QUANTIFYING FLOWS OF URBAN GOODS USING IMAGE PROCESSING AND MACHINE LEARNING

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1. Problem statement

2. Algorithm
   - Image processing
   - Tracking
   - Machine Learning

3. Prototype

4. Results, conclusion and perspectives
What flows of vehicles would be impacted if we decide to convert a given street into a pedestrian space?
• **Objective:** quantify – with a reliable, inexpensive and scalable tool – the logistic vehicles circulating through a given urban road.

• As a result, this work deals with “Real time vehicle detection, classification and counting for unsupervised traffic video in urban areas.”

• Current state of the art: vehicle tracking and counting exists for road traffic monitoring and speed control.
  - Several challenges appear for urban environments.
# Challenges of the Urban Setting

<table>
<thead>
<tr>
<th>SPEEDWAY</th>
<th>URBAN ROAD</th>
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<tbody>
<tr>
<td><strong>Axis of movement</strong></td>
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<tr>
<td>Speed</td>
<td></td>
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<tr>
<td><strong>Stops</strong></td>
<td></td>
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<tr>
<td>Vehicles</td>
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<tr>
<td><strong>Vehicle proximity</strong></td>
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</table>
Only video feed is available (no stereo vision, no 3D cloud)

Recording is not allowed (frames must be erased), i.e. real-time is mandatory

Low-resolution frames (inexpensive and scalable tool)

Camera is still

Daytime
TECHNICAL CHOICES

PYTHON

OPEN CV

TENSOR FLOW

RASPBERRY PI
ALGORITHM

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ALGORITHM OVERVIEW

**IMAGE ACQUISITION**
Tranforms the incoming video feed (orientation, resolution, fps, etc.).
Deals with different sources and formats of video.

**IMAGE PROCESSING**
Performs background substraction.
Deals with filters and and morphological tranformations.
Returns the locations and geometry of possible moving vehicles in each frame.

**TRACKING**
Calculates geometric projections of the detected objects.
Deals with merging and occlusion problems.

**CLASSIFICATION**
Classifies each moving object.
Keeps a “memory” of positions and types of each moving object.
Computes the most probable class of each object when it leaves the image.
IMAGE PROCESSING EXAMPLE

LOCATION
QUAI DE SEINE
(MUSÉE DU LOUVRE BRIDGE)
TRACKING APPROACH: GEOMETRICAL PROJECTIONS

CURRENT LOCATION AND PROJECTED POSITION IN THE NEXT FRAME

OVERLAP BETWEEN THE NEW LOCATION AND THE PROJECTED POSITION
TRACKING EXAMPLE

LOCATION
QUAI DE SEINE
(MUSÉE DU LOUVRE BRIDGE)
CLASSIFYING WITH A CONVULSIONAL ARTIFICIAL NEURAL NETWORK

DEEP CONVULSTIONAL NEURAL NETWORK

CLASSIFIER

« CAR »

TENSOR FLOW
TRAINING THE ARTIFICIAL NEURAL NETWORK

2500 initial images were transformed into a DB of 75000 labelled images (“CAR”, “LOGISTIC VEHICLE”, “BIKE” and “TRASH”).

30000 training iterations (≈30 minutes).

CLASSIFIER
94% accuracy
CLASSIFICATION
EXAMPLE

LOCATION
QUAI DE SEINE
(MUSÉE DU LOUVRE BRIDGE)
3/ 

PROTOTYPE

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COMPONENTS AND 3D PRINTING

Total cost under 70€
FIRST PROTOTYPE

QUANTIFYING FLOWS OF URBAN GOODS USING IMAGE PROCESSING & MACHINE LEARNING
www.chairelogistiqueurbaine.fr
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RESULTS

• Real time!

• Detection of 95% of the vehicles within the vision range.

• 94% of the detected vehicles are correctly classified.

NEXT STEPS

• More training data for ML:
  – New types of vehicles such as “bicycle”, “truck” (≠ sizes), “taxi” and “bus”.
  – New angles of capture.

• Optimization of parameters (both ML and IP).

• Adapt the algorithm to use any existing video feed (ex. city cameras).
THANKS FOR YOUR ATTENTION

ANY QUESTIONS?

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