

Monitoring Transportation Systems Everyone Here or A Few Everywhere

Smart City X

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**POLYTECHNIQUE
MONTREAL**

WORLD-CLASS
ENGINEERING

You can't manage what you can't measure

What is the most important development in transportation in the last decade?

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Outline

Sensor typology

Point Sensors

Spatial Sensors

Distributed Sensors

Perspectives

Sensor typology

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Distributed Sensors

Perspectives

What is a sensor?

*A sensor (also called detector) is a converter that measures a **physical quantity** and converts it into a **signal** which can be read by an observer or by an (today mostly **electronic**) **instrument***

(Wikipedia)

What to measure?

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- What characteristics?
 - **counts**, speed and occupancy rate
 - **classified** according to the user/vehicle characteristics: type, length, weight, etc.

What to measure?

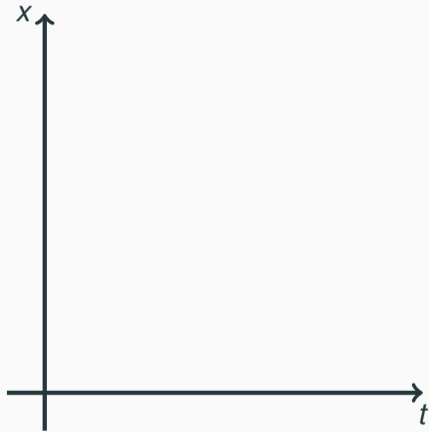
- **Users** and **vehicles**
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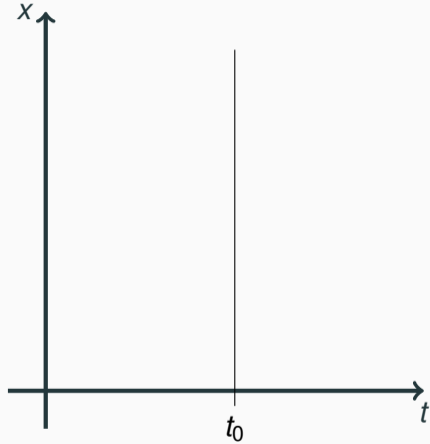
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Where and when?

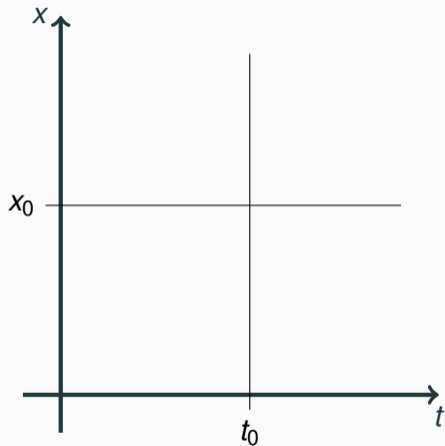
Spatio-temporal coverage



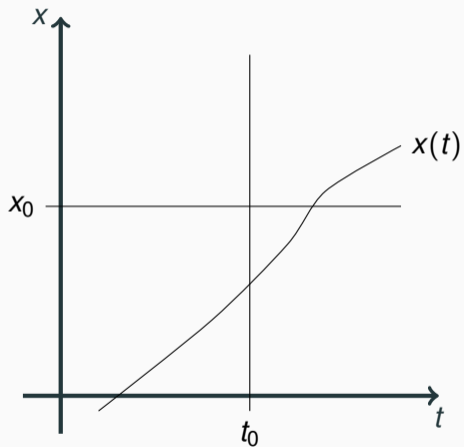
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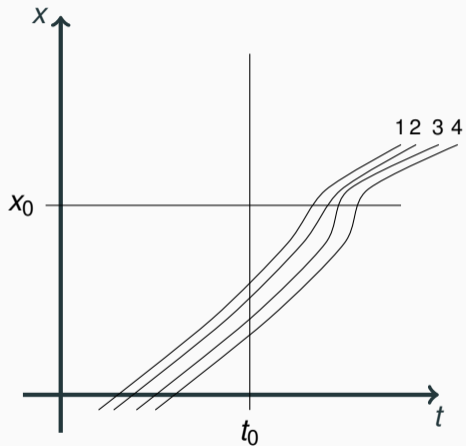
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- Accuracy, robustness (calibration)

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Common methods

- Manual (counts)

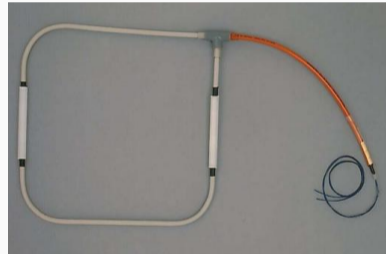
Common methods

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Common methods

- Manual (counts)
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- Inductive loops
- Magnetic sensors
- Radar
- Infrared sensors

Eco-compteur, la référence du comptage des piétons en extérieur

- Installation rapide sur tout type de support
- Comptage ponctuel et permanent
- Système compact et discret



10 ans GSM mobile très solide

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Spatial sensors

- Aerial photos

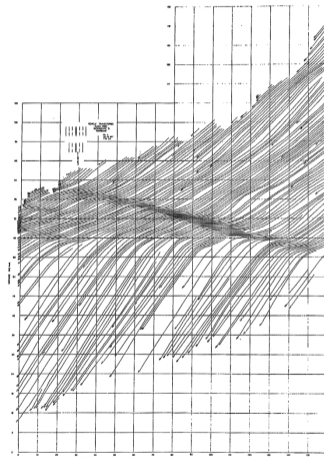


Figure 3.2. Vehicle Trajectories Showing a Kinematic Disturbance in Lane One

Spatial sensors

- Aerial photos
- Satellite images

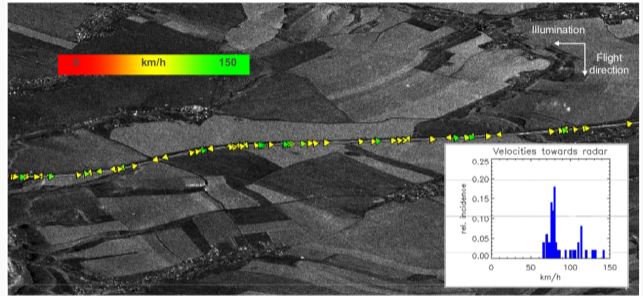


Figure 2 TerraSAR-X Traffic Measurement on the A4 Motorway West of Dresden, Germany

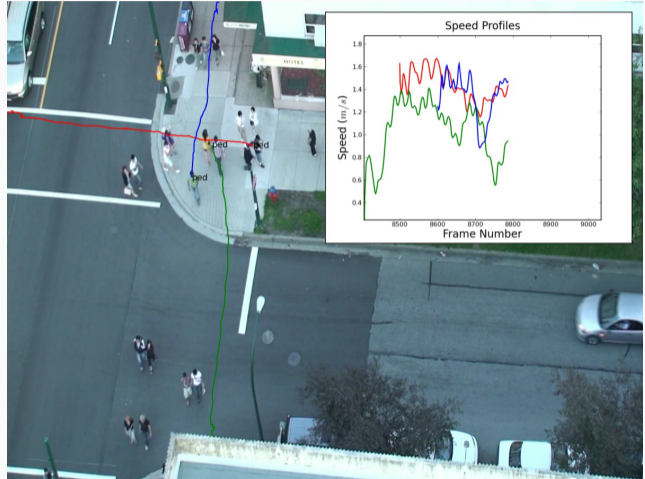
Spatial sensors

- Aerial photos
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- Video sensors



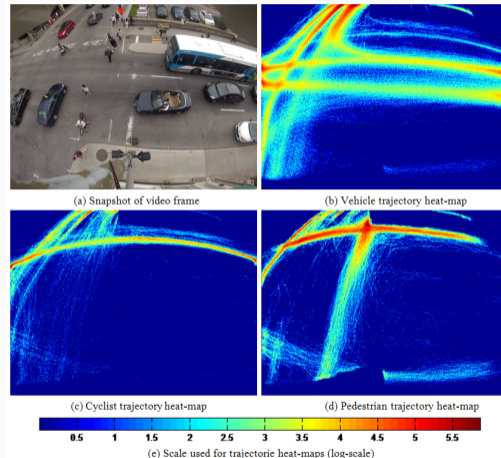
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Technologies for automated vehicle identification (AVI)

- Video-based automated license plate recognition (ALPR), used for cordon area congestion pricing (London and Stockholm)
- RFID tags used for toll collection (Singapour, Golden Ears bridge in Vancouver, A25 and A30 bridges in Montréal)
- Bluetooth and Wifi sensors



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What is the purpose?



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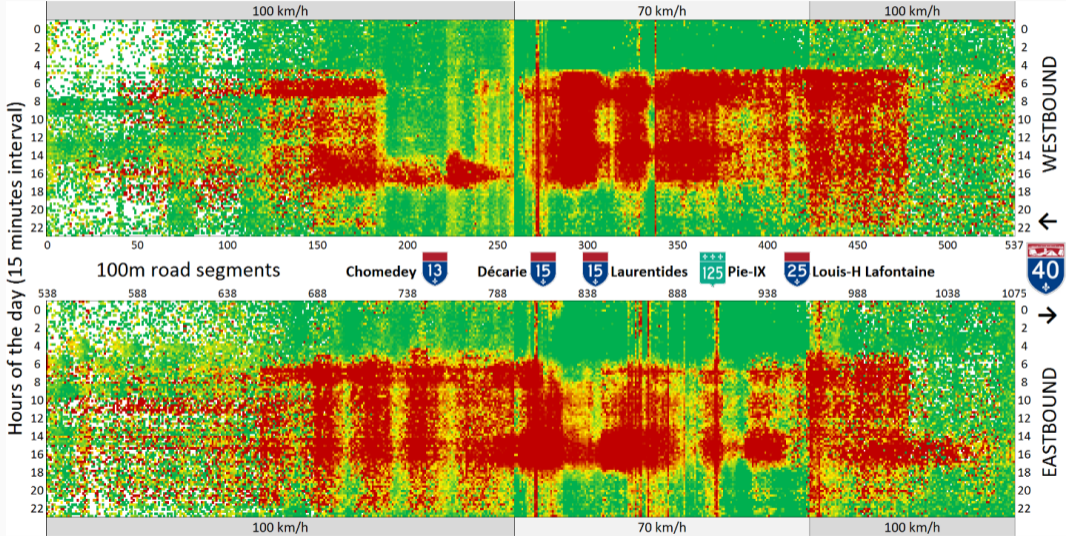
Perspectives

- **Communication** technology + **localization** technology (GNSS) = area-wide, continuous traffic monitoring
 - vehicles/users + sensors = probes
 - crowdsourcing of the traditional floating car method
 - robust, “free”, real time data collection over the network
 - smartphones can be used to provide real time information back

Distributed sensors

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- Tracking of mobile phones
- Smartphones: projects Mobile Century and Millenium (Berkeley/Nokia), companies (INRIX, Google, TomTom)

Distributed sensors



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- Constant progress of technologies, refinements
- “Old” technologies are still much in use, with new possibilities offered by computing, more storage and real time availability
- More and more sensors everywhere, communicating in real time = the **Internet of things (IoT)**
 - no mention of vehicles, a.k.a. connected “computers on wheels”

You can't manage what you can't measure

You can't manage if you can't archive, organize and process your data

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- Importance of data processing and management
- The era of “big data” and data science
 - opportunities and challenges to solve problems that could not be solved previously

Questions?

<http://nicolas.saunier.confins.net>

