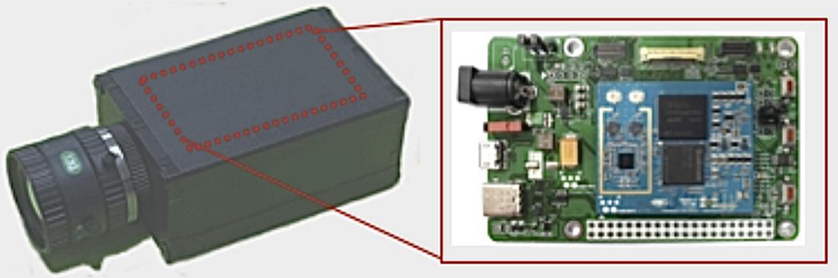
Hungarian Algorithm

Object Tracking

Counting Algorithm

Object Counting

Embedding



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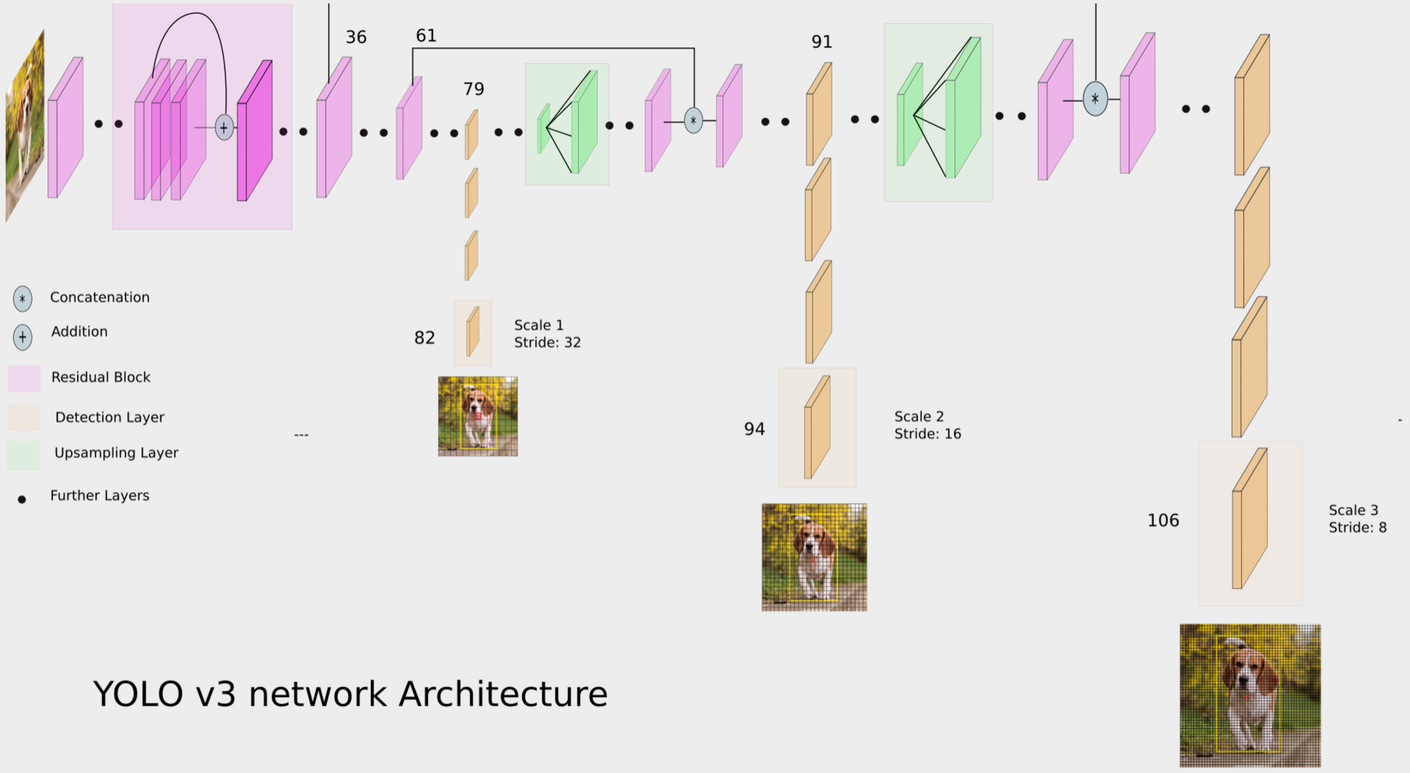
Web

YOLO v3 기반 검출기



YOLO v3 network Architecture

YOLO v3 : Convolutional Neural Network 기반으로

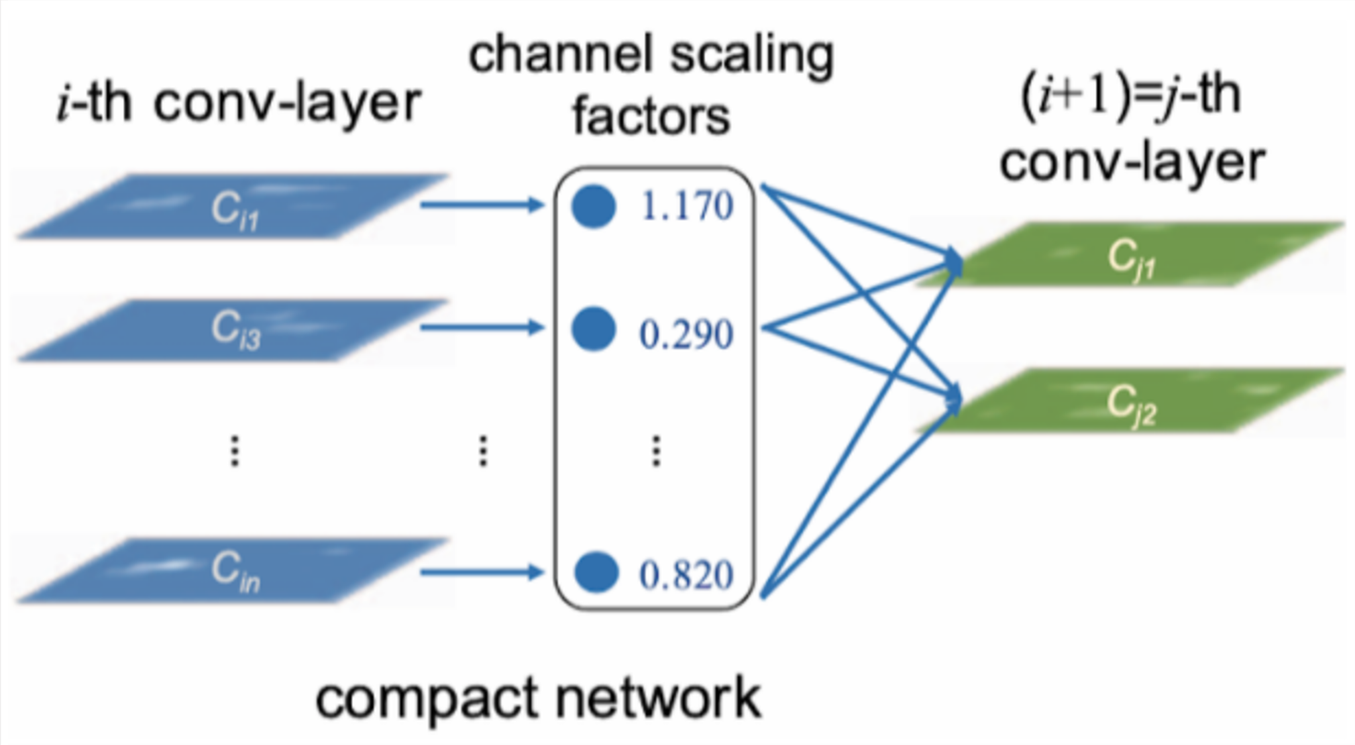
객체의 종류, 위치, 크기를 적은 연산량으로 검출하는 **One-Stage Detector**

J. Redmon and A. Farhadi, “YOLOv3: An Incremental Improvement,” arXiv:1804.02767, 2018.

YOLO v3 기반검출 모델, 최적화 방법론 적용

Model 최적화 1. Channel Pruning

‘Channel Pruning’을 적용한 Network Slimming

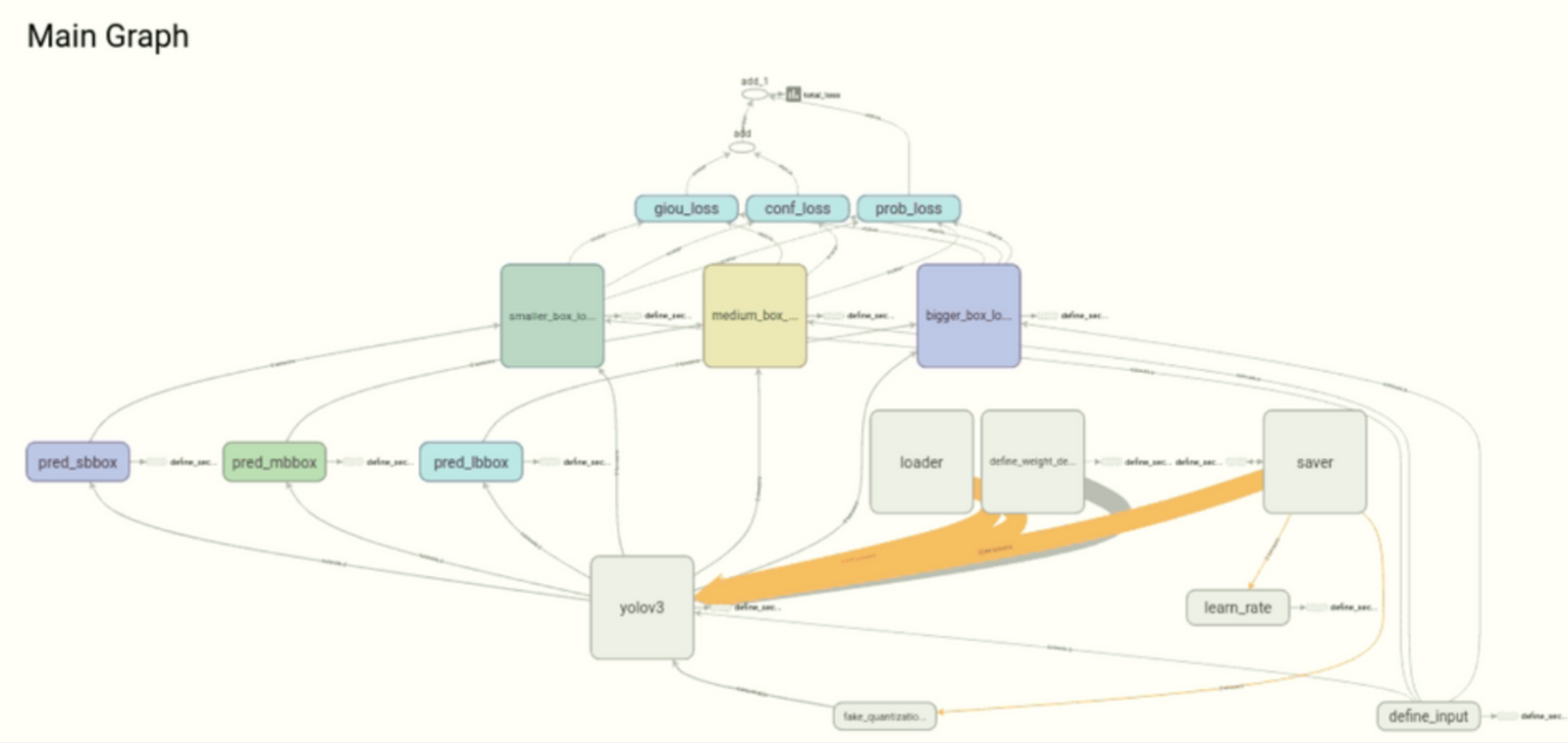


Zhuang Liu, "Learning Efficient Convolutional Networks through Network Slimming"
2017 IEEE International Conference on Computer vision

Model 최적화 2. QAT

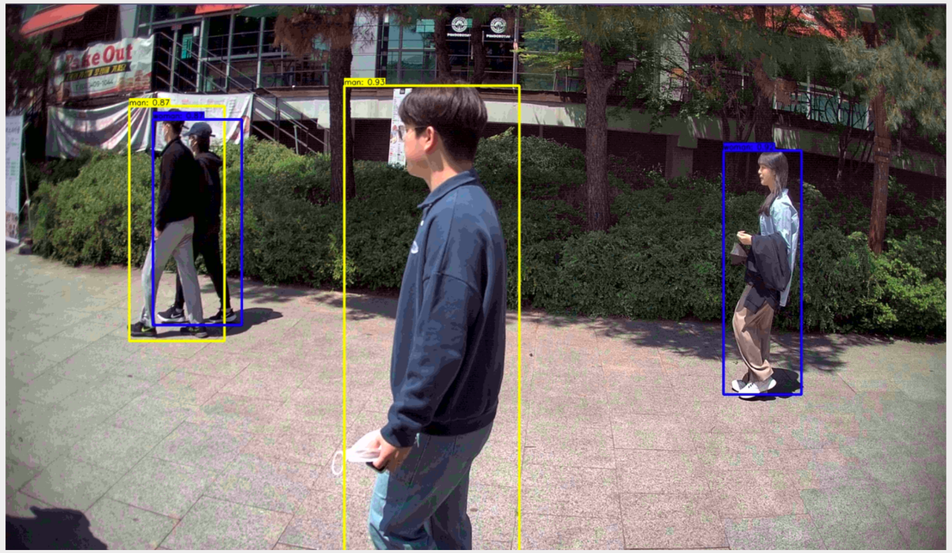
Quantization-aware Training (QAT, 양자화 인식 학습)

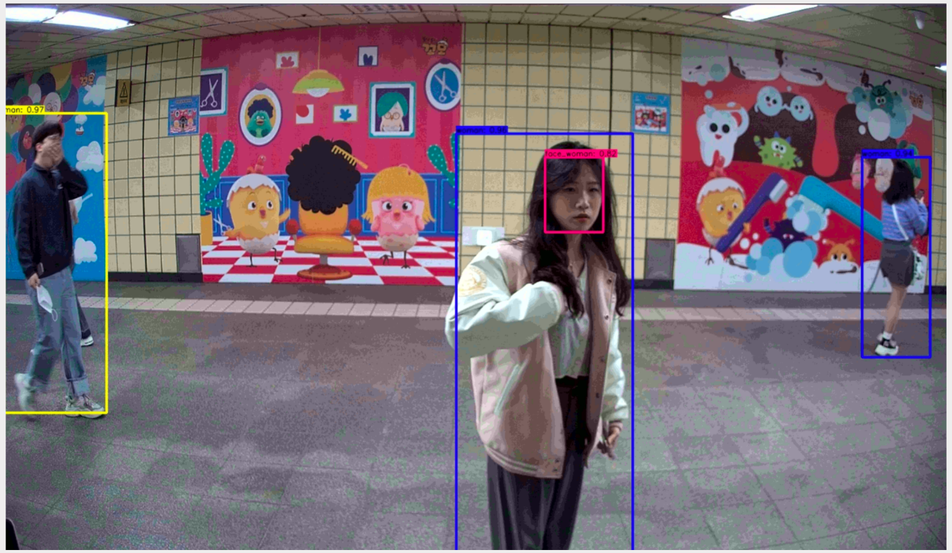
Channel Pruning 적용으로 일시적으로 감소한 정확도,
QAT 적용하며 2차 학습(fine-tuning)하여 성능 다시 향상

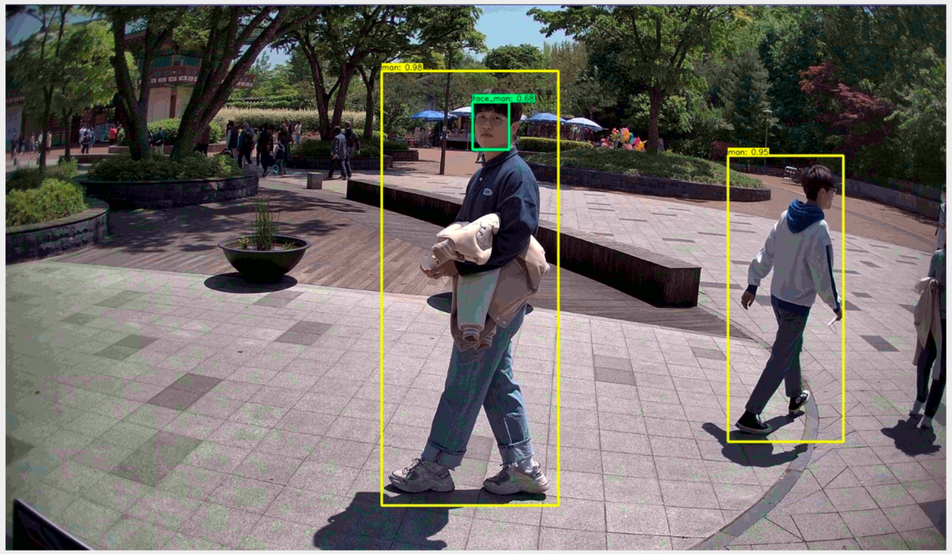


양자화 인식 학습(QAT) 적용 후 추론 그래프

검출 Model 성능 정성 평가







Tracking

YOLO v3

Channel-wise Pruning

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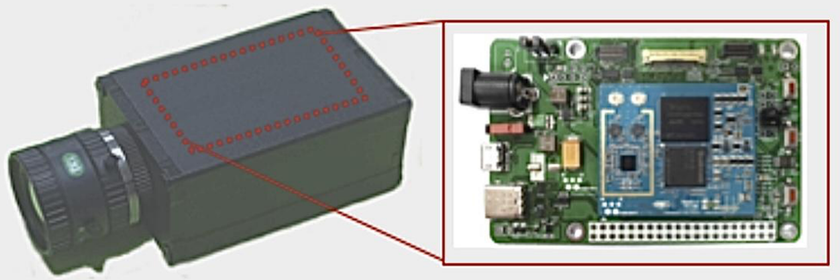
Object Counting

Embedding



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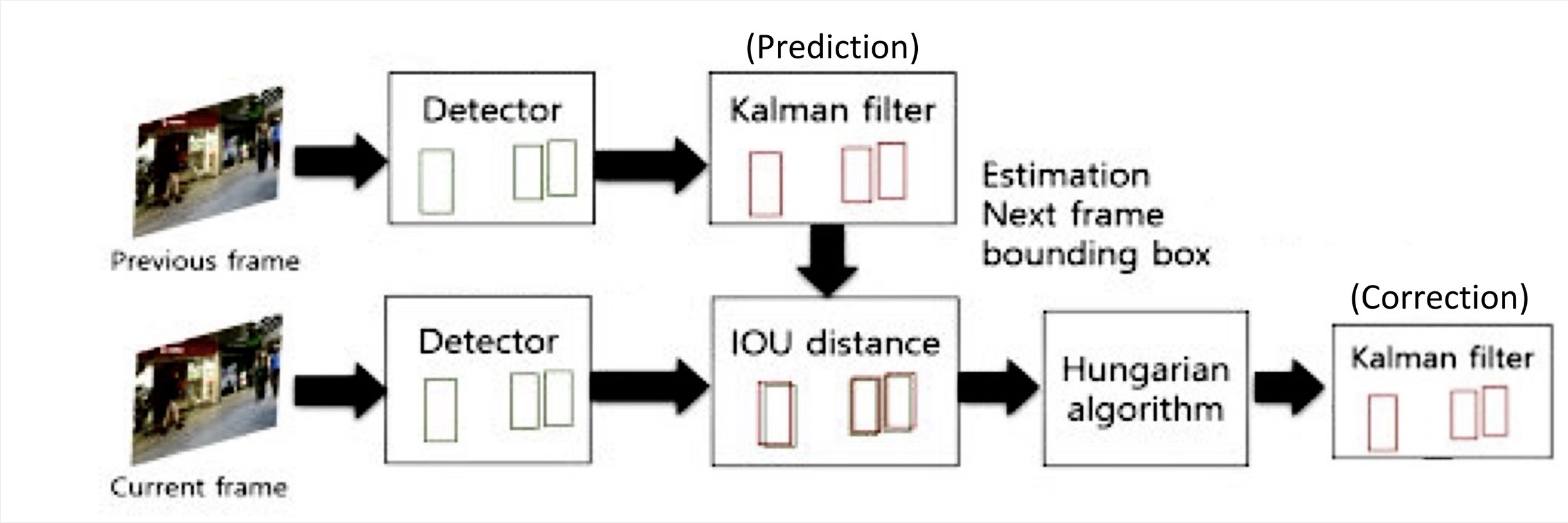
Web

SORT Tracking Algorithm

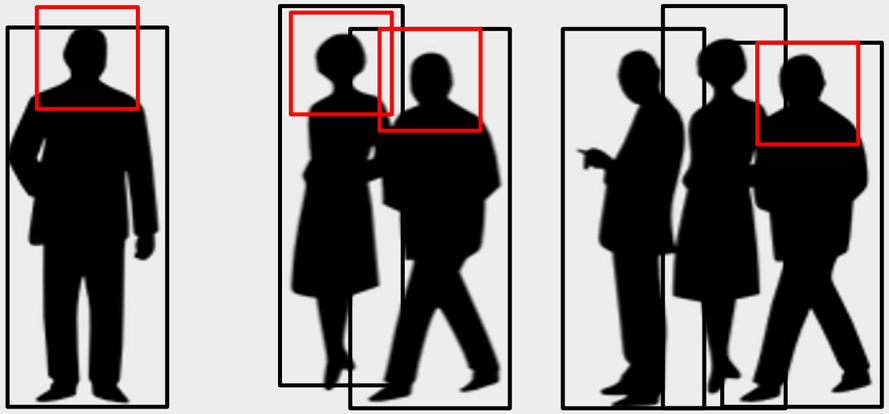


***Kalman Filter*와 *Hungarian Algorithm*을 이용한**

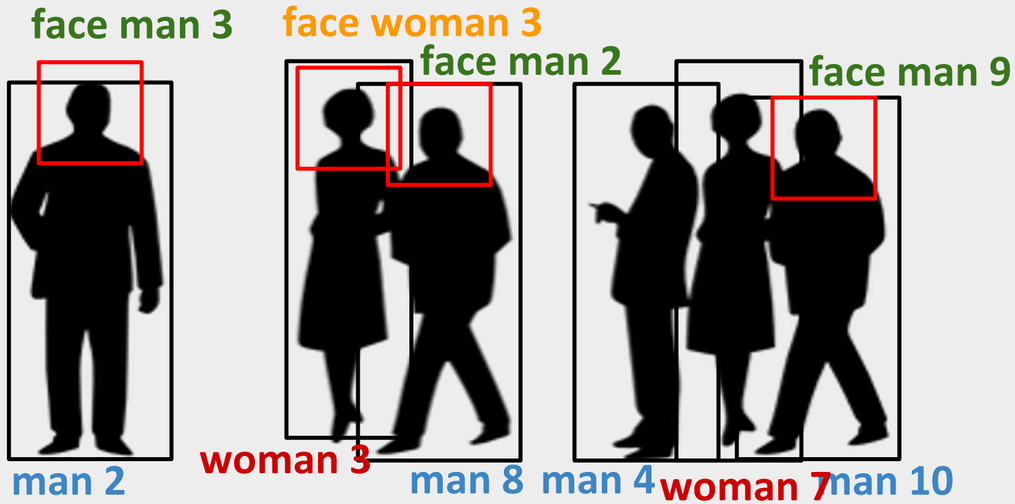
SORT Tracking Algorithm 적용

추적 결과

[x, y, width, height, Object ID, Object Class]



Object Detection



Object Tracking

Counting

YOLO v3

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Kalman Filter

Hungarian Algorithm

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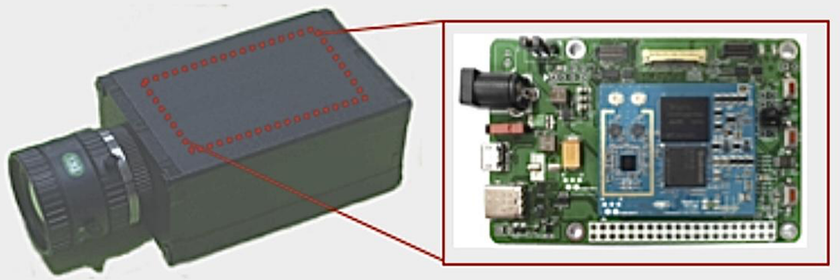
Embedding



QCS605

Web

계수 알고리즘

Embedding

YOLO v3

Channel-wise Pruning

Quantization

Object Detection

Kalman Filter

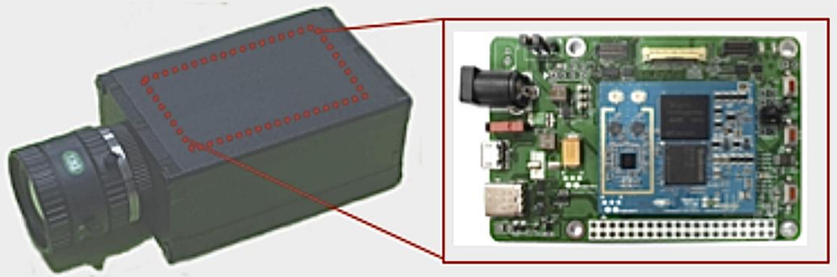
Hungarian Algorithm

Object Tracking

Counting Algorithm

Object Counting

Embedding



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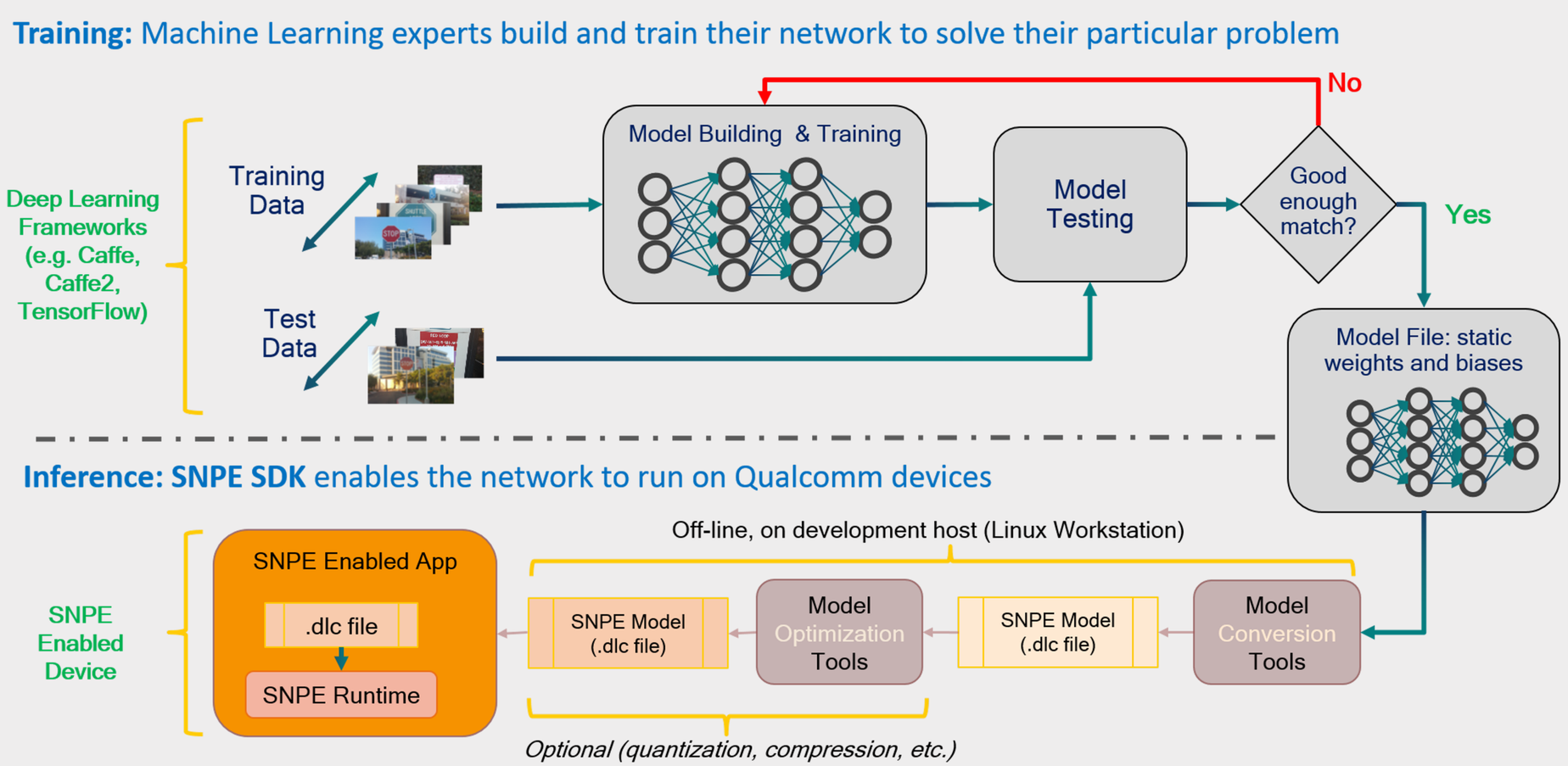
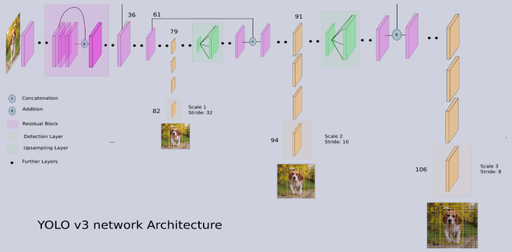
Embedding Part



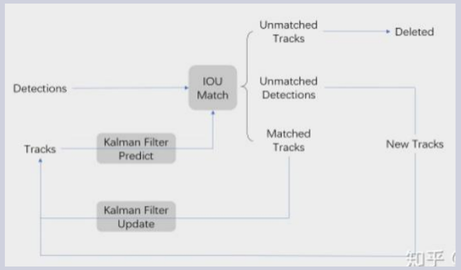
SNPE (Snapdragon Neural Processing Engine):

Qualcomm에서 개발한 모바일 기기용 AI 프레임워크

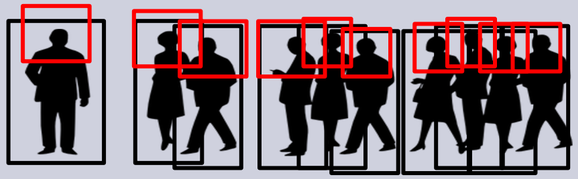
Embedding & LAN 통신



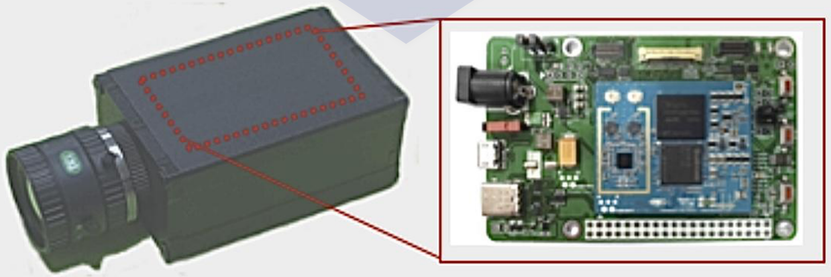
1. 검출 모델



2. 추적 알고리즘



3. 계수 알고리즘



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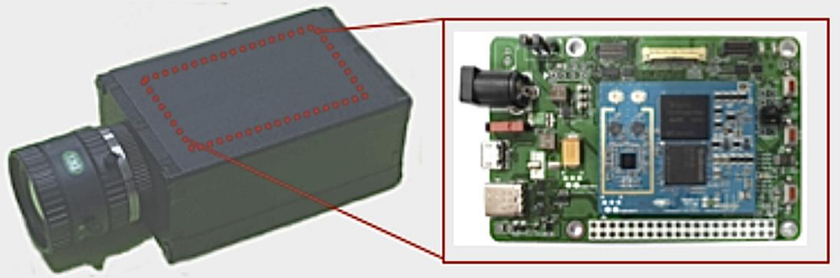
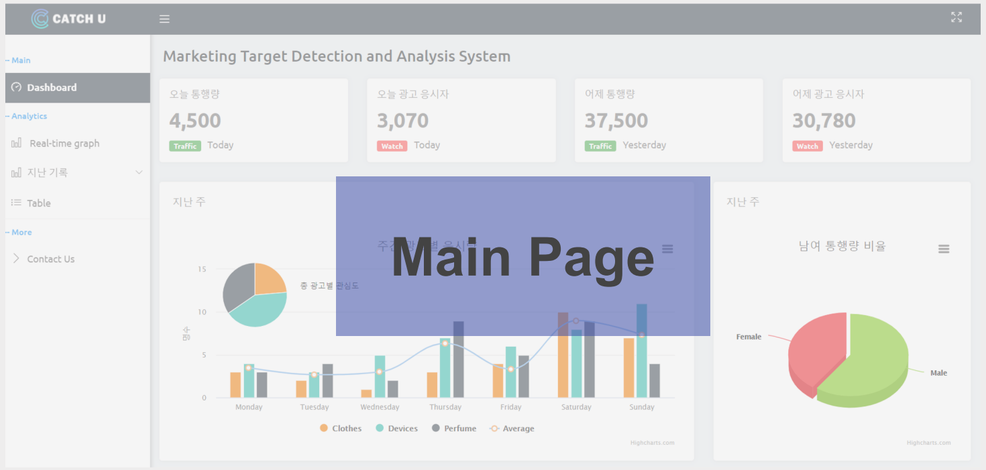
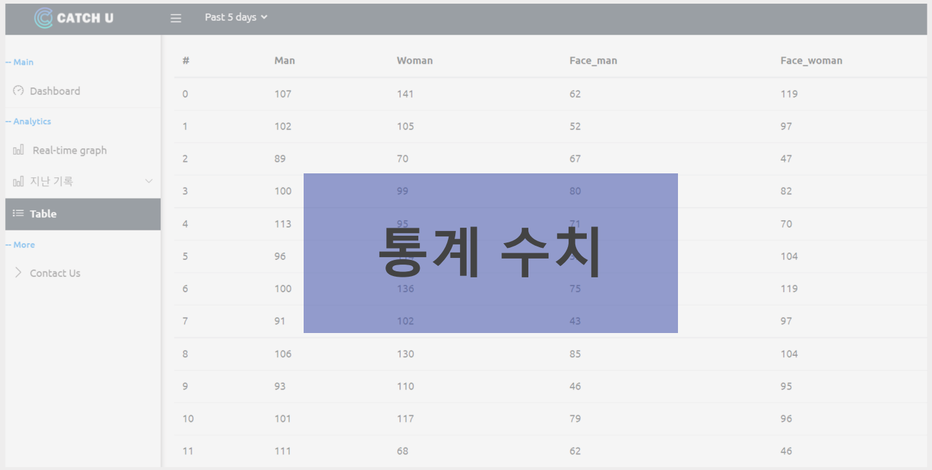


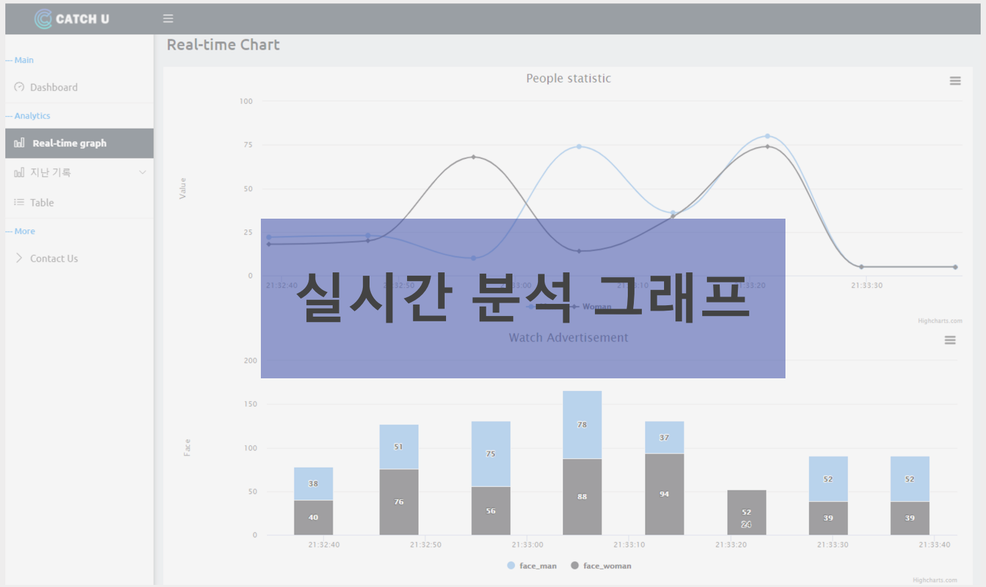
QCS605

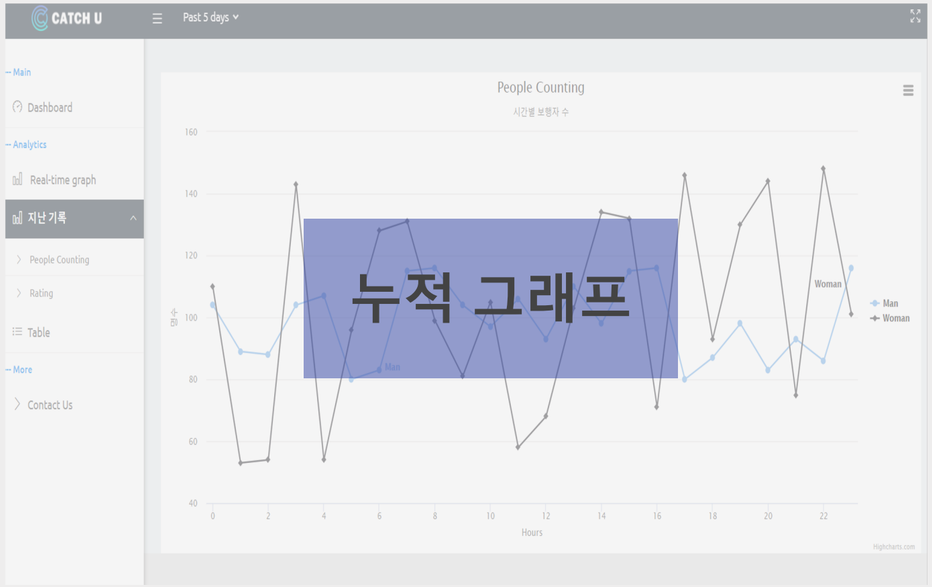
Web

Web Service









보행자 계수 현황을 다양한 Chart로 시각화

03 실험 결과

개발 환경

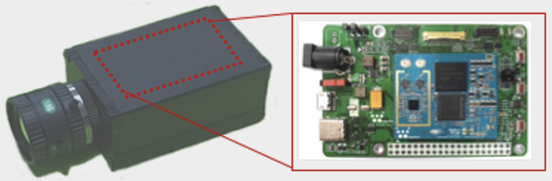
Data Set

검출 성능 평가

계수 성능 평가

개발 환경

Dataset 구축



임베디드 보드 일체형 카메라
(협력 업체: WITHROBOT)

Tensorflow

Vysor

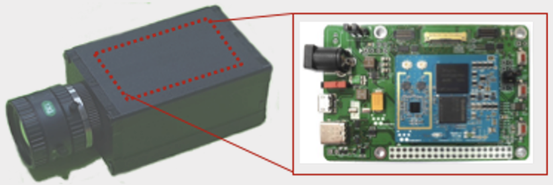
Labelimg

검출기 학습

Tensorflow

Pytorch

Board & Web



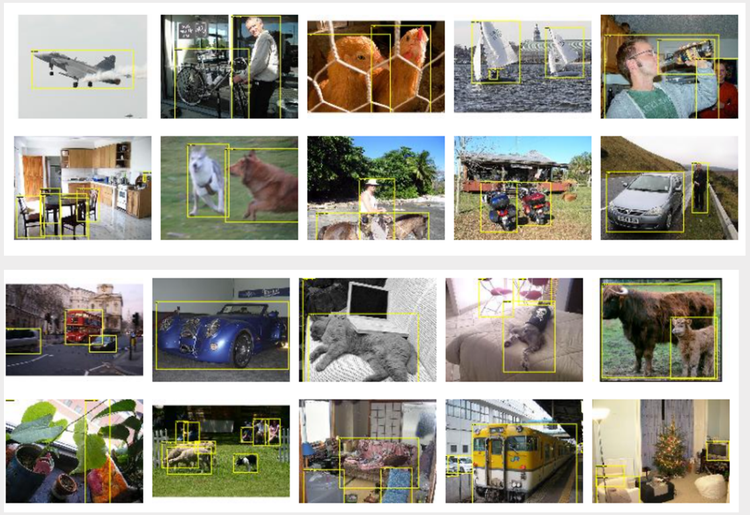
임베디드 보드 일체형 카메라
(협력 업체: WITHROBOT)

Highcharts

Flask

Ajax

Dataset



Pascal VOC 2007

CelebA

수집 Dataset
3879 장

7335 장

총 Dataset : 11214 장

Train Data : 9531 장
8.5

Test Data : 1683 장
1.5

검출 Model 성능 정량 평가

💫 Channel Pruning 적용 전후 변화

	Channel Pruning x	70% Channel Pruning
Total Dataest (공용+수집)	77.81%	73.38%
공용 Dataset	73.98%	69.09%
수집 Dataset	82.91%	79.37%
inference Time (GPU)	0.0099 ms	0.0063 ms

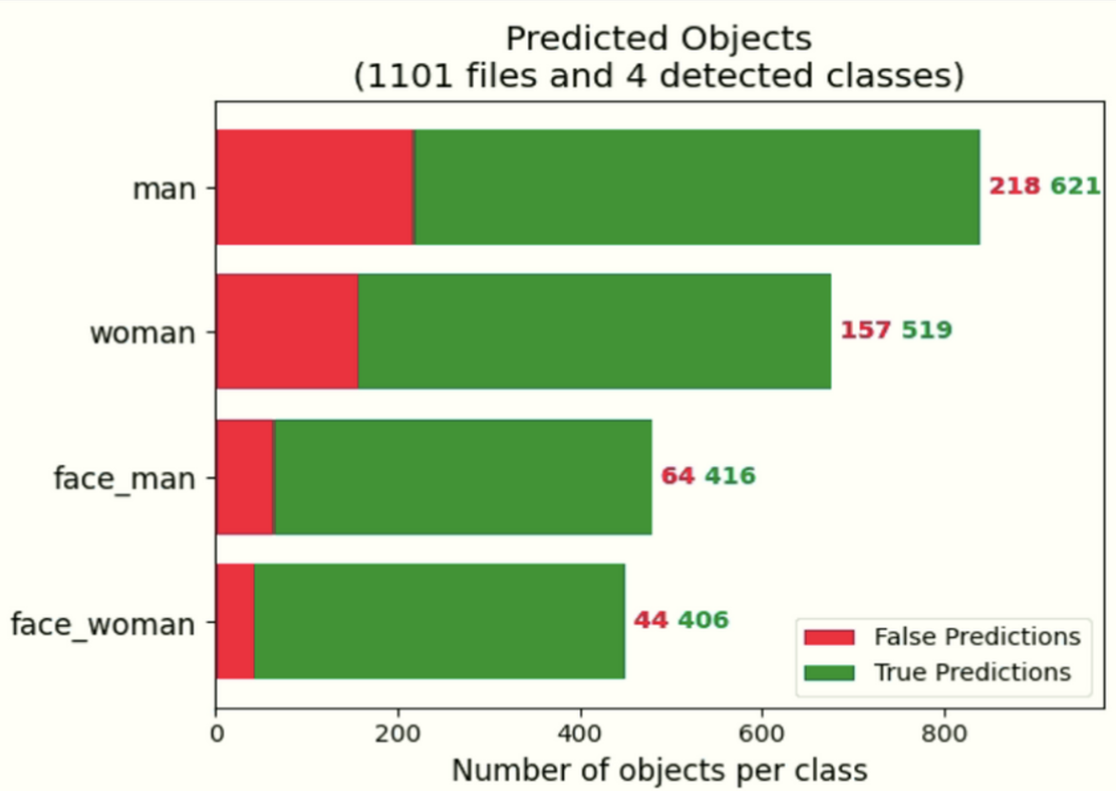
➡ 70 % Channel Pruning 적용 후

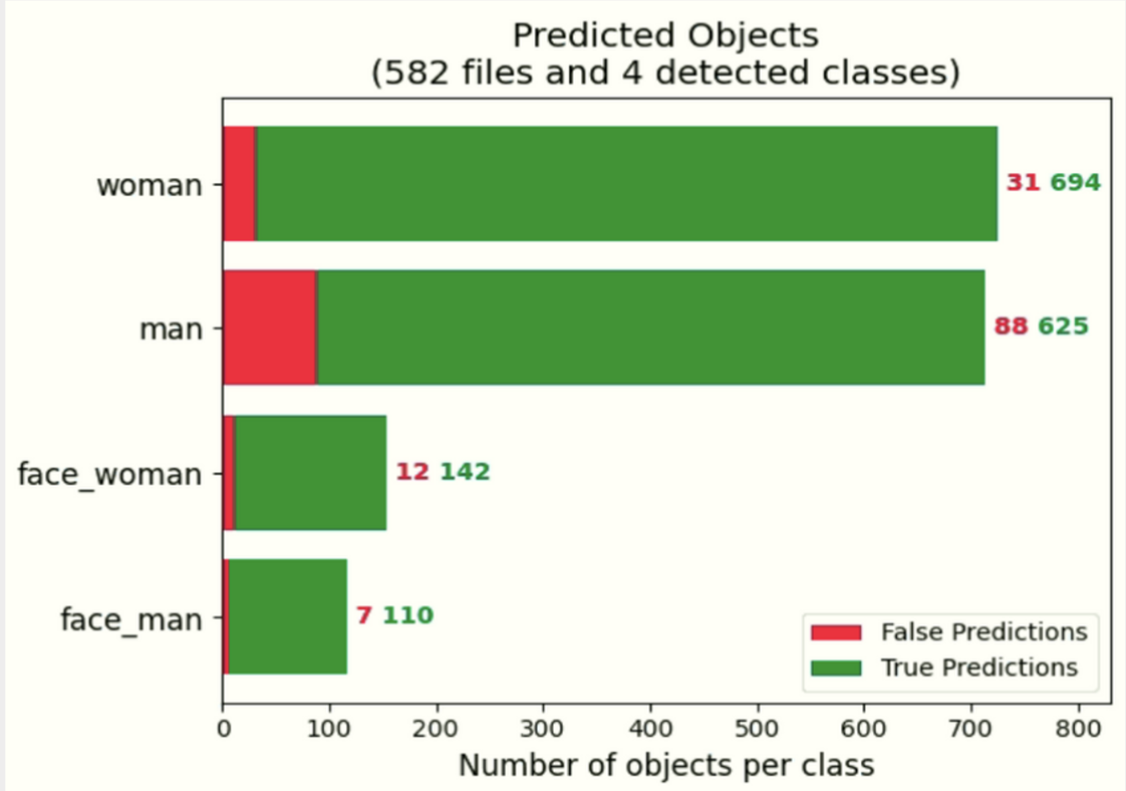
👉 여전히 높은 정확도 유지

👉 추론 시 Inference Time 감소

검출 Model 성능 정량 평가

Total Dataset mAP: 73.38 %





공용 Dataset mAP: 69.09 %
(Pascal VOC 2007 + CelebA)

수집 Dataset mAP **79.37 %**

계수 System 성능 평가

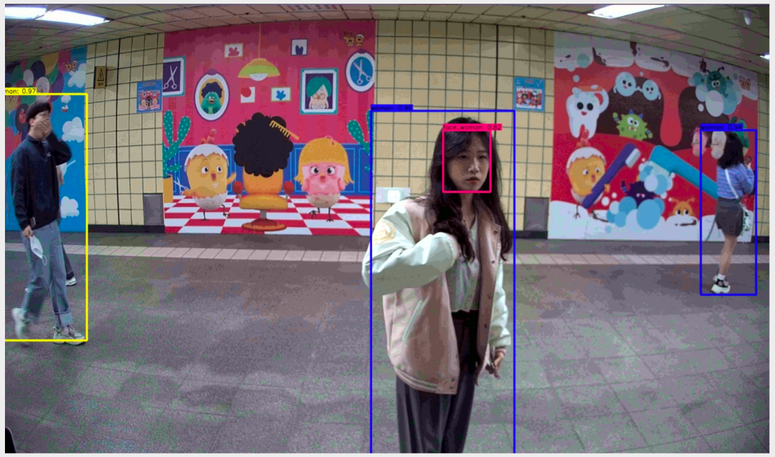
$$\text{계수 오차율} = \frac{|\text{참값} - \text{실험결과 값}|}{\text{참값}} \times 100\ (\%)$$

“100명”

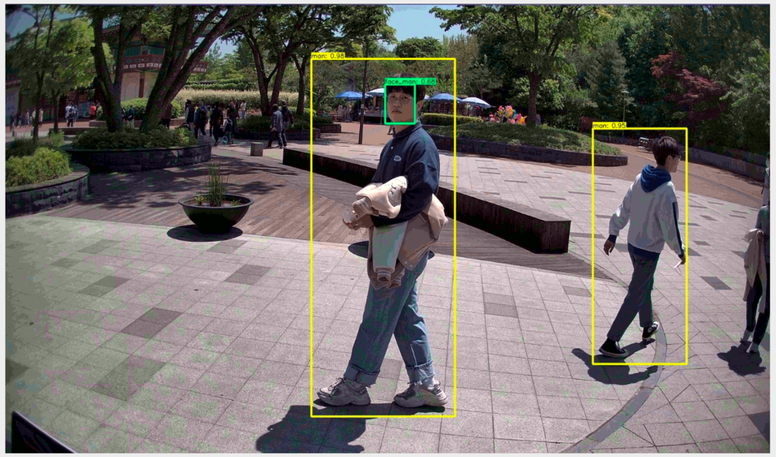
계수 System 성능 평가

계수 성능 평가 (계수 오차율)

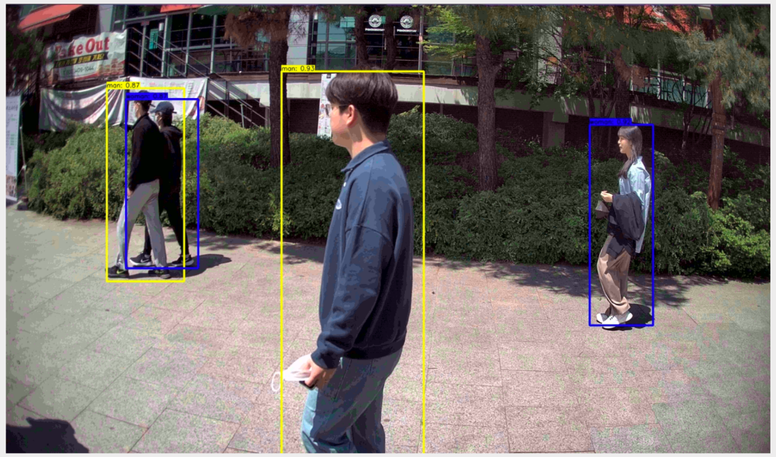
	보행자 (남)	보행자 (여)	광고 응시자 (남)	광고 응시자 (여)
Case 1	5 %	6 %	11 %	13 %
Case 2	7 %	9 %	10 %	8 %
Case 3	9 %	7 %	12 %	10 %



1. 어린이대공원 지하철 내



2. 어린이대공원 1번 출구 (지상)



3. 세종대학교 정문 앞 버스정류장

04 시연 영상

05 시장성

향후 발전 방향

Business Model

프로젝트 기대효과

계수 시스템 시장전망

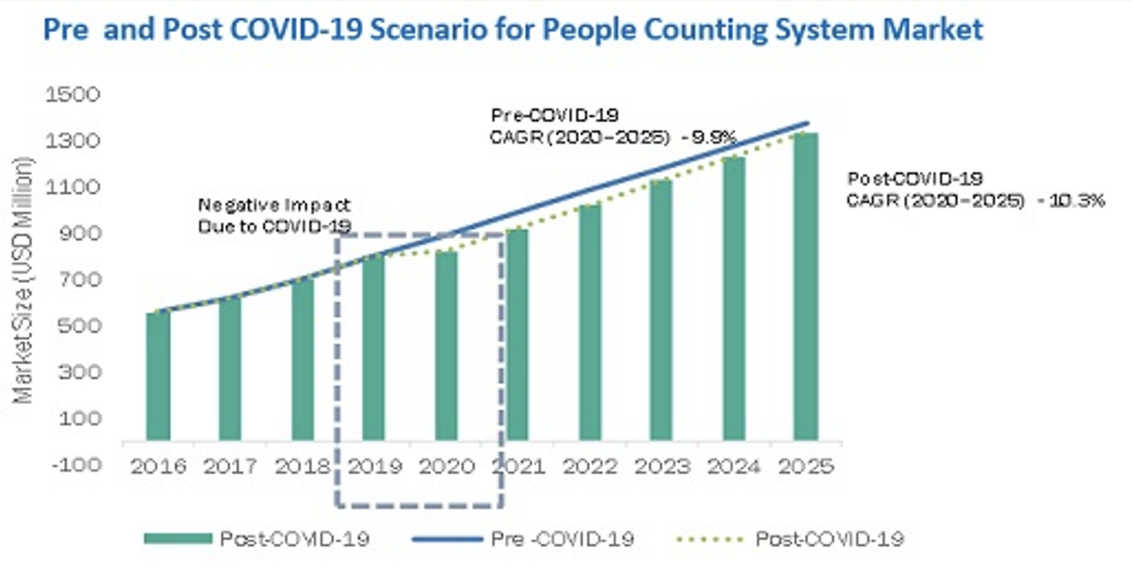


그림 1. COVID-19 전후 사람 계수 시스템 시장 변화 차트

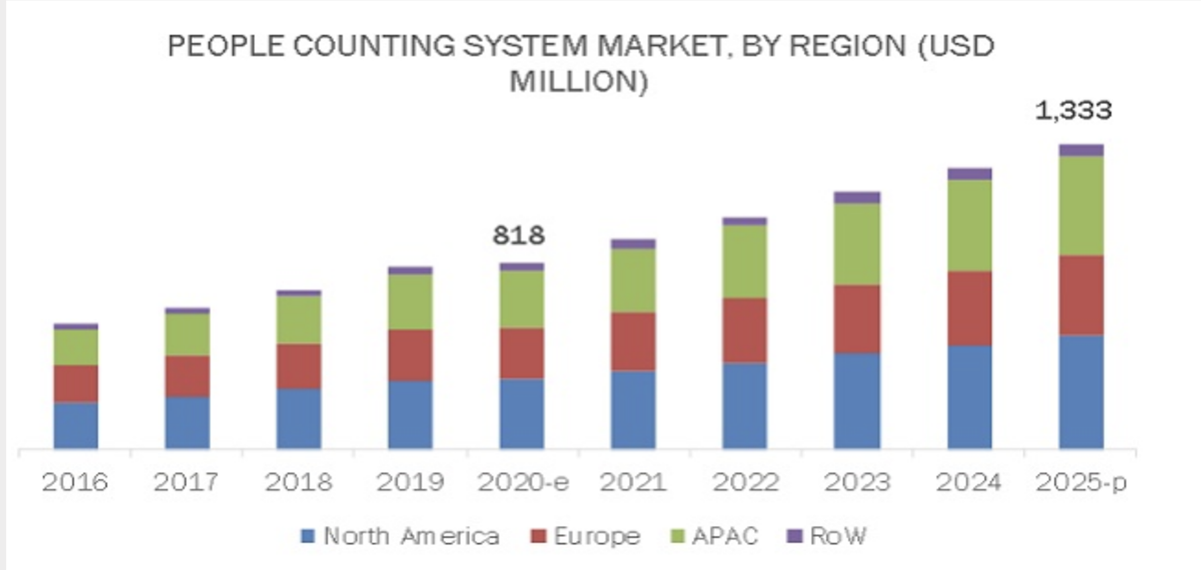


그림 2. 지역별 사람 계수 시스템 시장 현황

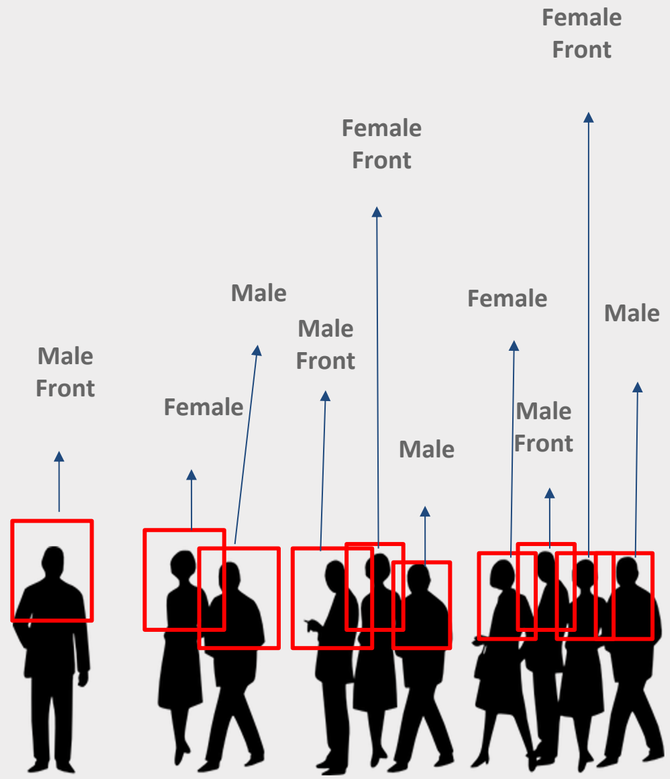
전망성

- 전체 보행자 계수 시스템 시장 규모는 2020년 약 8억 8100만 달러에서 2025년 1조 3,300억 달러로 성장할 것으로 예상
- 예측 연도 동안 10% CAGR로 성장할 것으로 예상

출처 :People Counting System Market with COVID-19 Impact Analysis by Type (Unidirectional, Bidirectional)

활용 방안

실시간 보행자 맞춤형 광고 추천 시스템



감사합니다