Traffic Analysis System

28/05/2021

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

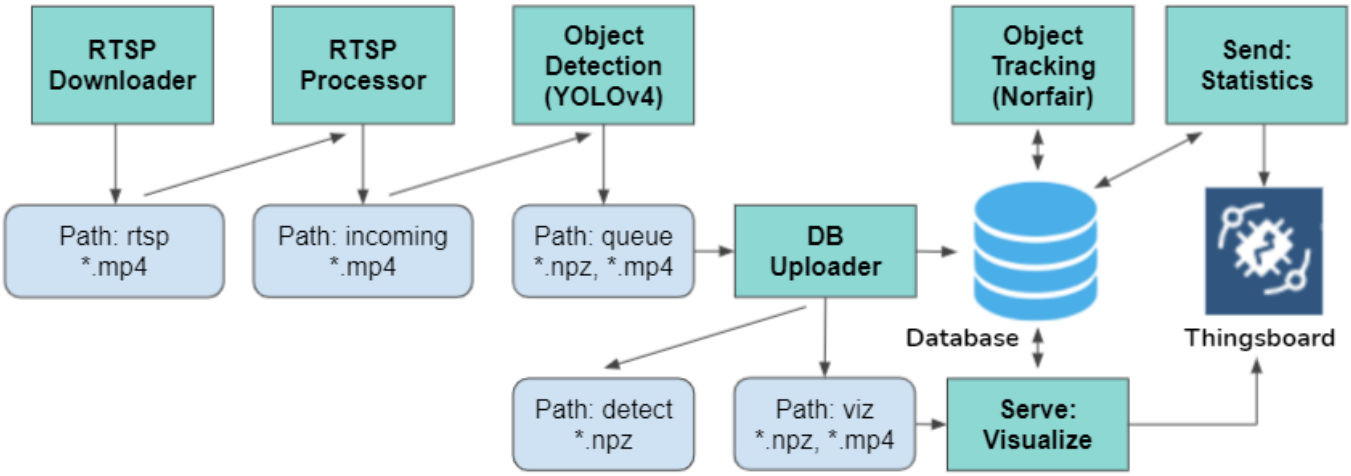
5. **Web server (Apache or Nginx)**

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

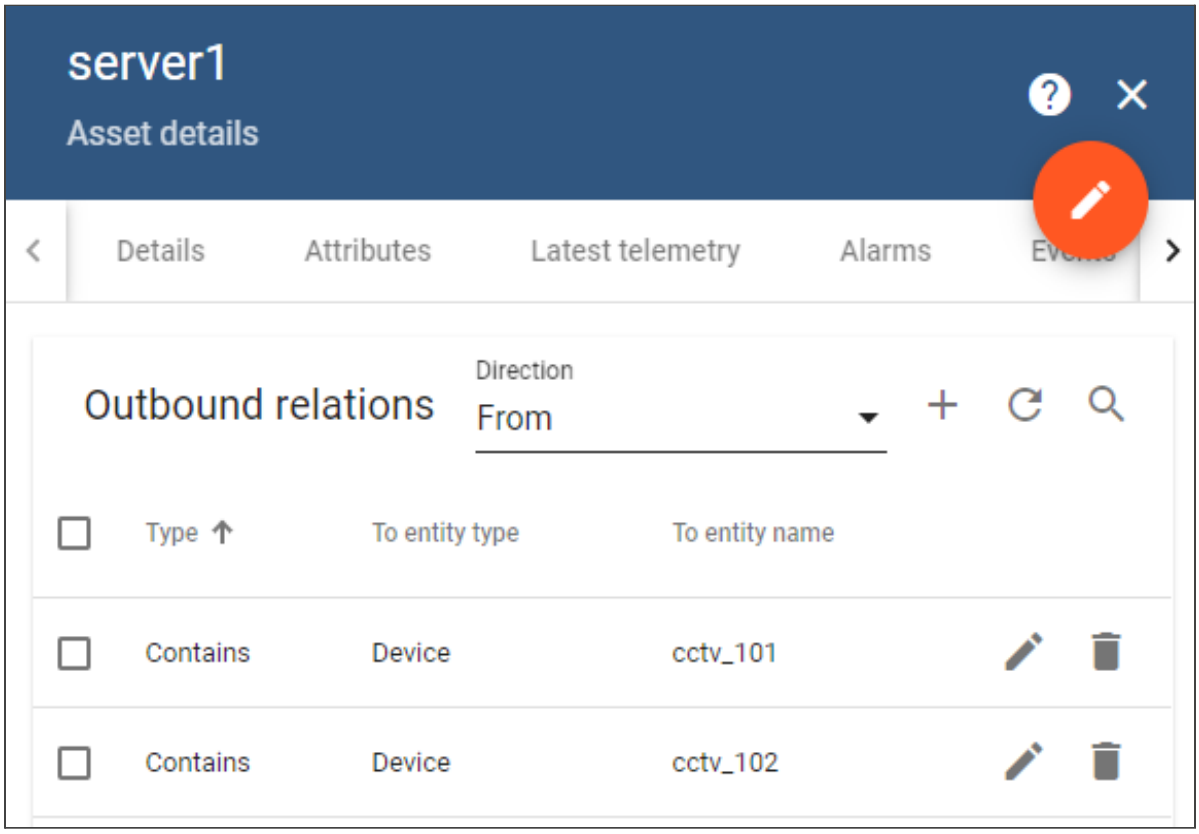
7. **Send: Statistics**
   Periodically, send statistic to Thingsboard

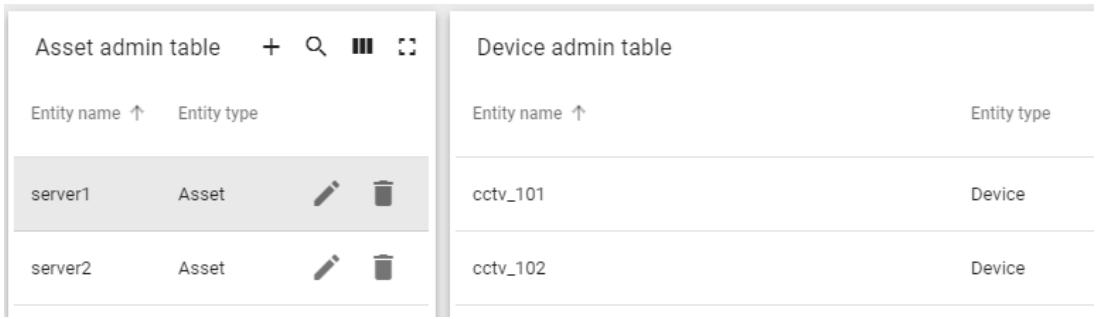
System Configuration

1. Thingsboard Relationship and Attributes

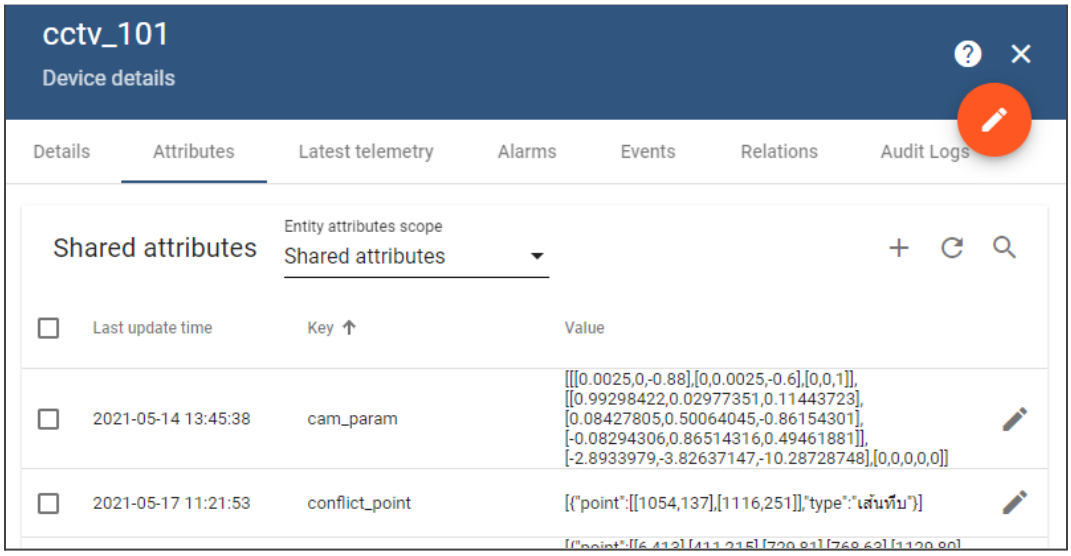
Asset: server

contains devices: **cctv**





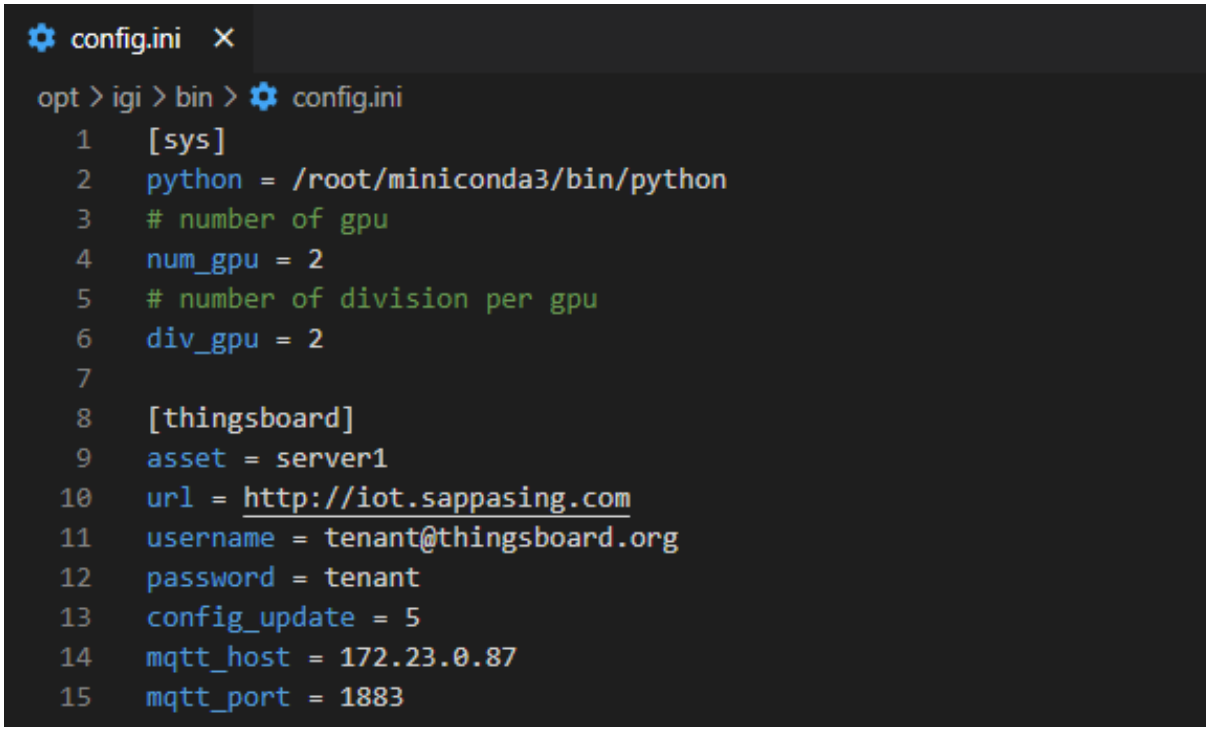
Device: cctv



Shared Attributes:

Attributes	Description
cam_param	Perspective adjustment matrix
lane_info	Lanes Informaton
rtsp_src	RTSP source (rtsp://host:port/stream)
speed_marker	Zone of LOS checking
conflict_point	Define conflict line that no car should cross
ai_disable	Disable AI processing (if true)

2. Local configuration (config.ini)



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', 'rtsp_src' ** If “ai_disable” = True, CCTV Active = False **

Components

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

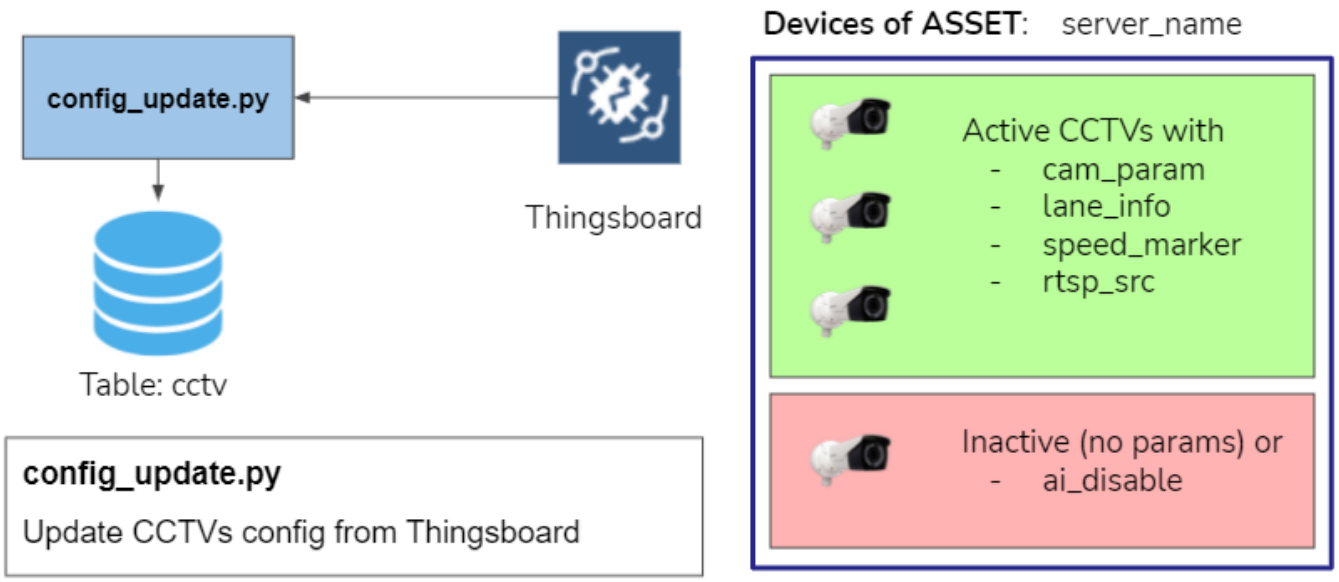
2. **CCTV Processor (cctv_processor.py)**
   Continuously process CCTV data

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

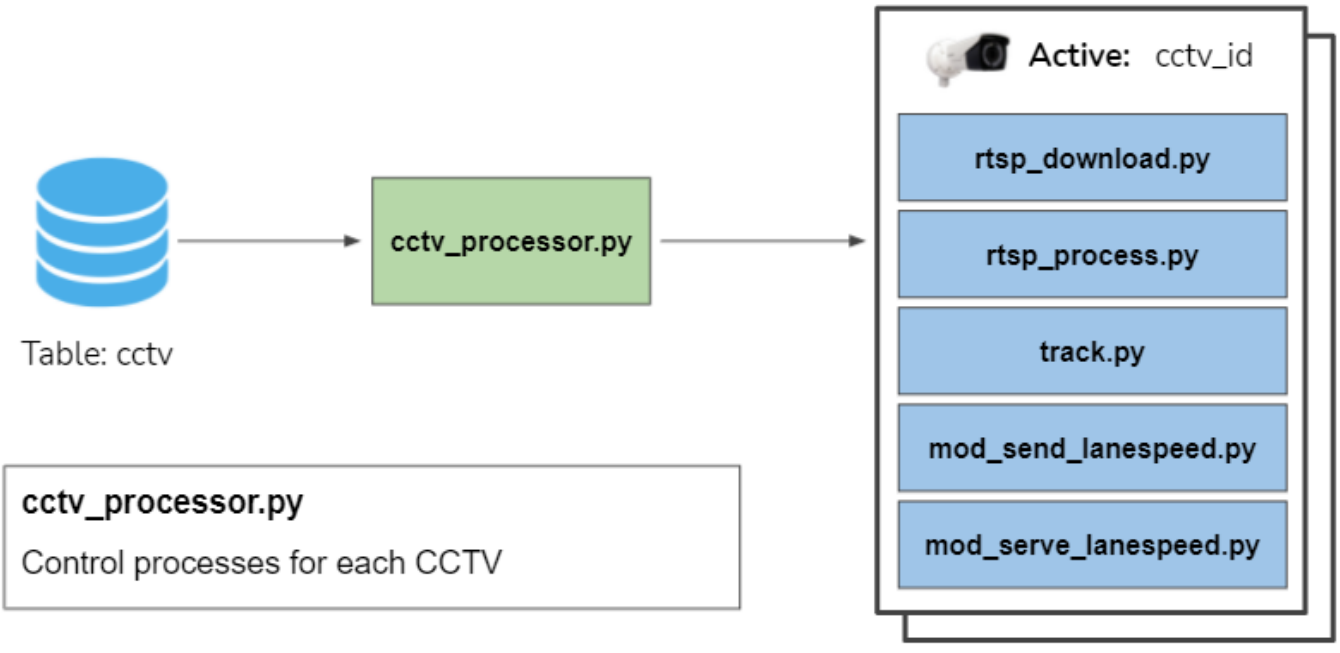
Config Updater



config_update.py

Update CCTVs config from Thingsboard

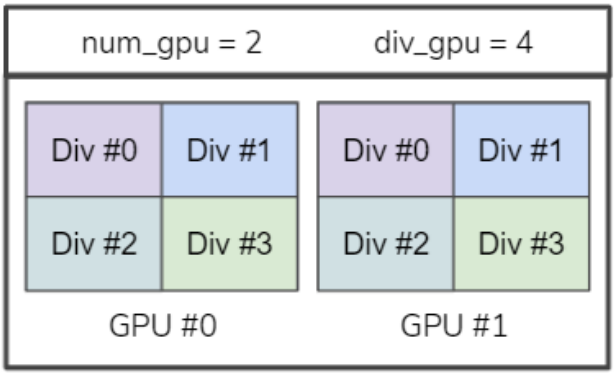
CCTV Processor



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#>
```

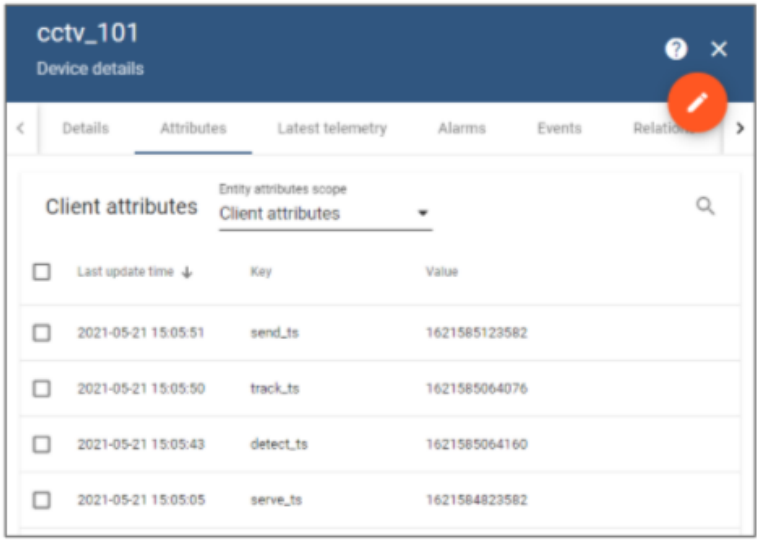
monitor.py

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



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>