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On-board estimation of water depth using low-cost sensors

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RENAULT

IFSTTAR

Context

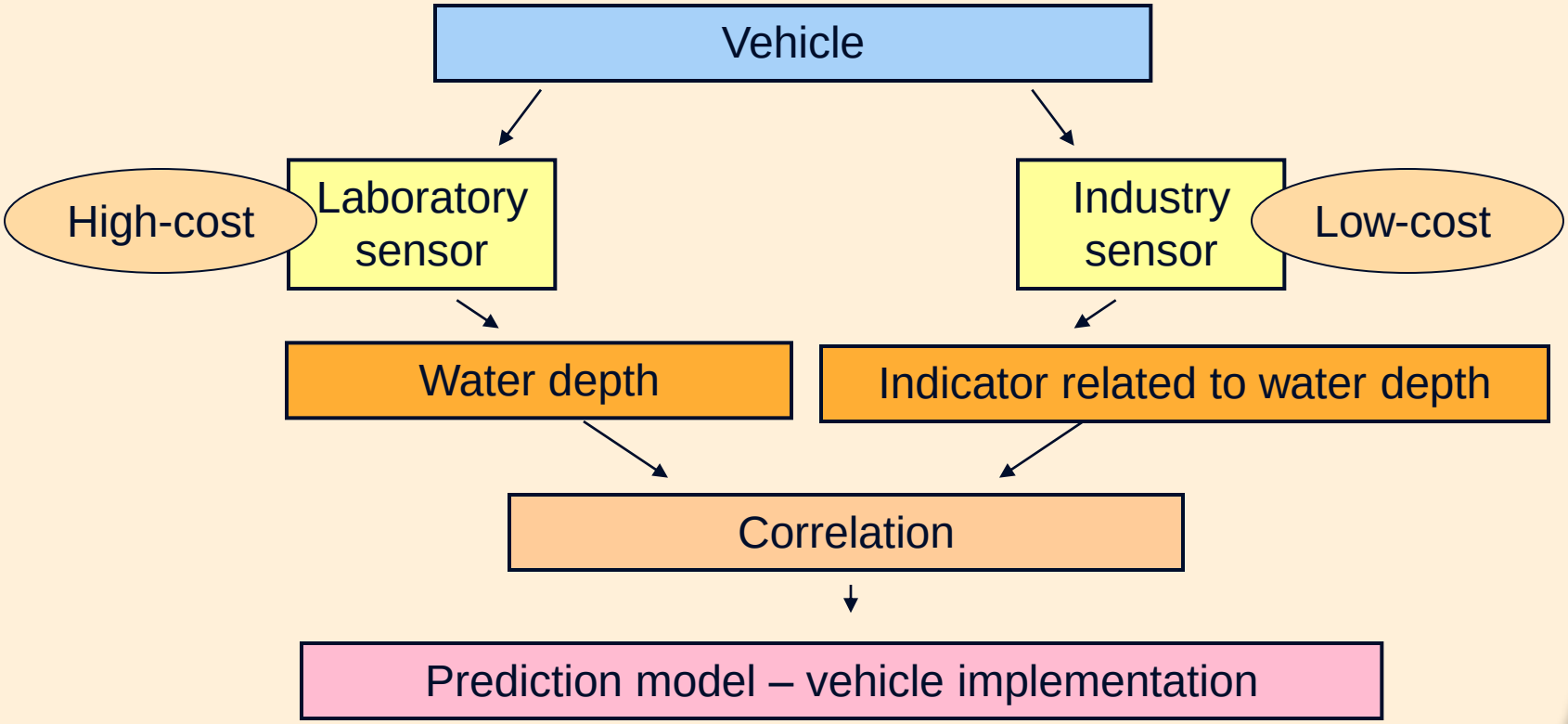
- **Accident risks x2 on wet roads**
- **Wrong assessment of danger**
  - **Unsuitable behavior of the driver**

📖 SWOV, 2009

- **On-board friction estimation**
  - **On-board water depth measurement**

Methodology and Experimental Setup

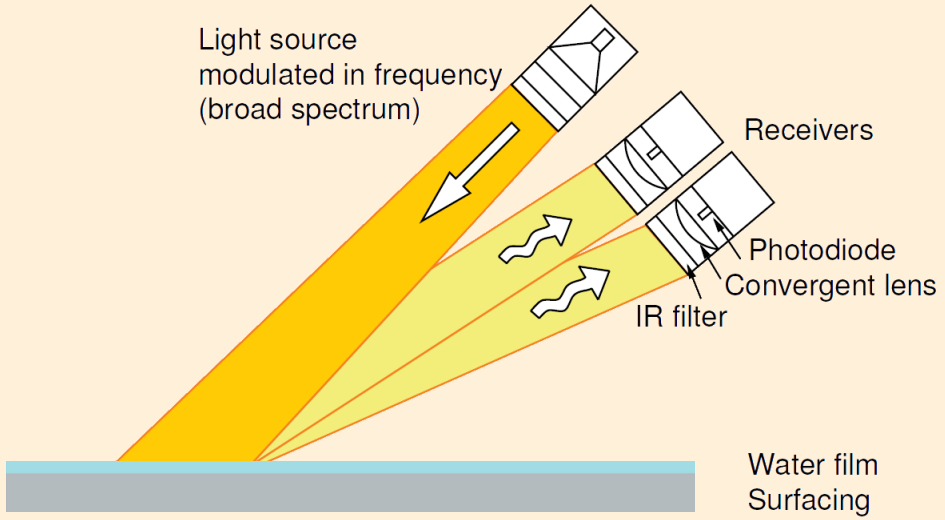
Methodology



Experimental Setup

Laboratory Sensor

Aquasens

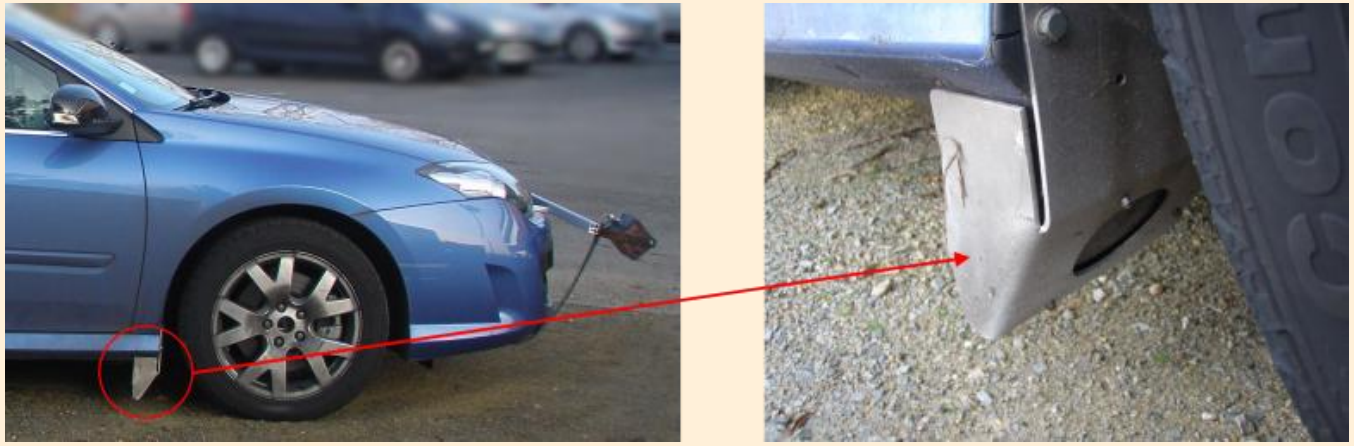


Principle of spectroscopy

- measuring range: 0 to 1 mm
- accuracy: 0.1 mm + WD/10
- response time: 0.01 s

Experimental Setup

Industrial Sensor

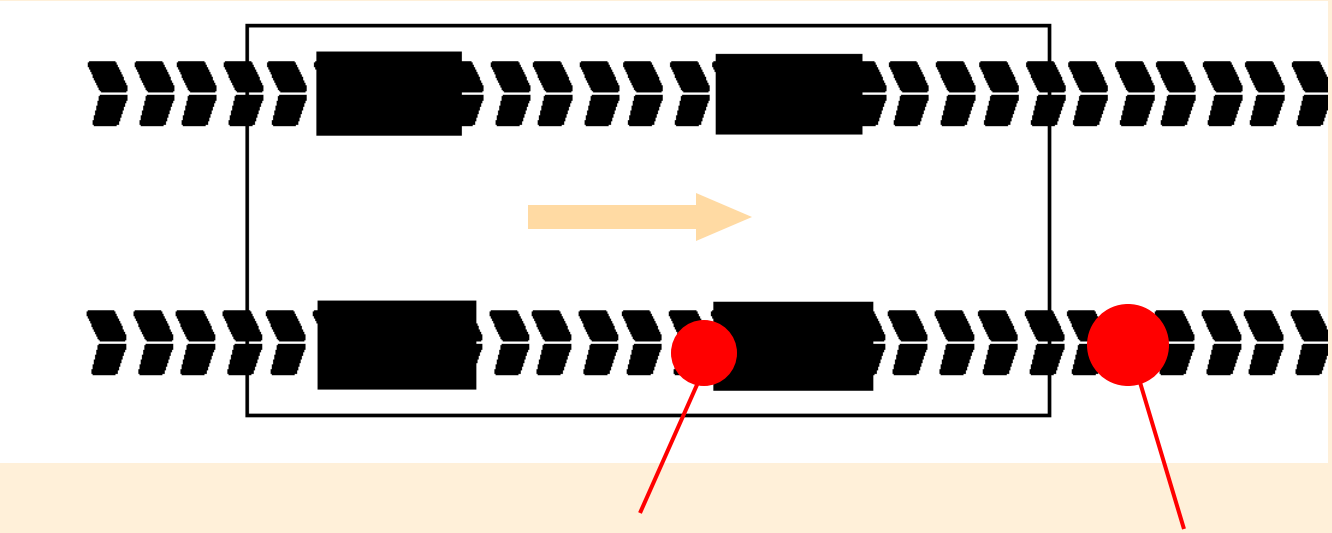


Accelerometric sensor system

- sensibility: 1 mV by m²/s
- bandwidth: 1 to 25000 Hz
- max. peak acceleration : 7500 m²/s

Experimental Setup

Both measurements in the right running track

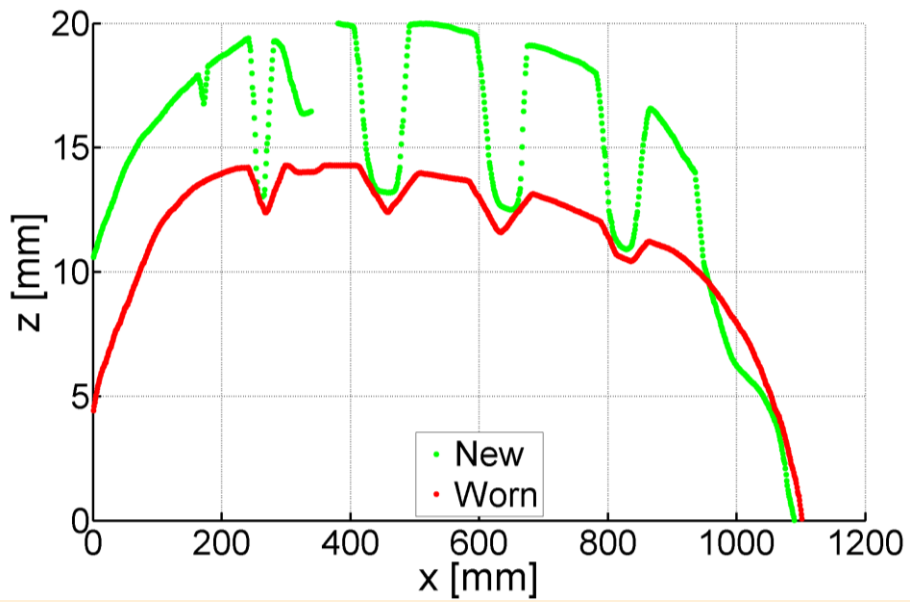


Experimental Program

Experimental Program

Tires

- 2 manufacturers
- New / Worn
- Summer / Winter



Speeds

30, 50, 70, 90 and 110 km/h

Pavements

- 5 pavements (wide MPD range)

→ Ifsttar Test Track

Ifsttar Test Tracks

- 13 surface dressings
  - 100 to 250 meters long
- Wetting system
- Weather monitoring

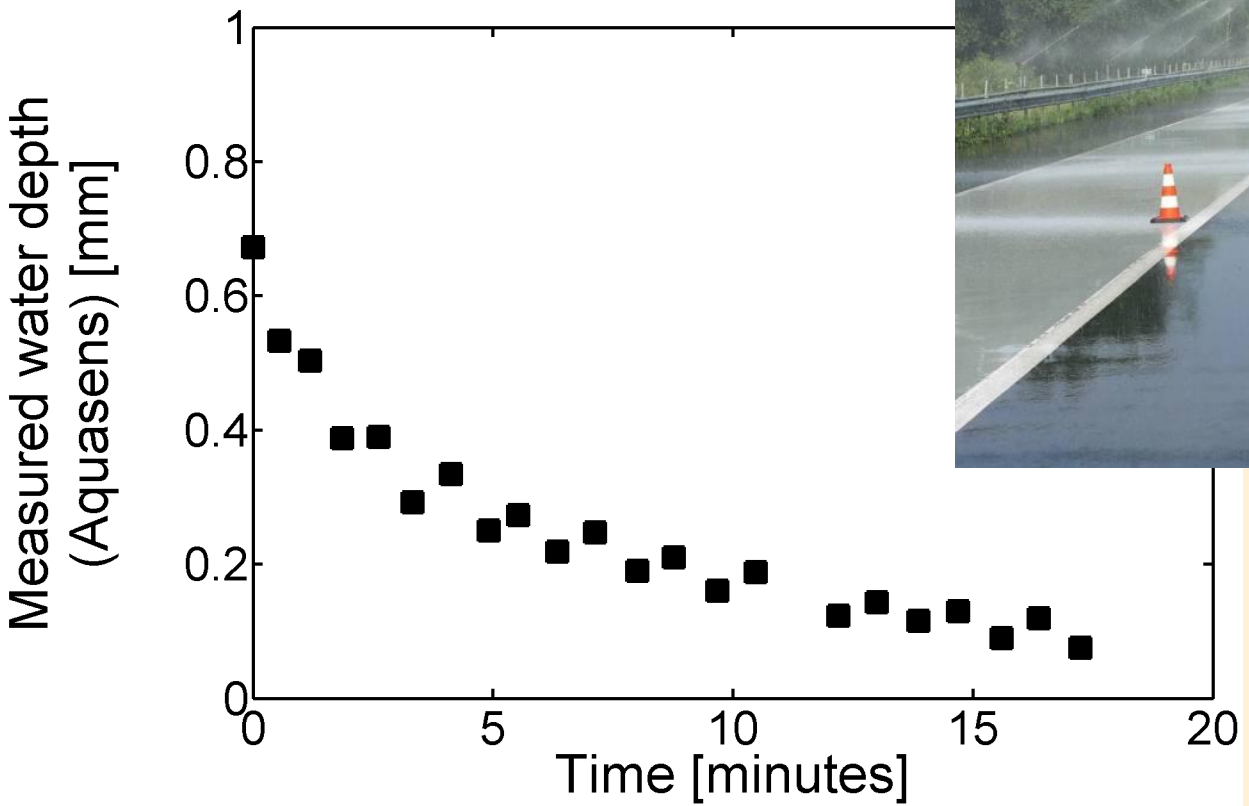
Tested pavements

Type of pavement	Size of aggregates (min/max)	Acronym	Track Name	MPD (mm)
Semi-coarse Asphalt Concrete (new)	0/10	SCAC 0/10	E1	0.66
Semi-coarse Asphalt Concrete (old)	0/10	SCAC 0/10	E2	0.82
High-friction chip seals	1.5/3	-	F1	1.17
Sand-Asphalt	0/4	-	L2	0.5
Very Thin Asphalt Concrete	0/10	VTAC 0/10	M1	1.3

Mean Profile Depth (MPD) measured by the *Rugolaser* device

→ **macrotexture** measurement

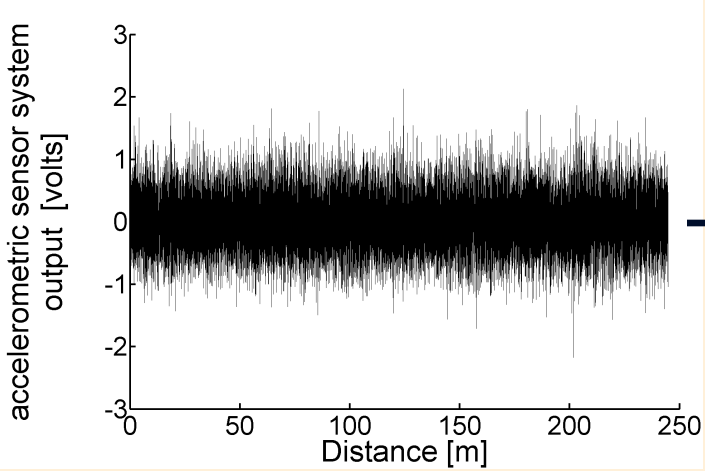
Surface Wetting



Successive measurements when drying

Data processing and Results

Data processing

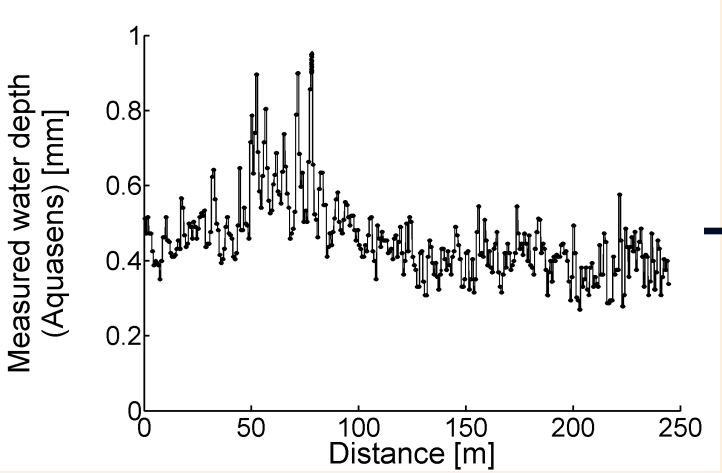


Signal processing

+

Filtering

Droplets speed indicator

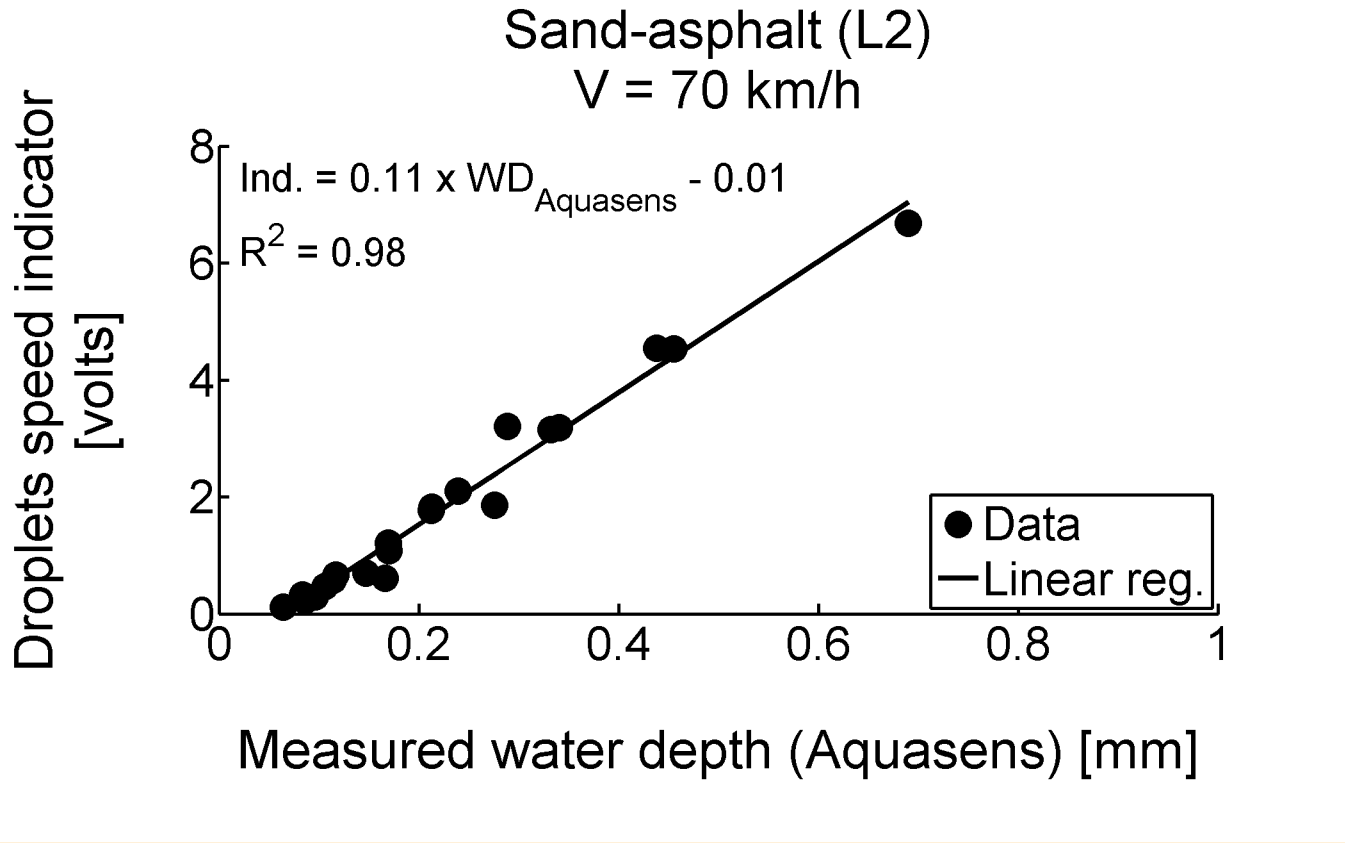


Mean value along the track (≈250 m)

Measured water depth

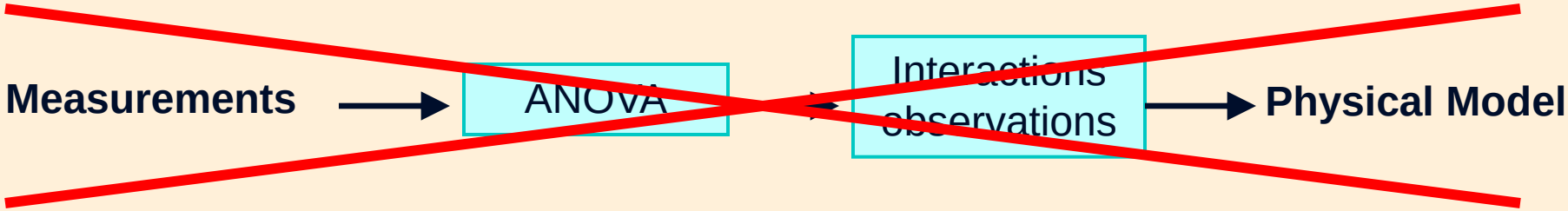
Results

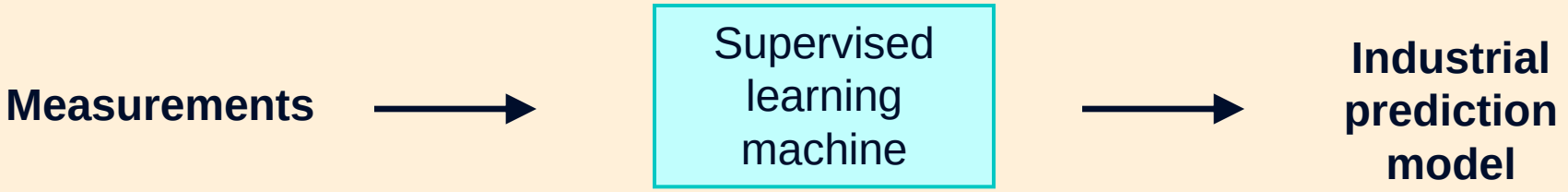
Droplets speed / Actual water depth



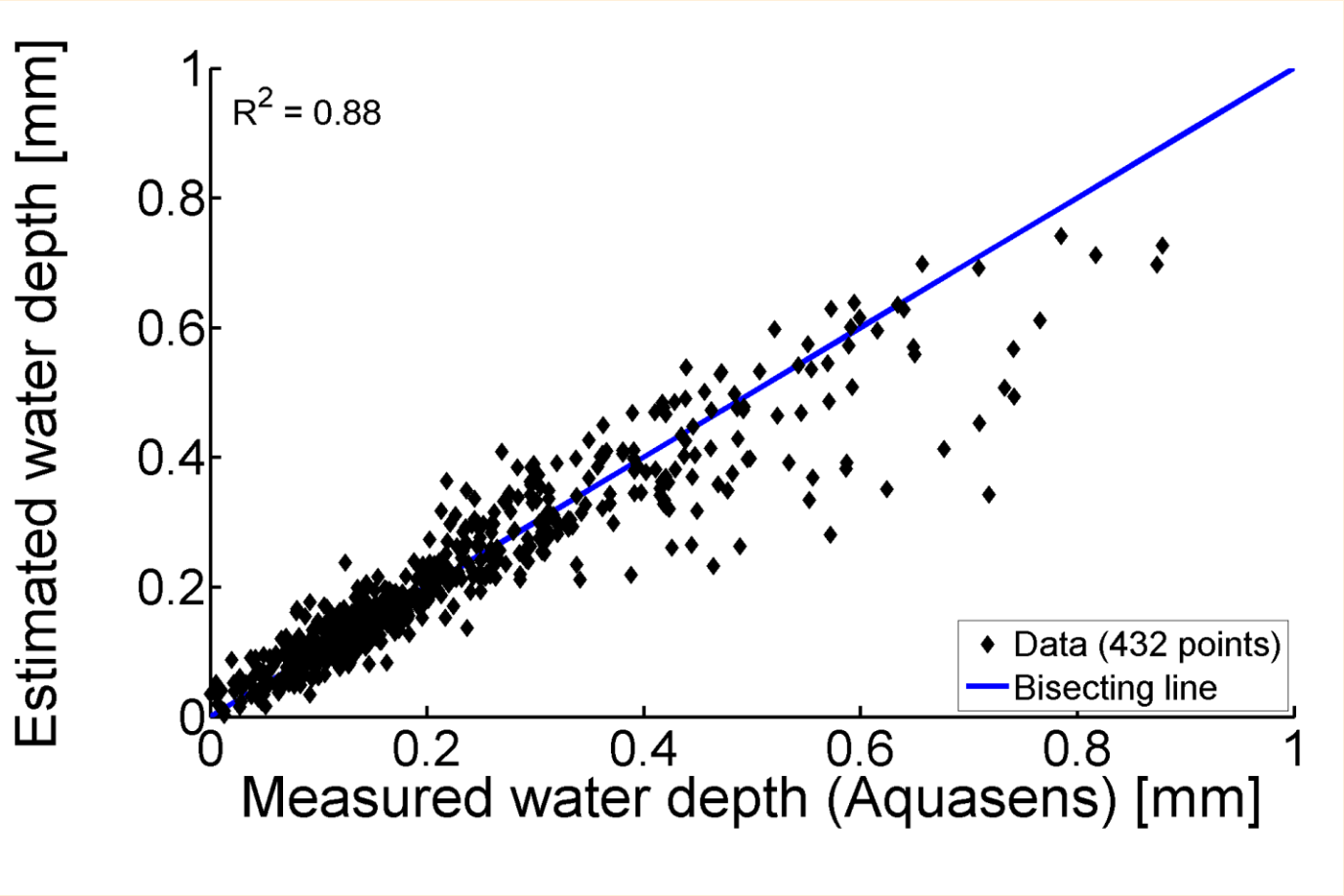
Results

On-board prediction model development





Developed Model



In prospect applications

- Detection of wet pavement
- Friction/aquaplaning models on-boarding
- Improvement of active-security systems
  - ABS
  - ESC
  - ACC
  - …
- Road management

Real-time processing

Thank you

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