# A Prototype System for Truck Signal Priority using Video Sensors

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# Outline

1. Motivation
2. Object Classification in Images
3. Experimental Results
4. Conclusion

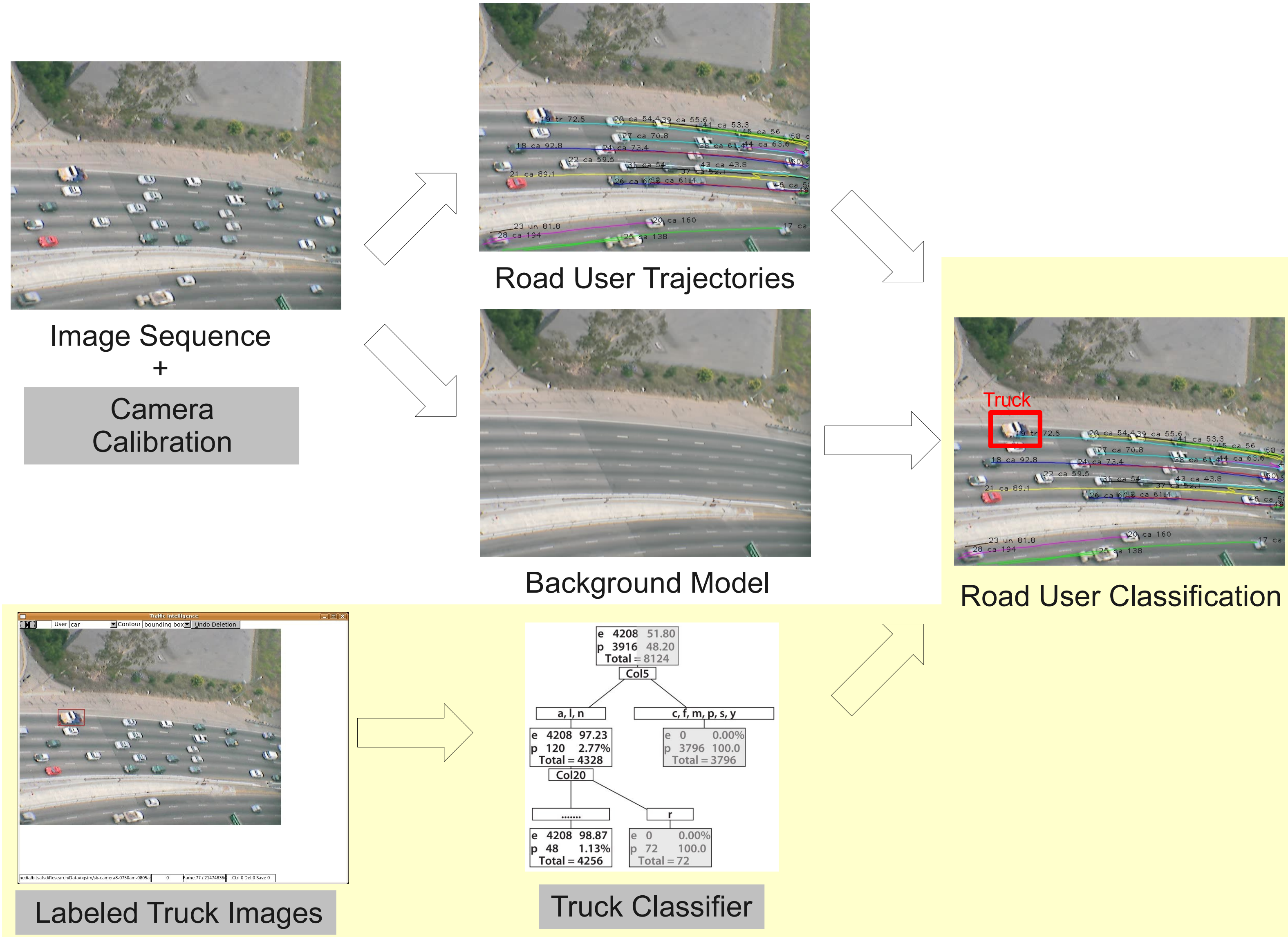
# Why Truck Priority?

- Benefits:
  - Reduce the cost of goods transportation.
  - Reduce red light running.
  - Encourage trucks to use specific truck routes.
  - Reduce emissions.
- This requires the ability to detect and track trucks.

# Video Sensors

- Video sensors have distinct advantages:
  - they are easy to install (or can be already installed),
  - they are inexpensive,
  - they can provide rich traffic description (e.g. road user tracking),
  - they can cover large areas,
  - their recording allows verification at any later stage.

# Detecting and Tracking Trucks



# Object Detection in Images

- Two types of object description variables:
  - describing the appearance.
    - e.g. SIFT, HoG features.
  - describing the shape.
    - e.g. (3D-)models, moments.

# Shape Description

- Extract a shape using background subtraction.

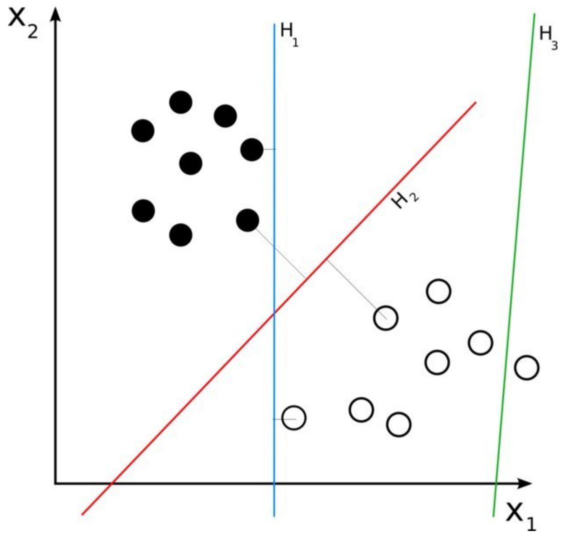
- Compute the moments of the shape.

$$m_{p,q} = \iint f(x,y)\, x^p\, y^q\, dx dy$$

*f(x,y)*=1 if the pixel at (x,y) is in the foreground
0 if the pixel at (x,y) is in the background

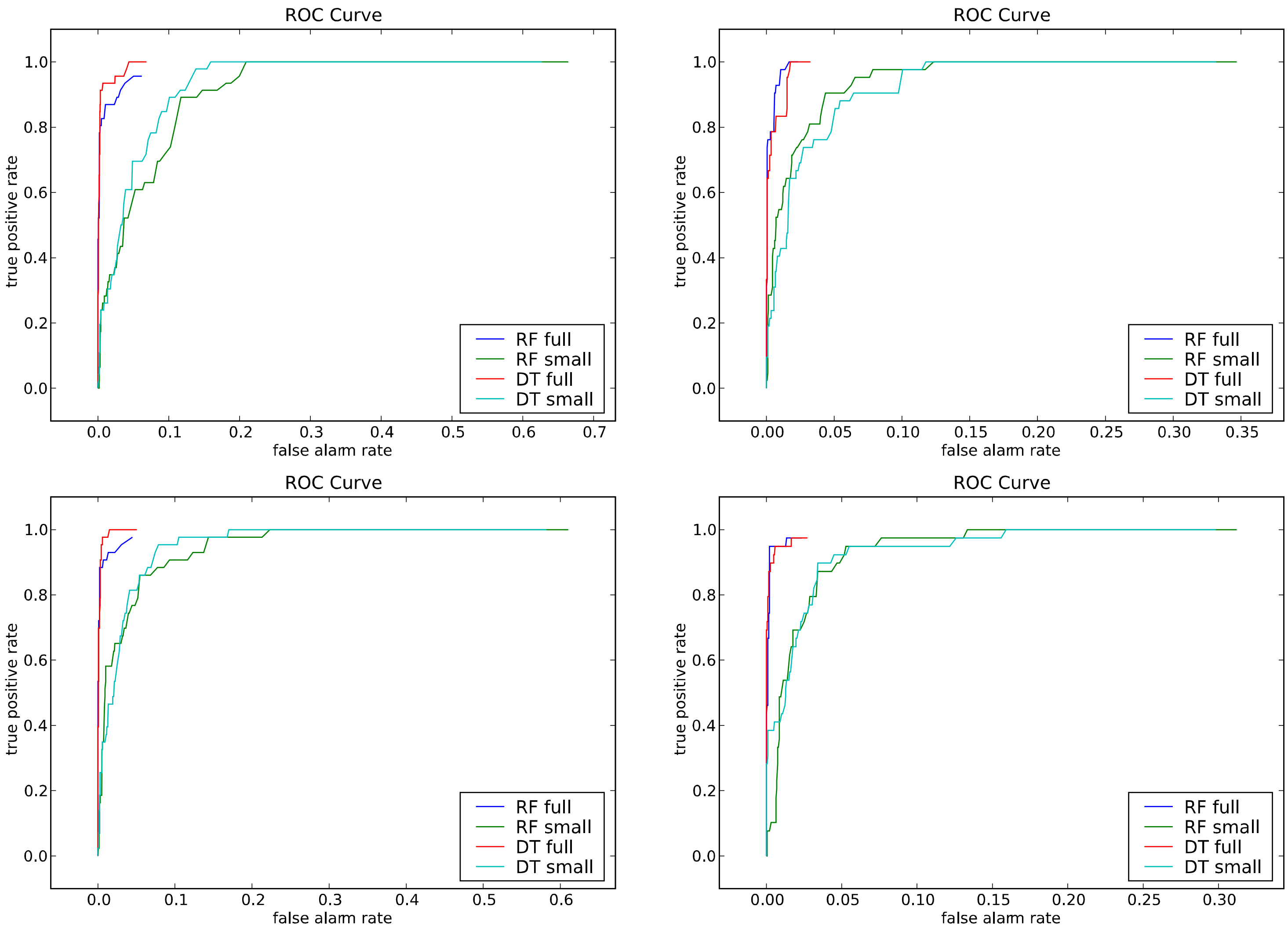
# Learn a Truck Classifier

- Using machine learning to learn a binary classifier (truck vs. other road users).




- The classifier returns a decision for each shape at each instant. A threshold *nDetections* is used to detect a truck.

# Experimental Results




X axis:
*1-Recall*$_{non\text{-}truck}$
also called false alarm rate

Y axis:
*Recall*$_{truck}$
also called true positive rate

DT: Decision Tree
RF: Random Forest

# Experimental Results

- The recall for trucks reaches 78% to 95% on test data, with a false alarm rate below the 0.5% value used for the system simulation.

| | | | | |
|---|---|---|---|---|
| 8:05 to 8:20 | Decision Tree | Full | 44 | 78.57 |
| | | Small | 117 | 23.81 |
| | Random Forest | Full | 19 | 78.57 |
| | | Small | 73 | 40.48 |
| 8:20 to 8:35 | Decision Tree | Full | 29 | 92.31 |
| | | Small | 111 | 38.46 |
| | Random Forest | Full | 12 | 94.87 |
| | | Small | 89 | 10.26 |

# Experimental Results

# Experimental Results: TkSP

- TkSP: green extension or red truncation.
- Conventional / Advanced TkSP: prediction of truck arrival time and queue dissipation time thanks to real-time tracking.
- Detection at 300m from the intersection.
- Simulation of the Knight St corridor in Vancouver B.C. (3 intersections with TkSP).
- The Advanced TkSP strategy outperformed conventional TkSP strategy.

# Experimental Results: TkSP

- Especially effective
  - at two-phased intersections,
  - when traffic volume was less than that of the morning peak hour,
  - when truck proportion was equal to or less than 2%,
  - and when priority was not locked after a green extension or red truncation.
- Under the best conditions, average truck travel times were reduced by 9.16% and 0.93% in the peak and opposing directions, respectively.

# Conclusion

- Prototype system for truck detection and tracking using video sensors.
- Tested on real world data: high recall for trucks, from 78% to 95%, and a false alarm rate below the 0.5% value used for simulation.
- Future work:
  - classify all road users and include other description variables,
  - multi-camera system.

# Questions?