Traffic Analysis System

27/05/2021

Software Requirements and Installation

1. **OS: Ubuntu 20.04 LTS**

2. **Python version 3.8**
   apt install python3.8
   apt install python3-pip

3. **FFmpeg version 4 or newer**
   apt install ffmpeg

4. **PostgreSQL version 12 or newer**
   apt install postgresql
   create custom user, password, database

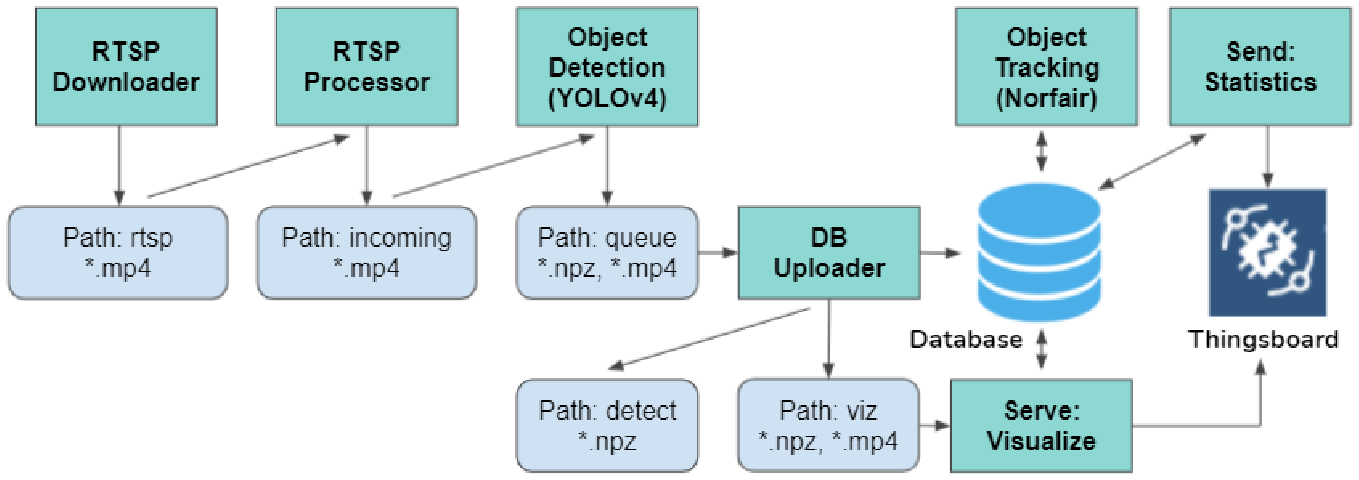
5. **Web server (Apache or Nginx)**

6. **Python libs from standard repo (pip install -r requirements.txt)**
   ffmpeg-python
   psutil
   psycopg2-binary
   pandas
   paho-mqtt
   norfair
   pandarallel

7. **Special Python libs**
   - PyTorch for system CUDA version (https://pytorch.org/)
   - OpenCV 4
     apt update
     apt install libopencv-dev python3-opencv

8. **Traffic Analysis System**
   8.1. Install software (https://github.com/DRR-IGI/workflow.git)
   8.2. Setup local configuration file (bin/config.ini)
   8.3. Make data dirs
        python makedirs.py
   8.3. Setup database
        psql -d (db_name) < ../sql/schema.sql
   8.4. Start/ Stop the system
        bin/start.sh
        bin/stop.sh

Main Processing Workflow



1. **RTSP Downloader**
   Download segment of RTSP video into path: rtsp

2. **RTSP Processor**
   Check and move complete video segments into path: incoming

3. **OBject Detection (YOLOv4)**
   Detect objects in video, write detection results to a npz file. Move complete data into path: queue

4. **DB Uploader**
   - Upload detection results, move the npz file to path: detect
   - Generate frame-no and timestamp mapping to support visualization, move the npz file with video into path: viz

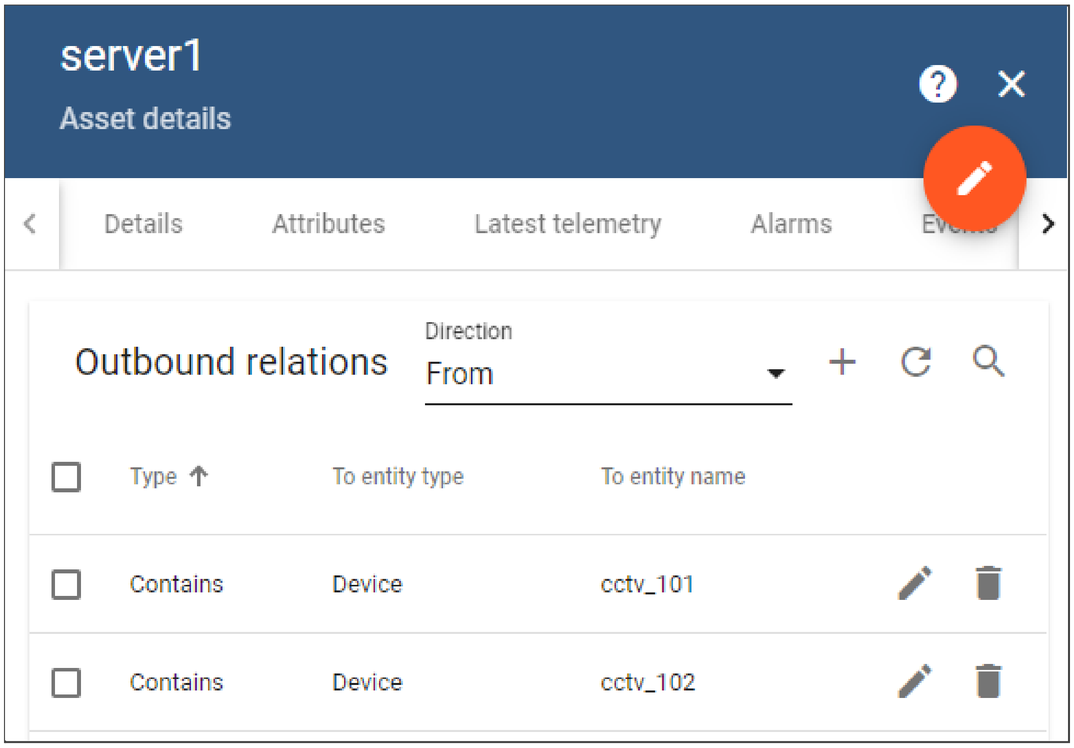
5. **Object Tracking (Norfair)**
   In the database, wait for new detection data and create tracking data

6. **Serve: Visualize**
   Periodically, generate visualization and send a trigger to Thingsboard

7. **Send: Statistics**
   Periodically, send statistic to Thingsboard

System Configuration

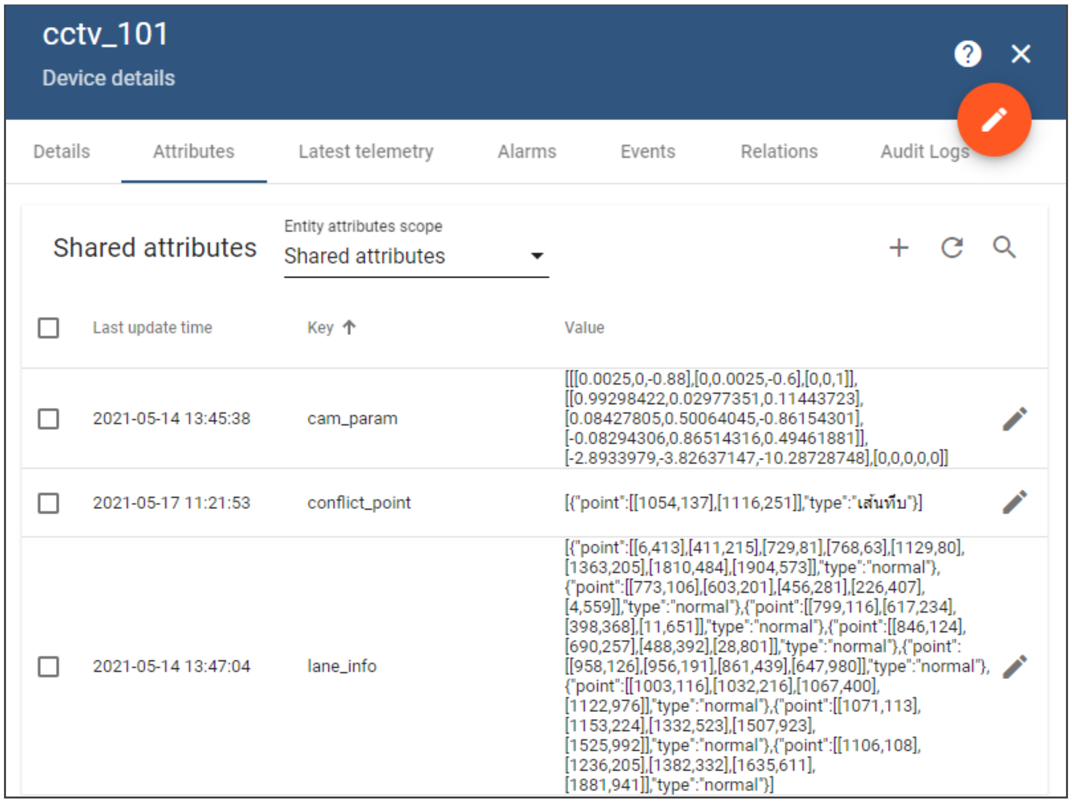
1. Thingsboard Relationship and Attributes



Outbound relations

Direction: From

Type	To entity type	To entity name
Contains	Device	cctv_101
Contains	Device	cctv_102

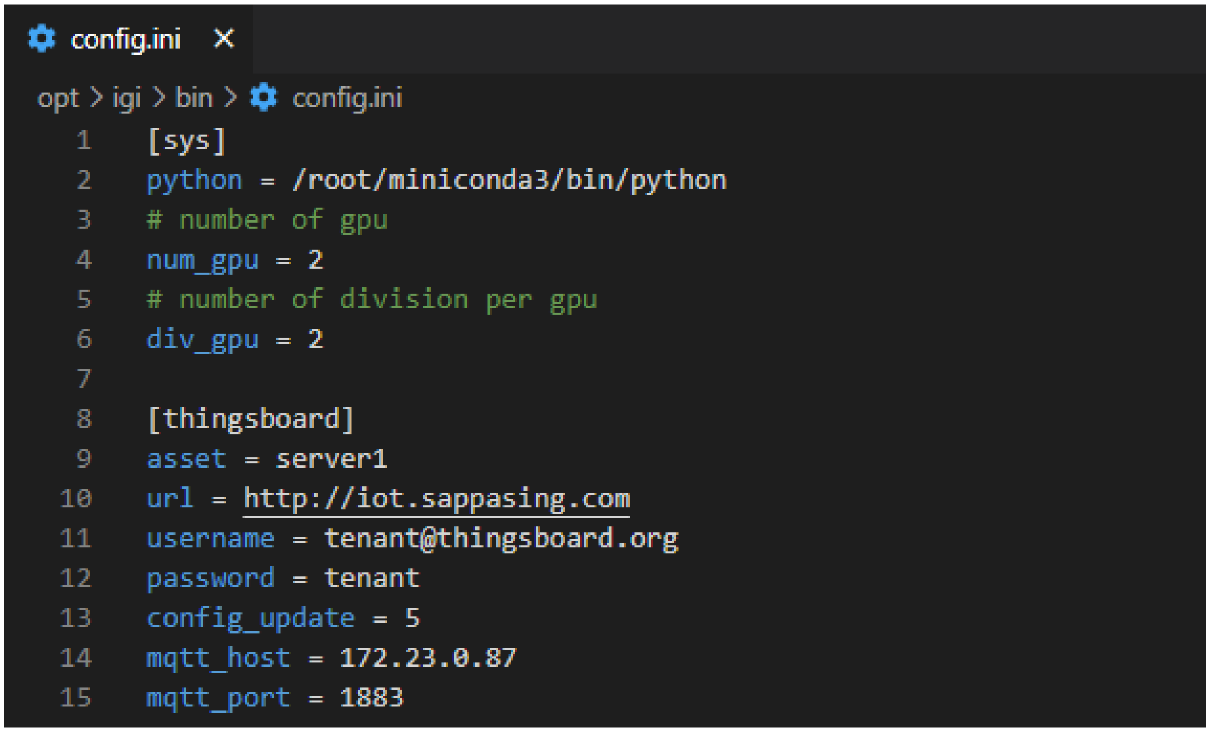


Shared attributes

Entity attributes scope: Shared attributes

Last update time	Key	Value
2021-05-14 13:45:38	cam_param	[[[0.0025,0,-0.88],[0,0.0025,-0.6],[0,0,1]], [[0.99298422,0.02977351,0.11443723], [0.08427805,0.50064045,-0.86154301], [-0.08294306,0.86514316,0.49461881]], [-2.8933979,-3.82637147,-10.28728748],[0,0,0,0,0]]
2021-05-17 11:21:53	conflict_point	[{"point":[[1054,137],[1116,251]],"type":"เส้นทึบ"}]
2021-05-14 13:47:04	lane_info	[{"point":[[6,413],[411,215],[729,81],[768,63],[1129,80], [1363,205],[1810,484],[1904,573]],"type":"normal"}, {"point":[[773,106],[603,201],[456,281],[226,407], [4,559]],"type":"normal"},{"point":[[799,116],[617,234], [398,368],[11,651]],"type":"normal"},{"point":[[846,124], [690,257],[488,392],[28,801]],"type":"normal"},{"point": [[958,126],[956,191],[861,439],[647,980]],"type":"normal"}, {"point":[[1003,116],[1032,216],[1067,400], [1122,976]],"type":"normal"},{"point":[[1071,113], [1153,224],[1332,523],[1507,923], [1525,992]],"type":"normal"},{"point":[[1106,108], [1236,205],[1382,332],[1635,611], [1881,941]],"type":"normal"}]

2. Local configuration (config.ini)



config.ini ×

opt > igi > bin > config.ini

```
[sys]
python = /root/miniconda3/bin/python
# number of gpu
num_gpu = 2
# number of division per gpu
div_gpu = 2

[thingsboard]
asset = server1
url = http://iot.sappasing.com
username = tenant@thingsboard.org
password = tenant
config_update = 5
mqtt_host = 172.23.0.87
mqtt_port = 1883
```

3. Database: CCTV Table

Column	Description
id	ID of CCTV (Integer)
device_id	Thingsboard: Device ID
name	Thingsboard: Name of CCTV
access_token	Thingsboard: Access Token
attributes	Thingsboard: CCTV shared attributes
last_update	Attributes last updated
active	Ready for processing (with valid attributes) Required Attributes: 'cam_param', 'lane_info', 'speed_marker', 'rtsp_src' ** If "ai_disable" = True, CCTV Active = False **

Components

1. **Config Updater (config_update.py)**
   Periodically update CCTV config from Thingsboard to DB

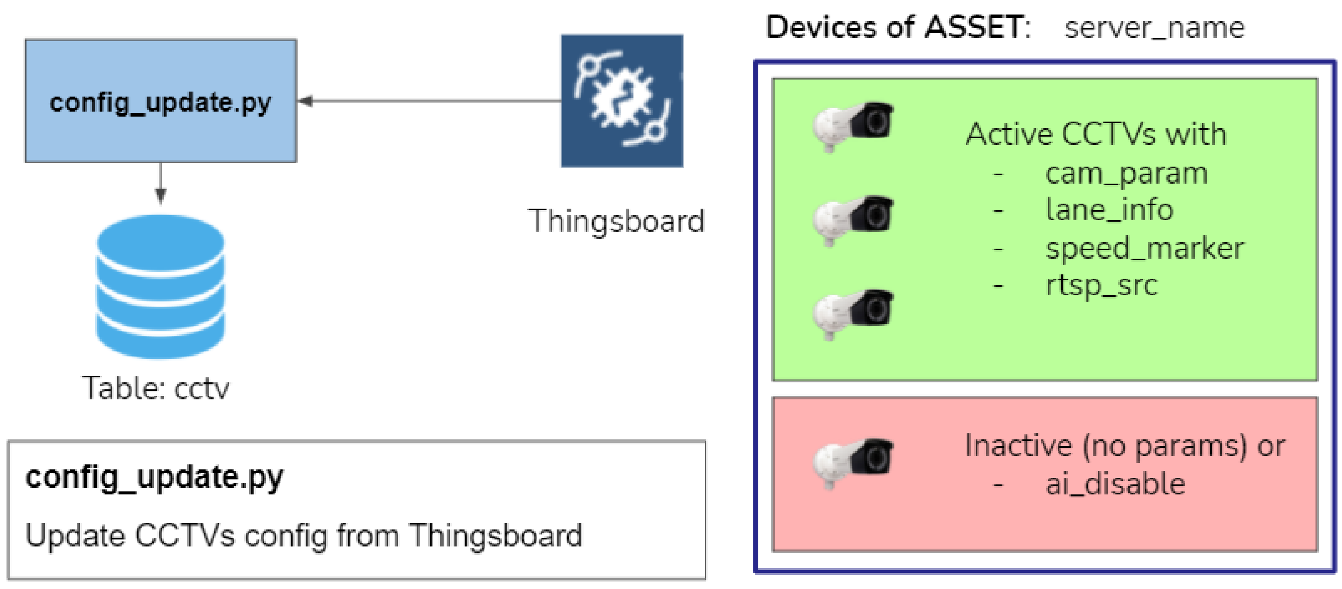
2. **CCTV Processor (cctv_processor.py)**
   Continuously process CCTV data

3. **Path Monitor (monitor.py)**
   Watch and process files in the path

Type of Processing

System processing	Per CCTV processing	Concurrent processing
Config Updater	CCTV Processor ● rtsp_download ● rtsp_process ● track ● mod_send_lanespeed ● mod_serve_lanespeed	Path Monitor

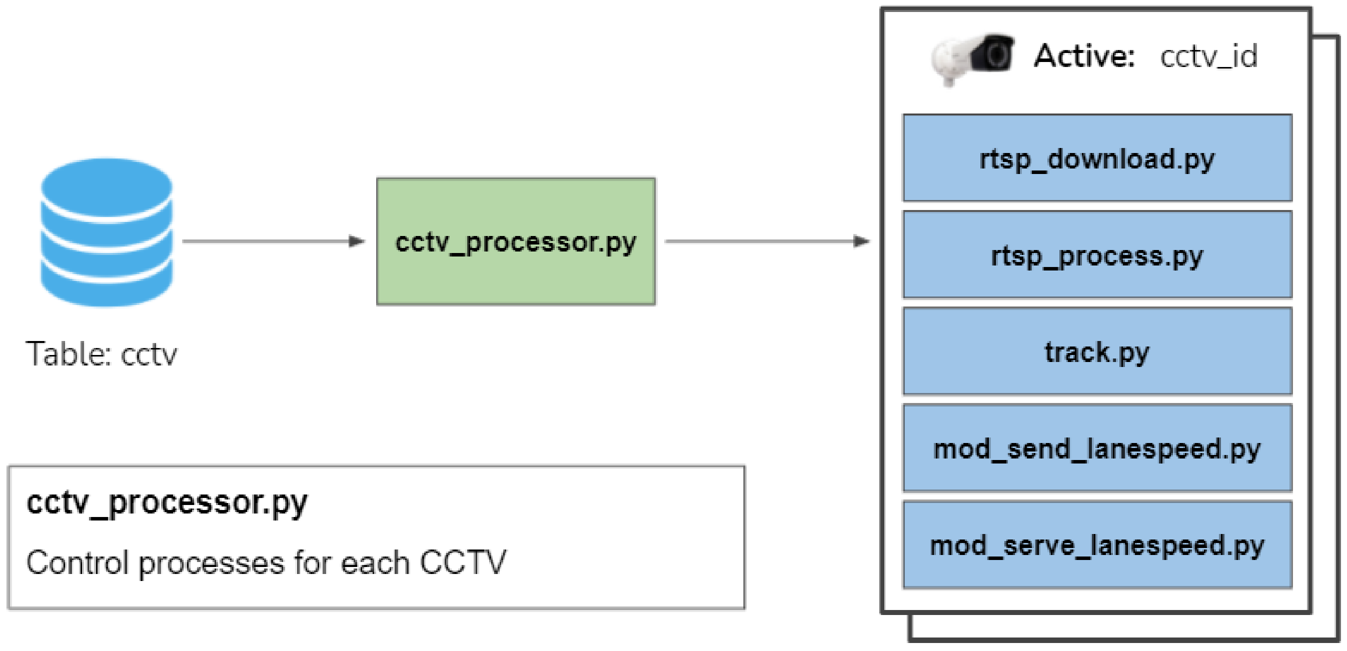
Config Updater



config_update.py

Update CCTVs config from Thingsboard

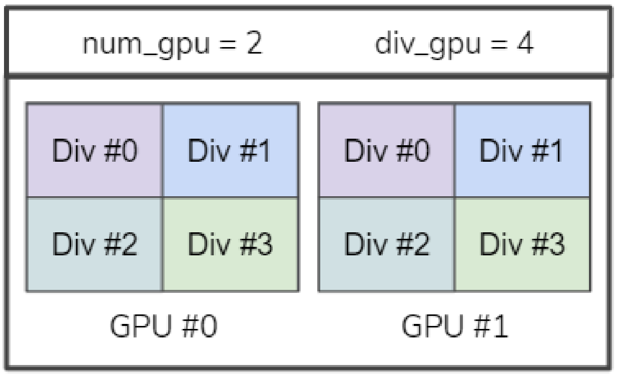
CCTV Processor



cctv_processor.py

Control processes for each CCTV

Path Monitor



```
monitor.py  <path>
  ├─monitor.py  <path> <gpu#> <div#>
  ├─monitor.py  <path> <gpu#> <div#>
  │ ...
  └─monitor.py  <path> <gpu#> <div#>
```

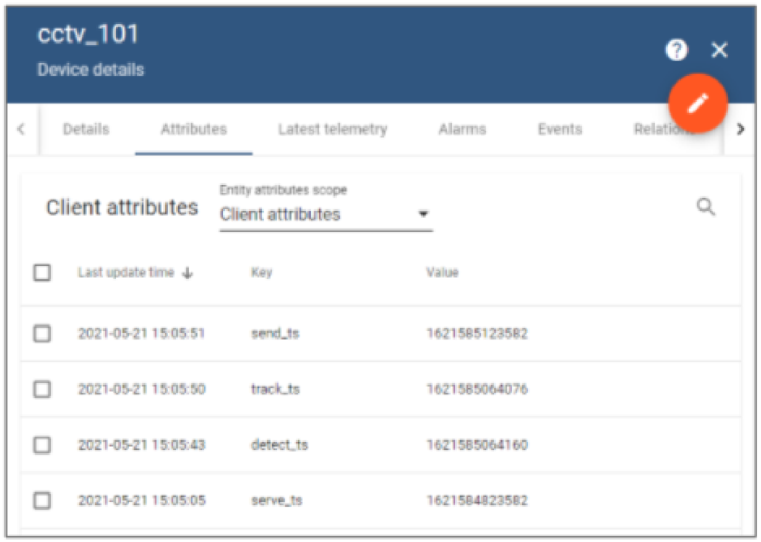
monitor.py

Watch and process files in path

Input Path	Operation	Output Path
incoming	detect.py	queue
queue	upload.py	viz, detect

CCTV Processing Status

Process	Key
RTSP Download / Process	rtsp_ts
Detect / Upload	detect_ts
Track	track_ts
Send Statistic	send_ts
Serve Visualization	serve_ts

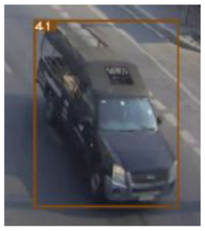


Last update time	Key	Value
2021-05-21 15:05:51	send_ts	1621585123582
2021-05-21 15:05:50	track_ts	1621585064076
2021-05-21 15:05:43	detect_ts	1621585064160
2021-05-21 15:05:05	serve_ts	1621584823582

Customization

1. Object Detection

Accurate Class Identification



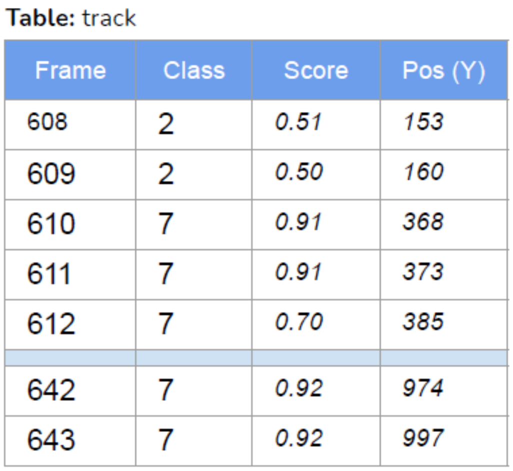
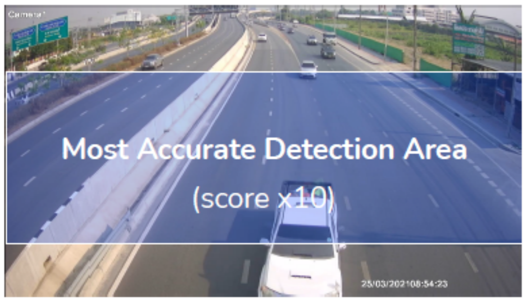
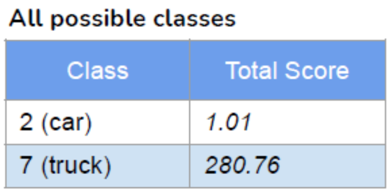


Table: track

Frame	Class	Score	Pos (Y)
608	2	*0.51*	*153*
609	2	*0.50*	*160*
610	7	*0.91*	*368*
611	7	*0.91*	*373*
612	7	*0.70*	*385*
642	7	*0.92*	*974*
643	7	*0.92*	*997*





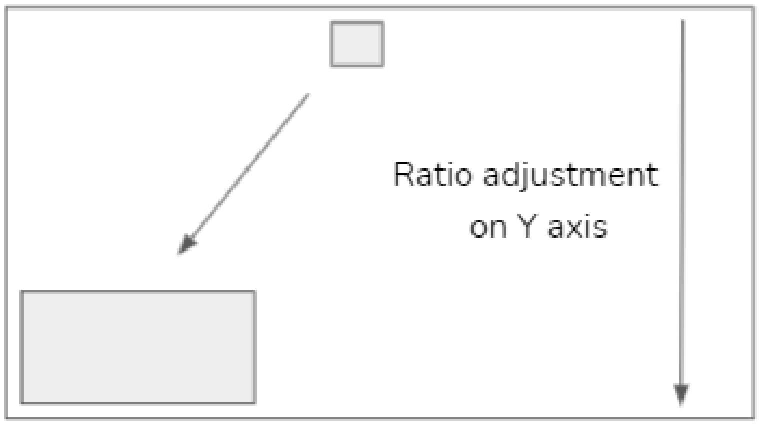
All possible classes

Class	Total Score
2 (car)	*1.01*
7 (truck)	*280.76*

2. Object Tracking

Custom distance function

- Ignore small bounding box
- Ignore Top 10%
- Y-axis distance ratio



Programs and command-line arguments

[config_update.py]

Update CCTV config from Thingsboard

```
python config_update.py [--sync sec]
```

[detect_opencv.py]

Object detection - YOLOv4 OpenCV DNN

```
python detect_opencv.py <source_video> [--weights model_weight_file] [--config
model_config_file] [--output out.npz]
```

[detect.py]

Object Detection - PyTorch YOLOv4

```
python detect.py <source_video> [--weights model_weight_file] [--config
model_config_file] [--output out.npz] [--device cuda_device]
```

[makedirs.py]

Make all required data dirs

[mod_avg_lanespeed.py]

Calculate average lanespeed and number of cars

```
python mod_avg_lanespeed.py <cctv_id> <start_ts> <stop_ts>
```

[mod_conflict_report.py]

Generate conflict report

```
python mod_conflict_report.py <cctv_id> <start_ts> <stop_ts> <out.csv>
```

[mod_LOS.py]

Generate LOS report

```
python mod_LOS.py <cctv_id> <start_ts> <stop_ts> <time_step> <out.csv>
```

[mod_send_lanespeed.py]

Send statistic data to Thingsboard

```
python mod_send_lanespeed.py <cctv_id> [last_ts]
```

[mod_serve_lanespeed.py]

Serve visualize video and send trigger to Thingsboard

```
python mod_serve_lanespeed.py <cctv_id> [last_ts]
```

[mod_viz_detect.py]

Visualize object detection

```
python mod_viz_detect.py <cctv_id> <start_ts> <stop_ts> <out.mp4>
```

[mod_viz_lanespeed.py]

Visualize Lane speed

```
python mod_viz_lanespeed.py <cctv_id> <start_ts> <stop_ts> <out.mp4>
```

[mod_viz_track.py]

Visualize Object Tracking

```
python mod_viz_track.py <cctv_id> <start_ts> <stop_ts> <out.mp4>
```

[mod_viz_trajectory_conflict.py]

Visualize Lane speed with trajectory view

```
python mod_viz_trajectory_conflict.py <cctv_id> <start_ts> <stop_ts> <out.mp4>
```

[monitor.py]

Monitor and process files in the path

```
python monitor.py <queue|incoming> [<gpu_id> <div_id>]
```

[rtsp_download.py]

Download video from RTSP source

```
python rtsp_download.py <cctv_id>
```

[rtsp_process.py]

Check and move RTSP video to path: incoming

```
python rtsp_process.py <cctv_id>
```

[start.sh]

Start the workflow

[stop.sh]

Stop the workflow

[track.py]

Object tracking with Norfair

```
python track.py <cctv_id> [last_ts]
```

[upload.py]

Upload object detection result to DB

```
python upload.py <input_video>
```