THE ANDREW & ERNA VITERBI FACULTY OF ELECTRICAL ENGINEERING

Work in Progress

SIPL
Signal and Image Processing Lab

TECHNION Israel Institute of Technology

# Identification of suspicious objects in security camera video


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### In collaboration with IDF


## Introduction

- The IDF possess an array of cameras stationed in the west bank
- The cameras overlook streets, bus stops, security checkpoints, etc.
- To eliminate dangerous events in the area, there's a need to identify suspicious objects and track them and their owners

## Goals

- Detect suspicious objects in real time
  - Alert when suspicious objects appear in the scene
  - Associate the objects to their owner
  - Indication of irregular events in real time

## Challenges

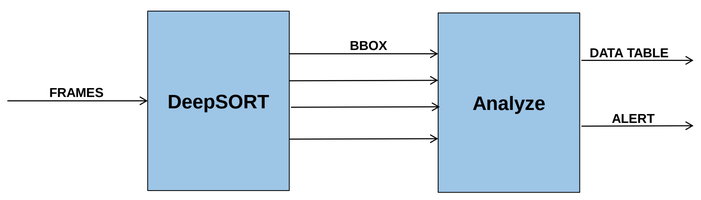
- Real time detection and tracking
- Building and maintaining database for tracking
- Define a measureable criteria for suspicious object
- Constantly changing environment (people and objects) adding complexity to the scene, hence decreasing the performance of the algorithm

## DeepSORT

- A multi-object tracking algorithm with deep network improves the performance of objects detections, using deep features for every bounding box
- Main steps:
  - Object Detection- using YOLO algorithm
  - Estimation of objects location- using Kalman filter-
    - Prediction- calculating direction and velocity between frames
    - Update- combining prediction and actual result to get better prediction on next use
  - Target Association- using Hungarian algorithm and IOU (intersection over union) criteria-
    - Hungarian algorithm solves association problem by minimizing association cost calculated by the matrix
      $D = \lambda \cdot D_k + (1-\lambda) \cdot D_a$
    - $D_k$ is mahalanobis distance between identifications and tracks
    - $D_a$ is the cosine distance between feature vectors of identifications and tracks
    - $\lambda$ is a weight factor
  - Track Identity Life Cycle- if tracked objected isn't identified for some predefined period, discard the track

## Analysis

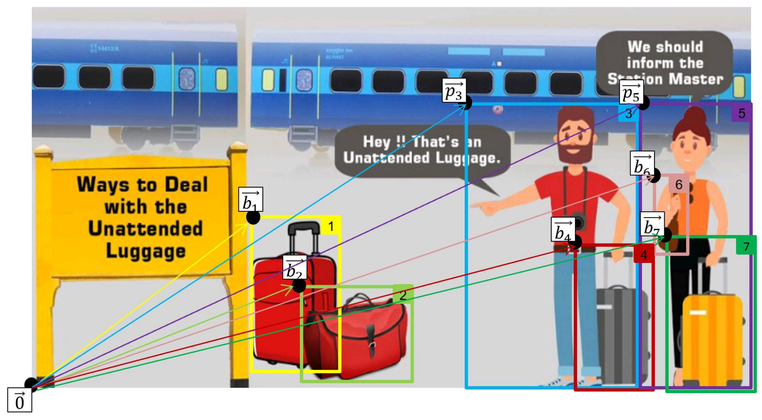
- Analysis of the relevant outputs from deepSORT:




- deepSORT outputs on tracks:
  - Bounding boxes
  - ID number
  - Class (person, backpack, etc.)


Example of the deepSORT output

- For each person calculate:
  - Distance to objects
  - IOU with objects
  - Other parameters for notification
- Deciding ownership




Scene example

- Ownership is decided by threshold $d_{th}$

| person | bag | $\lvert\vec{p_i} - \vec{b_j}\rvert < d_{th}$ |
|---|---|---|
| $\vec{p_3}$ | $\vec{b_1}$ | FALSE |
| $\vec{p_3}$ | $\vec{b_2}$ | FALSE |
| $\vec{p_3}$ | $\vec{b_4}$ | TRUE |
| $\vec{p_3}$ | $\vec{b_6}$ | FALSE |
| $\vec{p_3}$ | $\vec{b_7}$ | FALSE |
| $\vec{p_5}$ | $\vec{b_1}$ | FALSE |
| $\vec{p_5}$ | $\vec{b_2}$ | FALSE |
| $\vec{p_5}$ | $\vec{b_4}$ | FALSE |
| $\vec{p_5}$ | $\vec{b_6}$ | TRUE |
| $\vec{p_5}$ | $\vec{b_7}$ | TRUE |

Corresponding distance table

- Keeping track of previous owner association and the distance between them to identify object abandonment and suspicious activity
- For better results the distance is calculated between the middles of the bounding boxes

## Results

- Running deepSORT on example video:


First step- output of deepSORT

Example of association

- The threshold $d_{th} = 120\ [pixel]$
- Bag #3 distance from person #1 is $105\ [pixel]$ → bag #3 owner is person #1


Example of abandonment

- The owner left the bag, the distance is $470$
- → give an alert → bag #3 is a suspicious object and was left by person #1

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