GHENT
UNIVERSITY

FACULTY OF ENGINEERING
AND ARCHITECTURE

# DESIGN OF MULTIMEDIA APPLICATIONS

GHENT
UNIVERSITY

FACULTY OF ENGINEERING
AND ARCHITECTURE

ELECTRONICS AND INFORMATION SYSTEMS DEPARTMENT (ELIS)
IDLAB

# DESIGN OF MULTIMEDIA APPLICATIONS

## Assignment 3: GStreamer ! research

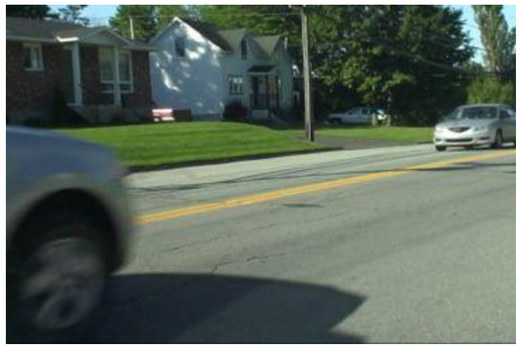
GHENT
UNIVERSITY

# OVERVIEW

- Assignment 1: Intro to media processing
- Assignment 2: Making a product that uses media
- Assignment 3: Misuse GStreamer for research

# MOTION DETECTION

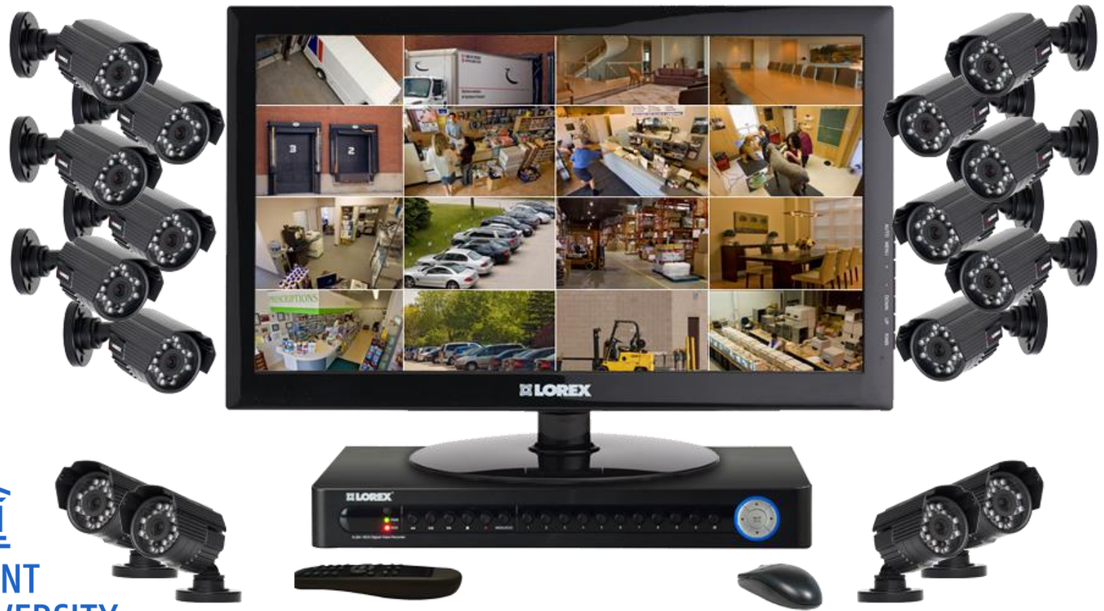
- Detect when something is moving inside a scene



GHENT UNIVERSITY

# APPLICATIONS

– A battery operated wildlife camera


– A surveillance camera system

GHENT UNIVERSITY

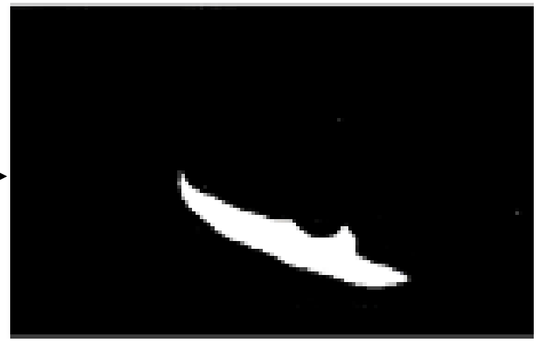
# BACKGROUND SUBTRACTION

Current frame

Background model

Foreground Mask Threshold

Foreground mask



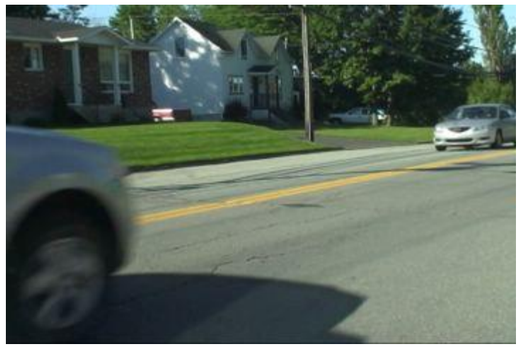
Motion Threshold

Motion/
No motion

# EXAMPLE

Background model

Input video



GHENT UNIVERSITY

# EXAMPLE

Background model

Foreground mask

GHENT UNIVERSITY

# BACKGROUND MODELING

- background initialization

- background update
  - When background objects leave the scene
  - When objects become background

Background initialization

Background update

GHENT UNIVERSITY

# PERFORMANCE EVALUATION

| | | Predicted condition | |
|---|---|---|---|
| | Total population | Predicted Condition positive | Predicted Condition negative |
| **TRUE condition** | condition positive | True positive | |
| | condition negative | | True negative |

GHENT UNIVERSITY

# PERFORMANCE EVALUATION

| | | Predicted condition | |
|---|---|---|---|
| | Total population | Predicted Condition positive | Predicted Condition negative |
| **TRUE condition** | condition positive | True positive | False Negative (Type II error) |
| | condition negative | False Positive (Type I error) | True negative |

GHENT UNIVERSITY

# PERFORMANCE EVALUATION

| | | Predicted condition | | |
|---|---|---|---|---|
| | Total population | Predicted Condition positive | Predicted Condition negative | |
| **TRUE condition** | condition positive | True positive | False Negative (Type II error) | True positive rate (TPR), Sensitivity, Recall, probability of detection = Σ True positive/ Σ Condition positive |
| | condition negative | False Positive (Type I error) | True negative | |
| | Accuracy (ACC) = Σ True positive + Σ True negative/Σ Total population | Positive predictive value (PPV), Precision = Σ True positive/ Σ Test outcome positive | | |

GHENT UNIVERSITY

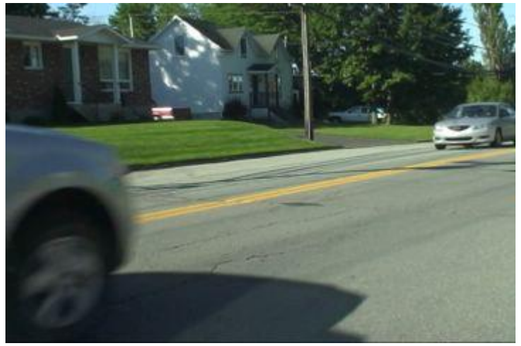
# PERFORMANCE EVALUATION

| | | Predicted condition | | | |
|---|---|---|---|---|---|
| | Total population | Predicted Condition positive | Predicted Condition negative | Prevalence = Σ Condition positive/ Σ Total population | |
| **TRUE condition** | condition positive | True positive | False Negative (Type II error) | True positive rate (TPR), Sensitivity, Recall, probability of detection = Σ True positive/ Σ Condition positive | False negative rate (FNR), Miss rate = Σ False negative/ Σ Condition positive |
| | condition negative | False Positive (Type I error) | True negative | False positive rate (FPR), Fall-out, probability of false alarm = Σ False positive/ Σ Condition negative | True negative rate (TNR), Specificity (SPC) = Σ True negative/ Σ Condition negative |
| | Accuracy (ACC) = Σ True positive + Σ True negative/Σ Total population | Positive predictive value (PPV), Precision = Σ True positive/ Σ Test outcome positive | False omission rate (FOR) = Σ False negative/ Σ Test outcome negative | Positive likelihood ratio (LR+) = TPR/FPR | Diagnostic odds ratio (DOR) = LR+/LR− |
| | | False discovery rate (FDR) = Σ False positive/ Σ Test outcome positive | Negative predictive value (NPV) = Σ True negative/ Σ Test outcome negative | Negative likelihood ratio (LR−) = FNR/TNR | |

GHENT UNIVERSITY

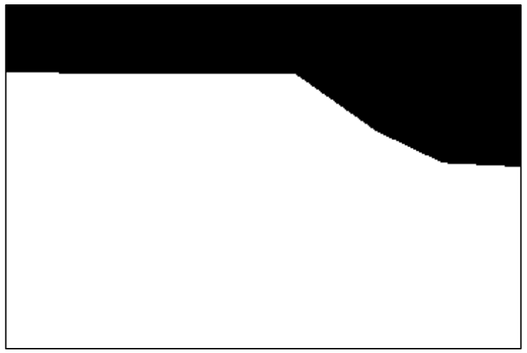
# DATASET

Input video



Groundtruth

Region of interest



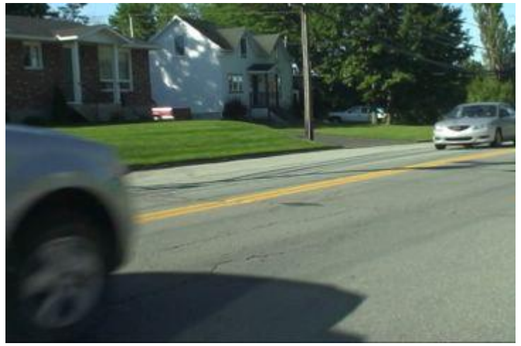
The groundtruth images contain 5 labels namely:

- ~0 : Static
- ~50 : Hard shadow
- ~85 : Outside region of interest
- ~170 : Unknown motion (usually around moving objects, due to semi-transparency and motion blur)
- ~255 : Motion

GHENT UNIVERSITY

# DATASET

Input video



Groundtruth



Datasets can be in a different format:

- MP4[AVC]
- MKV[JPG]
- …

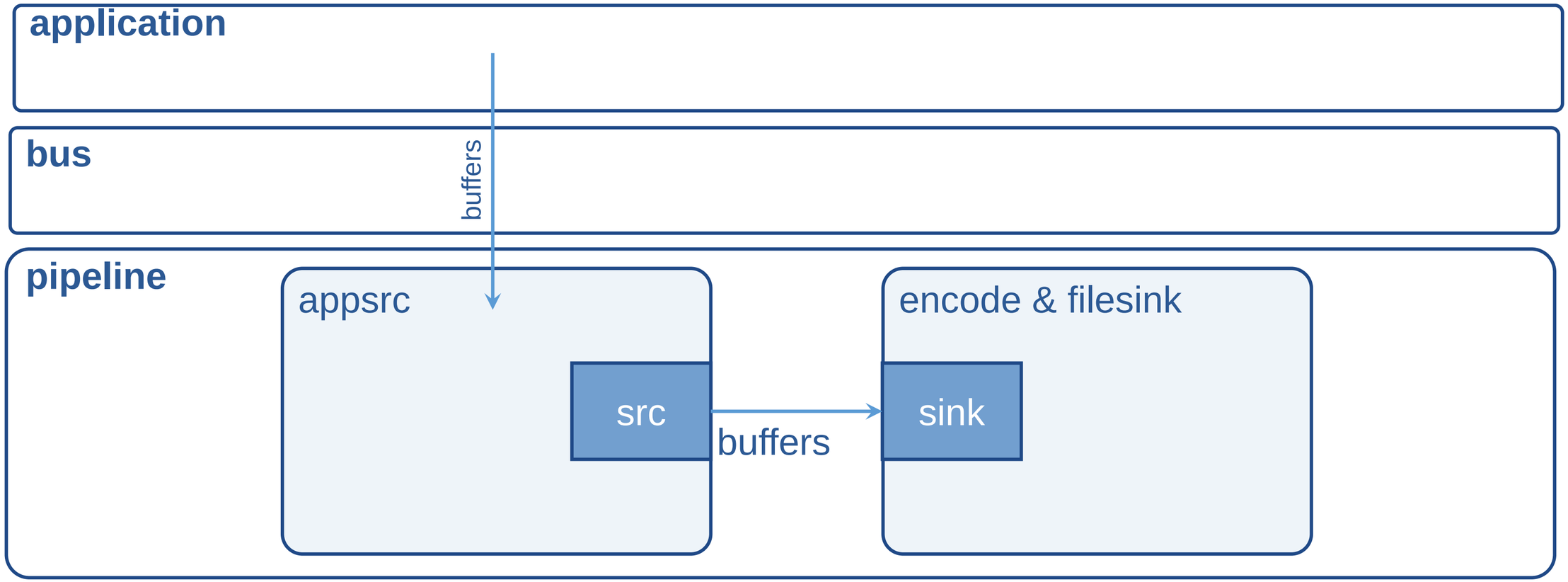
GHENT UNIVERSITY

# GSTREAMER

- Use Gstreamer to handle all these formats transparently.
  - Appsrc
  - Appsink

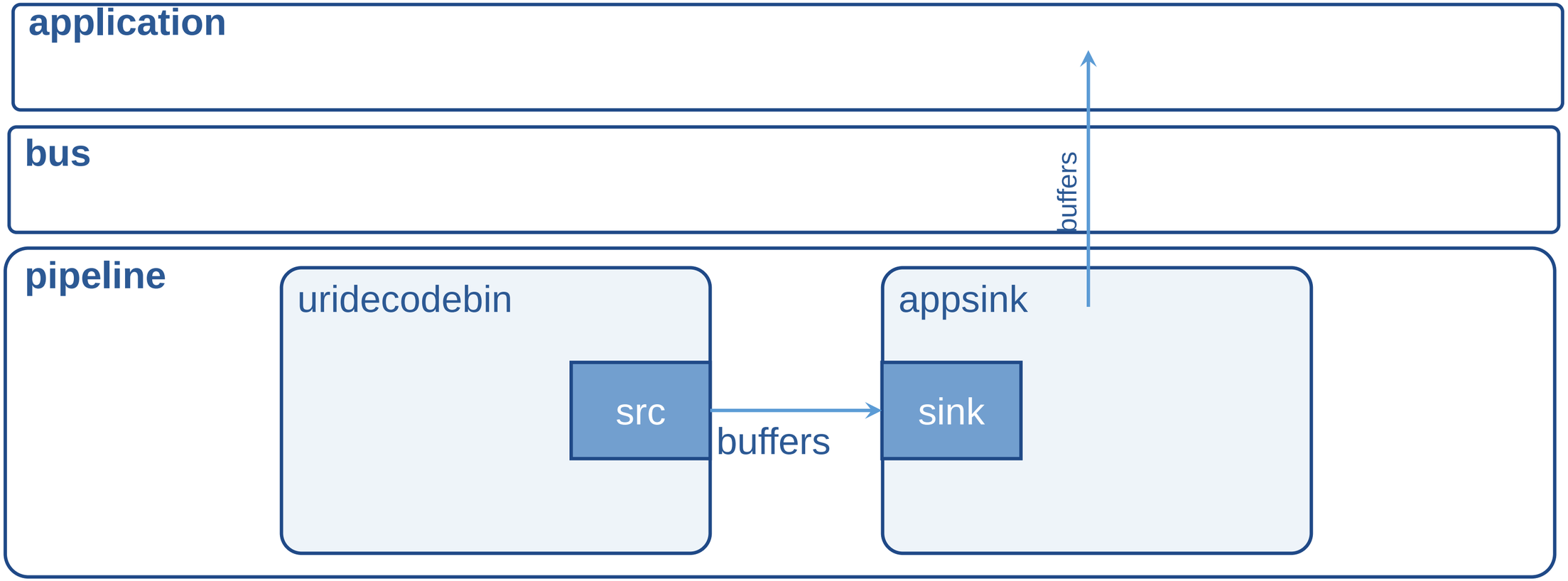
GHENT UNIVERSITY

# APPSRC AND APPSINK




GHENT UNIVERSITY

# APPSRC AND APPSINK



# ASSIGNMENT

- modular media research framework for motion detection
  - input & groundtruth: read using Gstreamer
    ROI: read using OpenCV: cv2.imread()
  - The groundtruth can be binarized:
    background (values 0 and 85)
    foreground (values 50, 170, and 255)
  - Visualize the background model and foreground mask.
  - Evaluate using precision, and recall.

# PERFORMANCE EVALUATION

| | | **Predicted condition** | | | |
|---|---|---|---|---|---|
| | Total population | Predicted Condition positive | Predicted Condition negative | Prevalence = Σ Condition positive/ Σ Total population | |
| **TRUE condition** | condition positive | True positive | False Negative (Type II error) | True positive rate (TPR), Sensitivity, **Recall**, probability of detection = Σ True positive/ Σ Condition positive | False negative rate (FNR), Miss rate = Σ False negative/ Σ Condition positive |
| | condition negative | False Positive (Type I error) | True negative | False positive rate (FPR), Fall-out, probability of false alarm = Σ False positive/ Σ Condition negative | True negative rate (TNR), Specificity (SPC) = Σ True negative/ Σ Condition negative |
| | Accuracy (ACC) = Σ True positive + Σ True negative/Σ Total population | Positive predictive value (PPV), **Precision** = Σ True positive/ Σ Test outcome positive | False omission rate (FOR) = Σ False negative/ Σ Test outcome negative | Positive likelihood ratio (LR+) = TPR/FPR | Diagnostic odds ratio (DOR) = LR+/LR− |
| | | False discovery rate (FDR) = Σ False positive/ Σ Test outcome positive | Negative predictive value (NPV) = Σ True negative/ Σ Test outcome negative | Negative likelihood ratio (LR−) = FNR/TNR | |

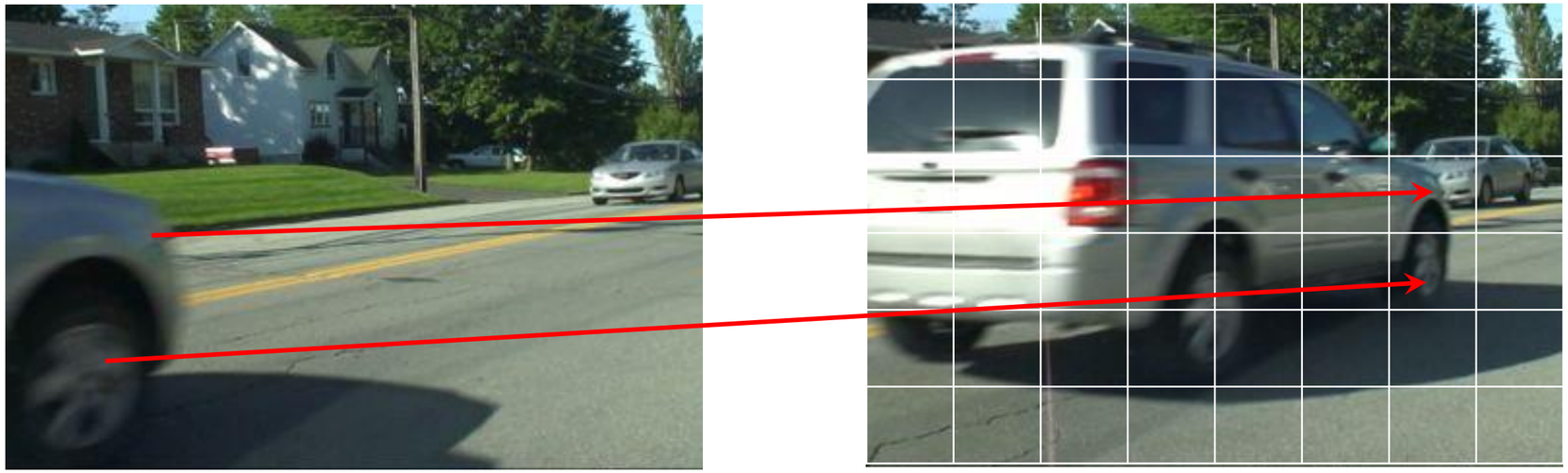
GHENT UNIVERSITY

# MEAN MOTION ESTIMATOR

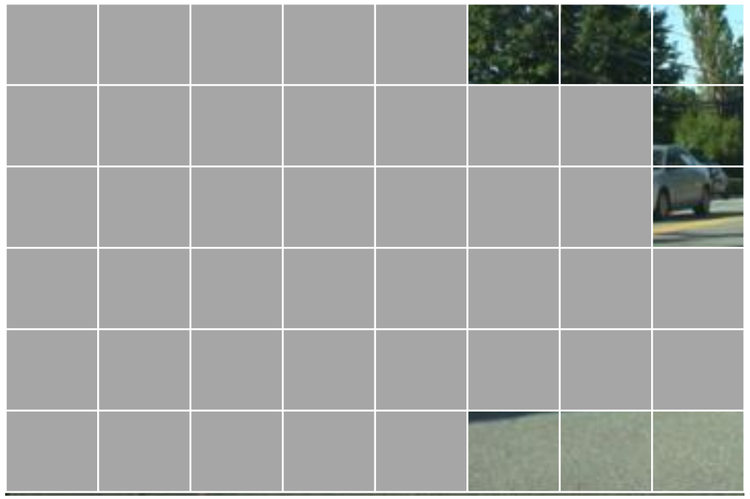
- Background = mean of the X previous frames.

GHENT
UNIVERSITY

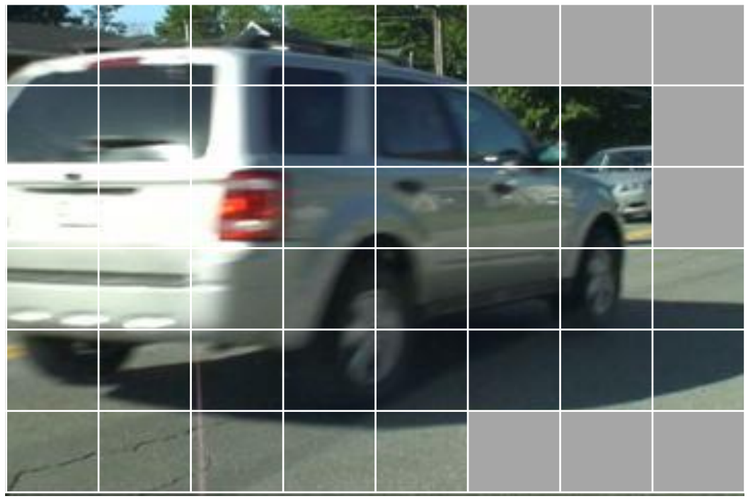
# BLOCK BASED ESTIMATOR



Background



Foreground



GHENT UNIVERSITY

# MIXTURE OF GAUSSIANS

- OpenCV: Open Source Computer Vision Library
- Mixture of Gaussians motion estimator


- Instead of mean/pixel
- Gaussian distribution/pixel
- If part of distribution → background

FACULTY OF ENGINEERING
AND ARCHITECTURE


Head supervisor: Glenn Van Wallendael [Glenn.VanWallendael@UGent.be]

Supervisors:

Vasileios Avramelos Vasileios.Avramelos@UGent.be
Sven Lieber Sven.Lieber@UGent.be
Baptist Vandersmissen Baptist.Vandersmissen@UGent.be
Niels Van Kets Niels.VanKets@UGent.be


GHENT
UNIVERSITY