Assessment of Possibilities to Distinguish Vehicles on the Basis of Wheel Load Characteristics

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Plan of presentation

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2. Research Area and Devices
3. Data Analysis
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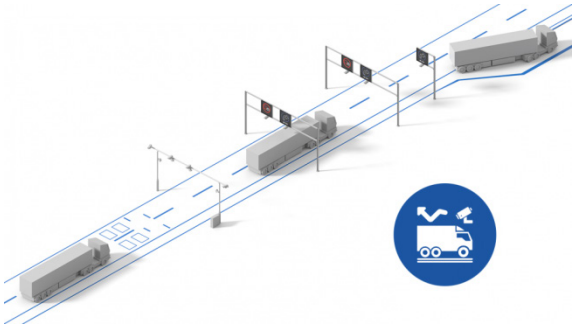
Introduction



•Weigh In Motion stations are an **important component** of intelligent transport systems.

•Current solutions for WIM stations are based on proven technologies, but still do **not provide a level of measurement reliability** that would allow for their **fully effective use as an automatic enforcement systems**.

•Also in Poland, since 2017 work has been carried out to create the basis for an **administrative system for dynamic measurement** of the vehicle parameters, which will ultimately enable the process of direct enforcement.

Introduction

•The analyses presented in this paper are part of the above-mentioned research and development project, the basic element of which is the development of a device for recording signals from, among others, strain gauges sensors

•In the context of the above, APM PRO is working on the project of **iWIM**

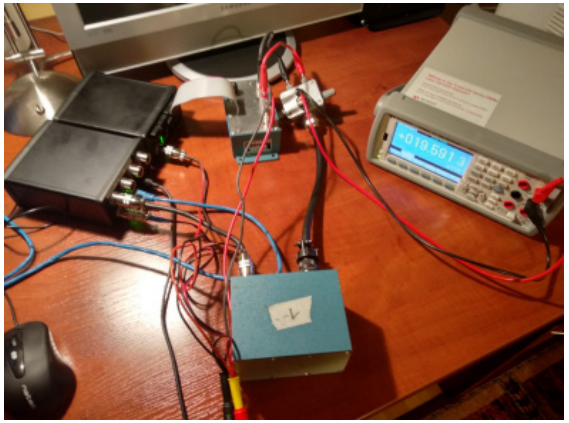
• **iWIM** is intelligent vehicle Weigh In Motion system which, thanks to the application of precise data recording and processing devices, additional sensors and algorithms for evaluation of measurement reliability, will allow to increase the efficiency of the system operation and improve the law enforcement process

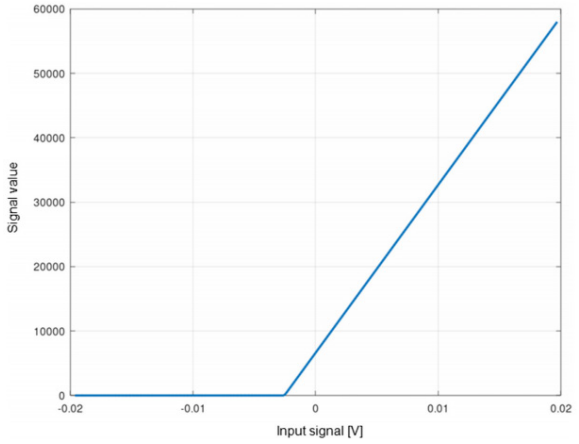
Research Area and Devices

The analyses were carried out with data gathered using the ITS test site located at the University of Bielsko-Biała

Research Area and Devices

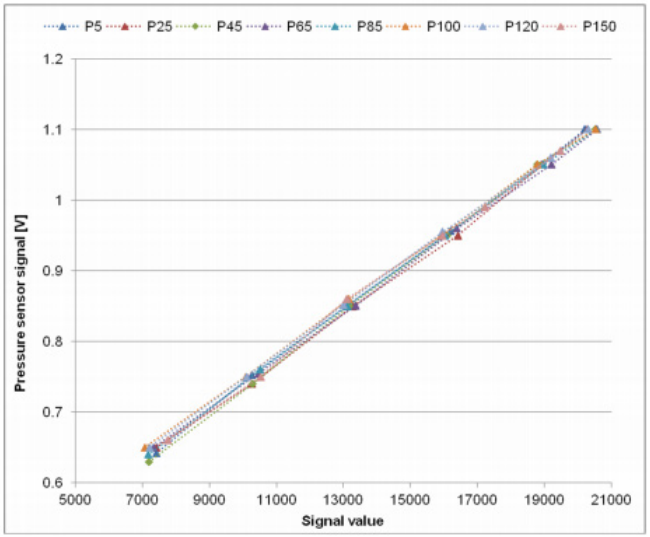
Importantly, as part of the project work (**iWIM**), data recording and processing circuits based on **FPGA** technology with built-in digital signal processor were developed. The developed amplifier has been tested for electrical parameters particularly for **linearity of signal gain** from strain gauges sensors.





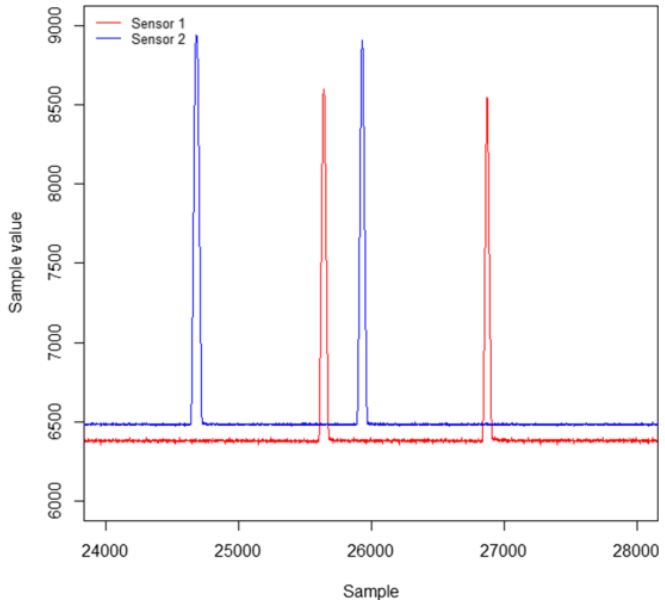
Research Area and Devices

The recording device in combination with a strain gauge sensor has been tested in the laboratory on the test bench.



Research Area and Devices

Finally the system was mounted in the control cabinet of the ITS test site and connected to the pavement-mounted strain gauge sensors.



Data Analysis

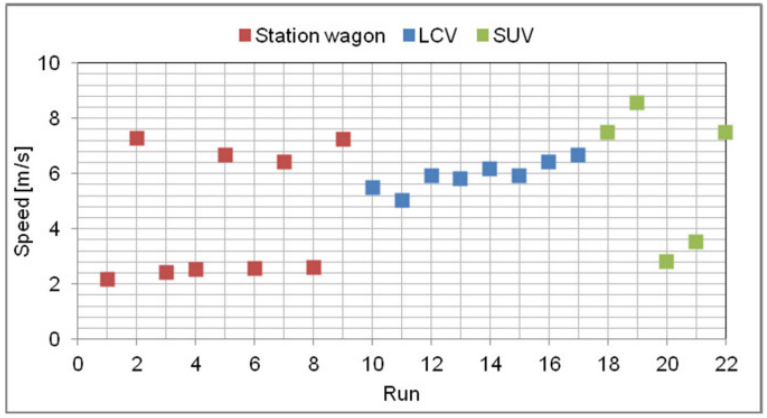
Within the framework of the research, multiple test runs were conducted with three vehicles:

– SUV (length 4888 mm, wheelbase 2890 mm),

– Station wagon SW (length 4650 mm, wheelbase 2700 mm),

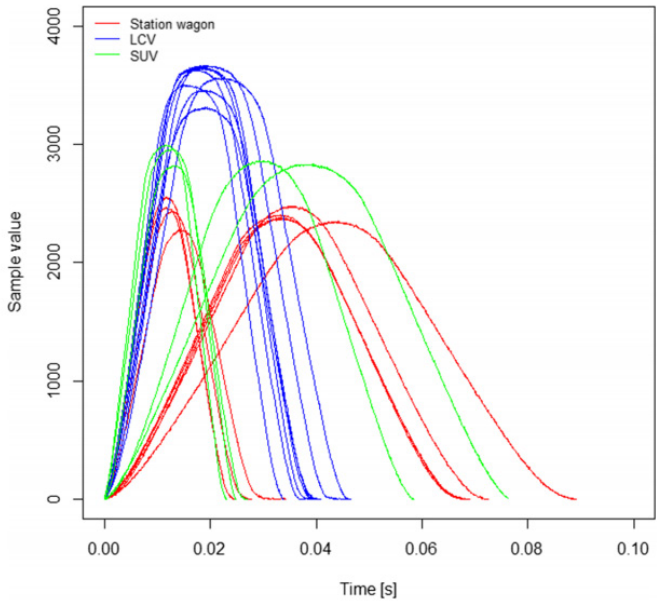
– LCV (length 8223 mm, wheelbase 4750 mm).

A total of 22 runs at different speeds were recorded.



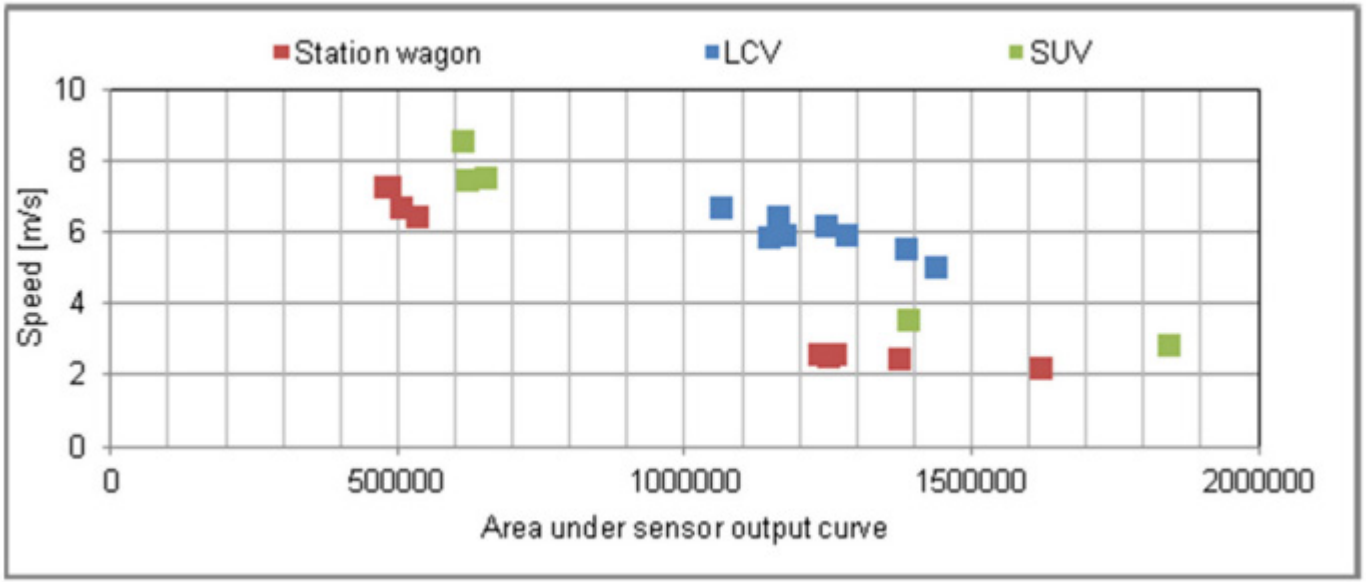
Data Analysis

For further analysis, it was decided to select only the data recorded for the vehicle's front left wheel. This is due to the fact that this pressure should, in principle, be the size with the least variation regarding the other vehicle wheels.



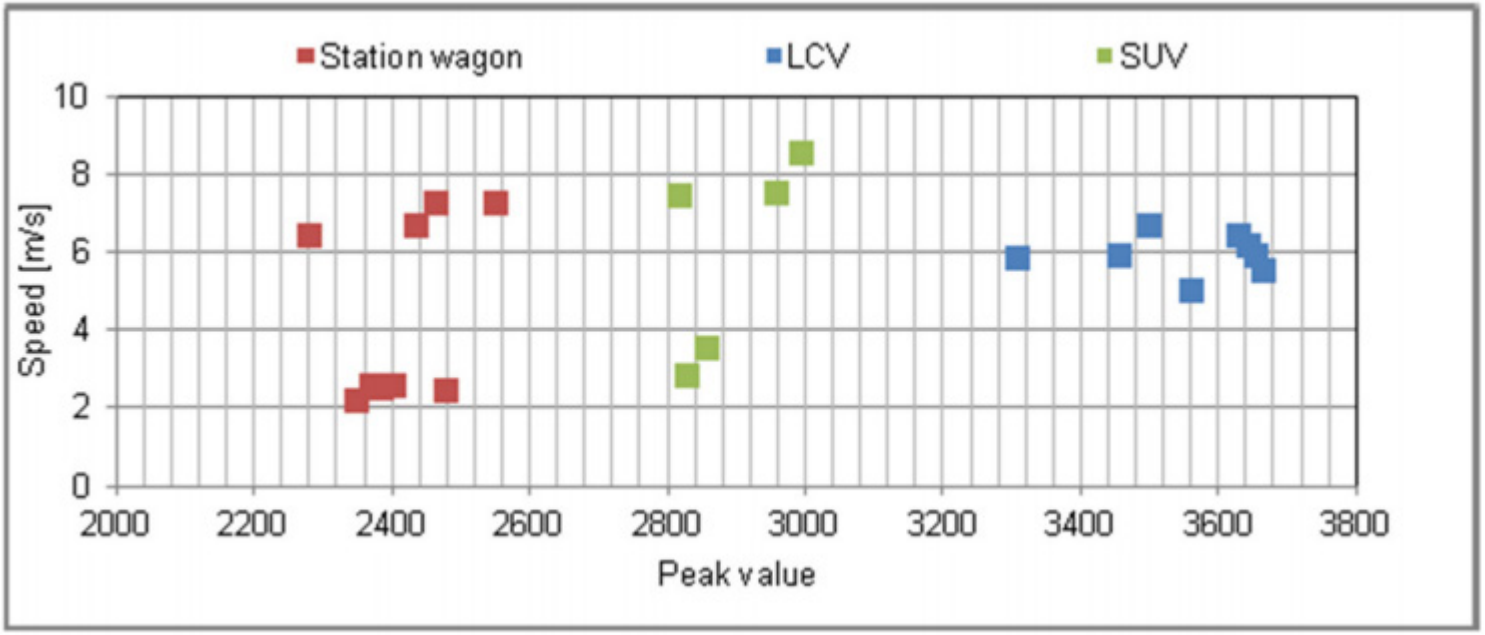
Data Analysis

Relation of the vehicle speed and the area under the signal value.



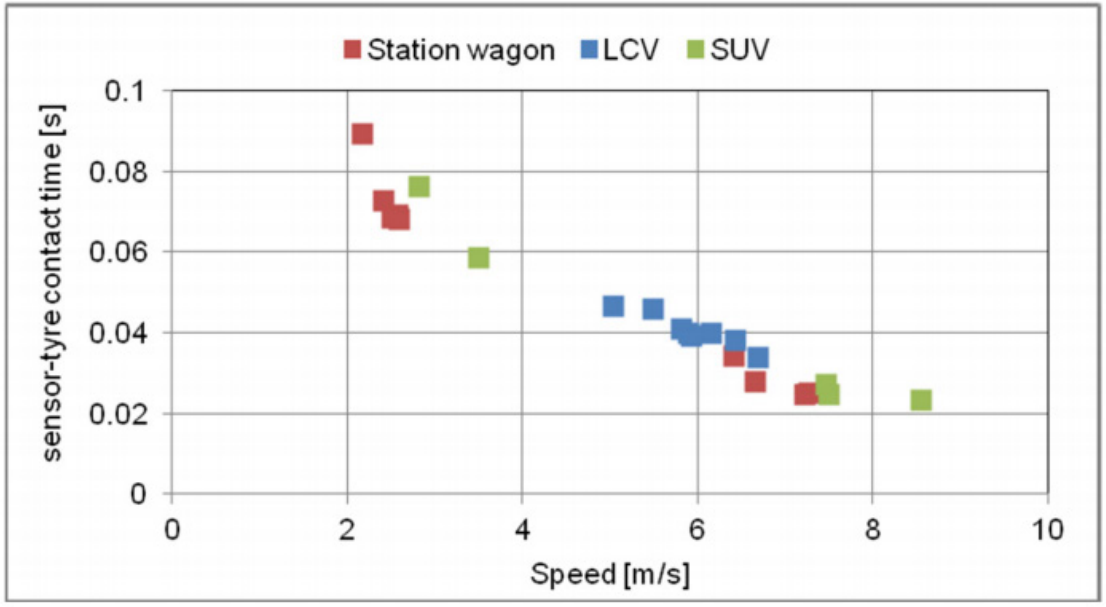
Data Analysis

Relation of the vehicle speed and the signal peak value.



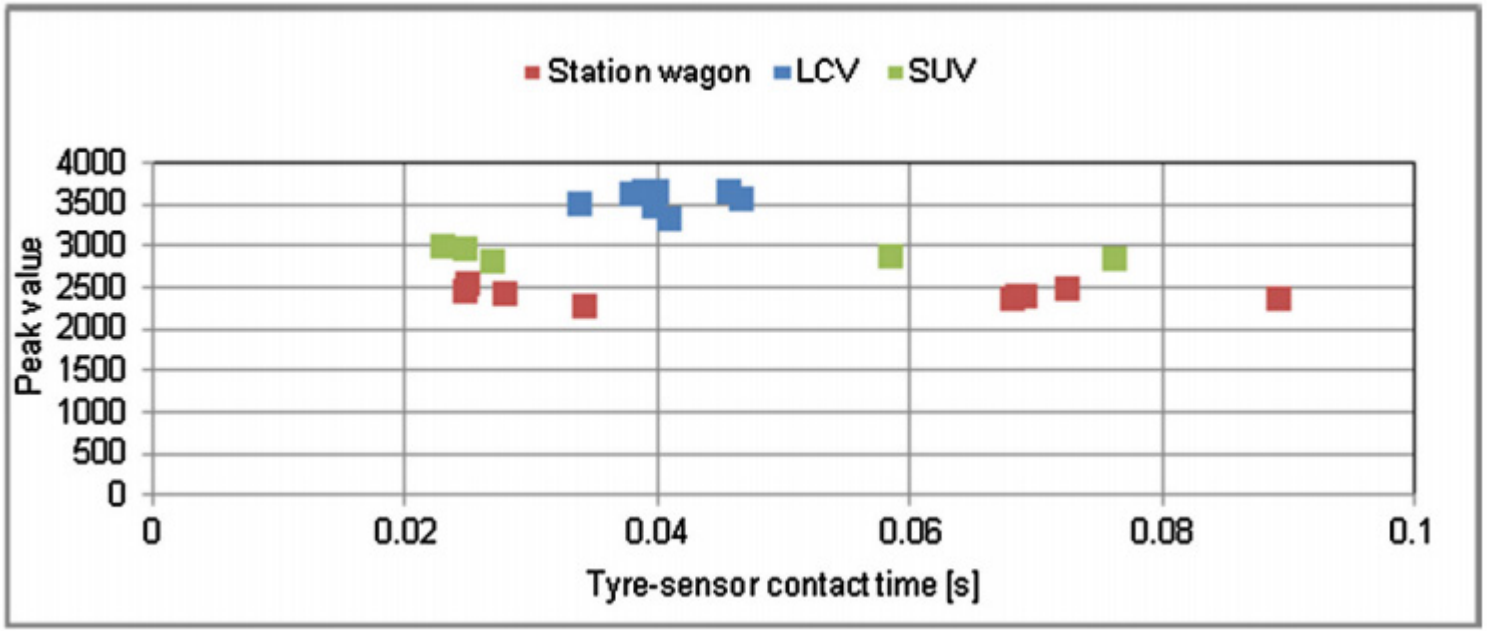
Data Analysis

The relation between the sensor-tyre contact time and speed of vehicle.



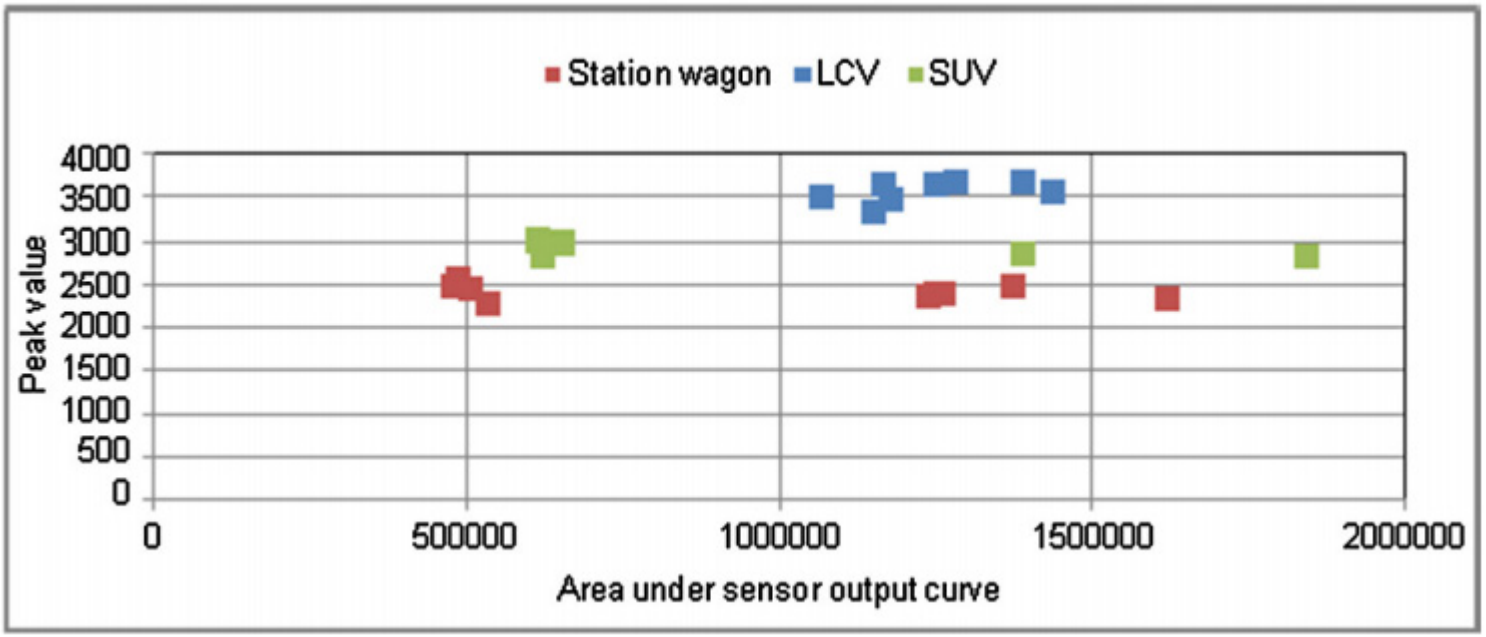
Data Analysis

The relation between the peak value and tyre-sensor contact.



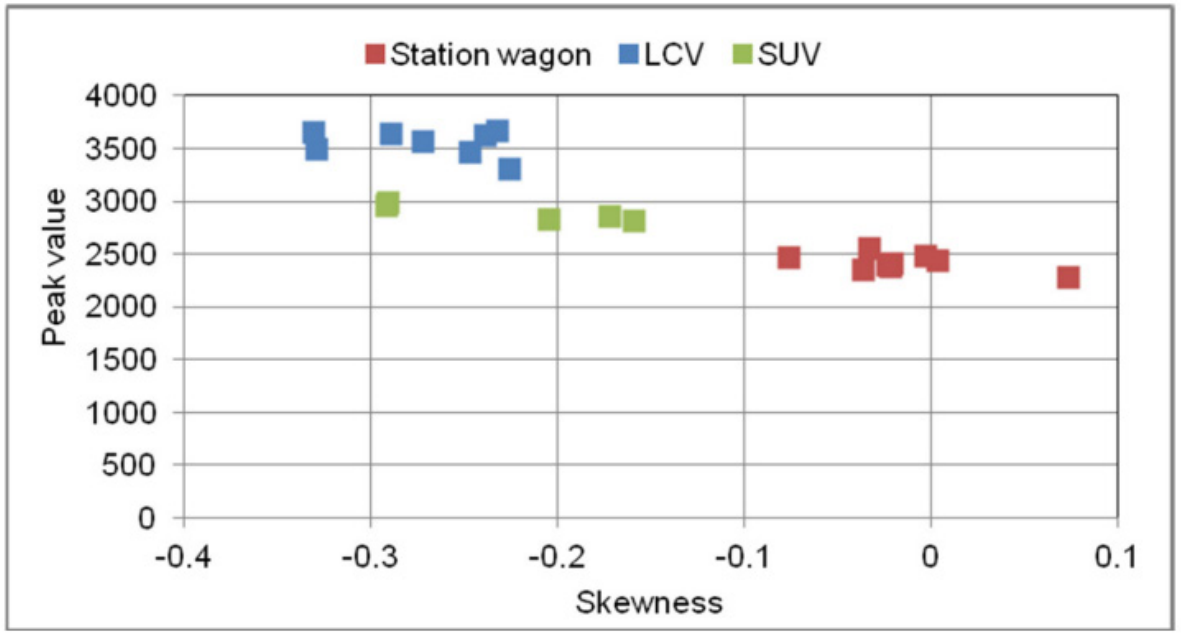
Data Analysis

The relation between the peak value and the area under the signal.



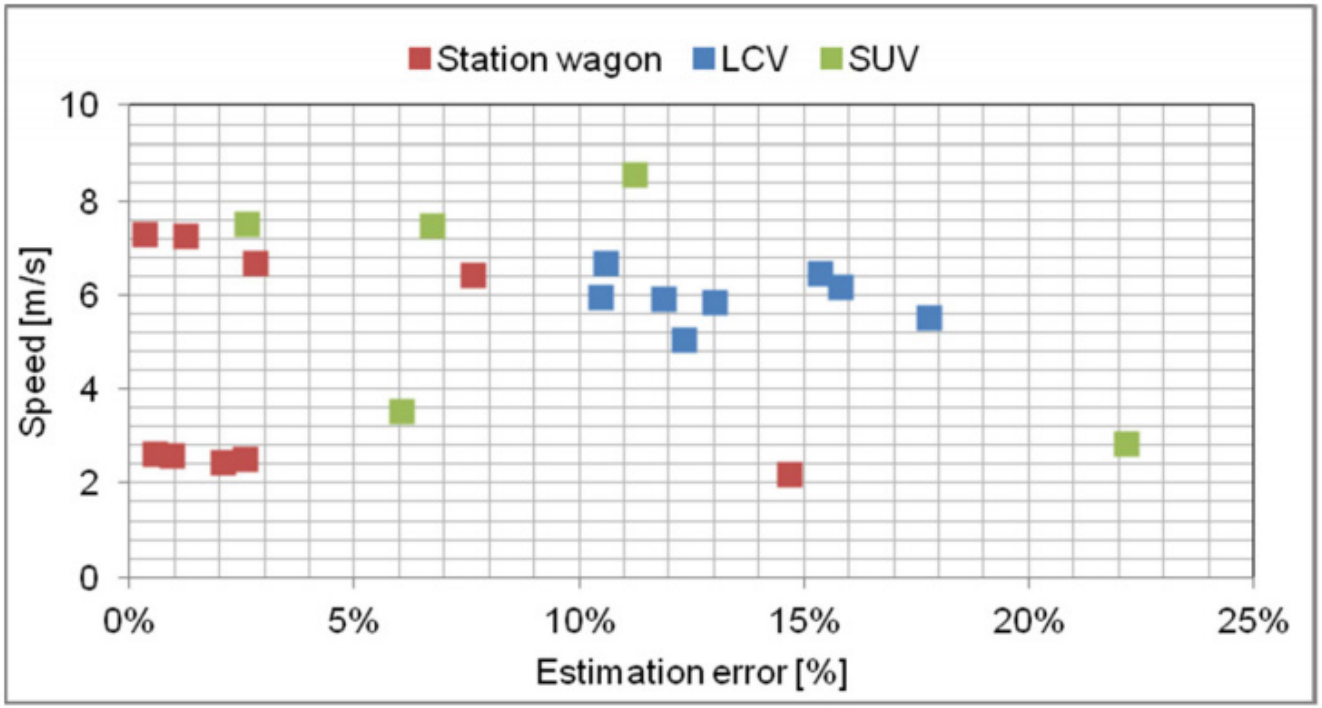
Data Analysis

Dependence of the peak signal value and the coefficient of skewness.



Data Analysis

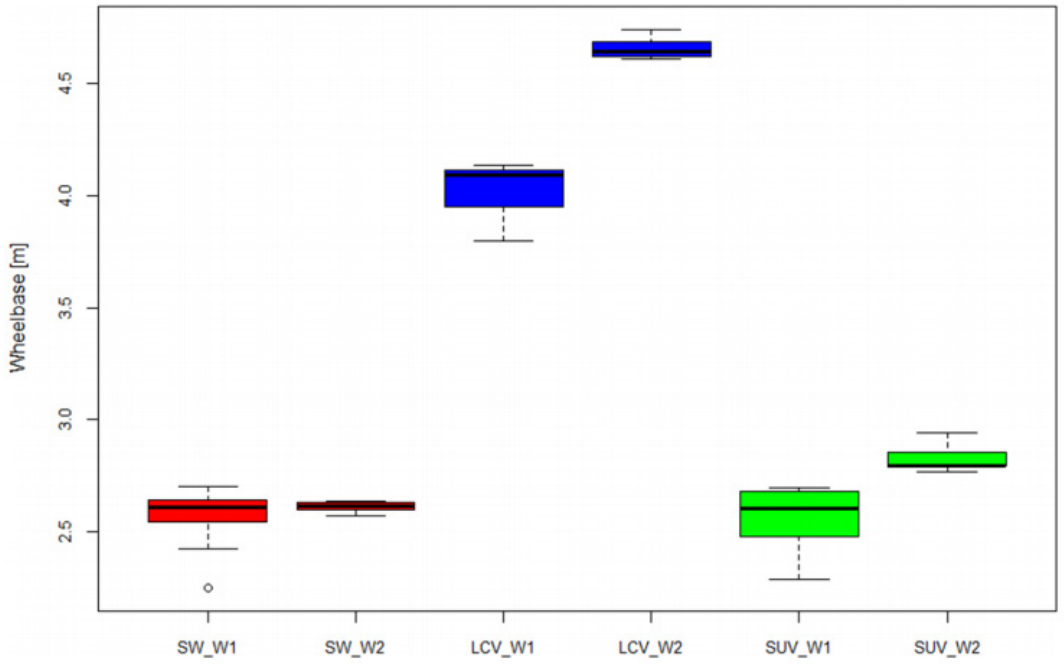
Dependence of speed and estimation error.



Data Analysis

The next step was to determine the wheelbase W as multiplication of speed S and time between peak value for left front and left rear tyre.

For this purpose, for the variant **W1** the estimated speed value was used, while for the variant **W2** the measured speed was used.

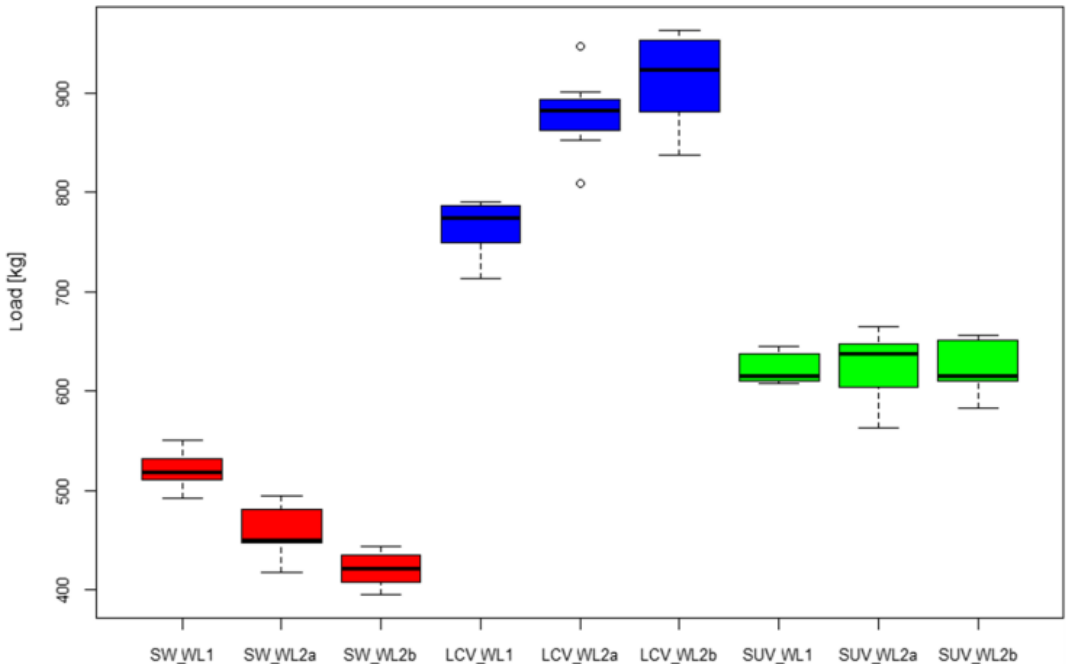


Data Analysis

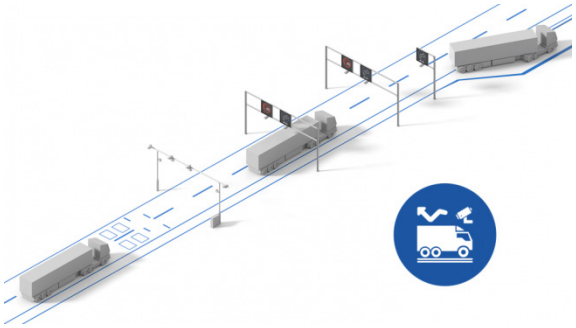
In the last stage of the presented analyses, the front left wheel load of the vehicle was estimated according to method 1 and method 2.

$$WL1 = a \cdot Max\ x_i$$

$$WL2 = (A \cdot b \cdot S)/L$$



Conclusion

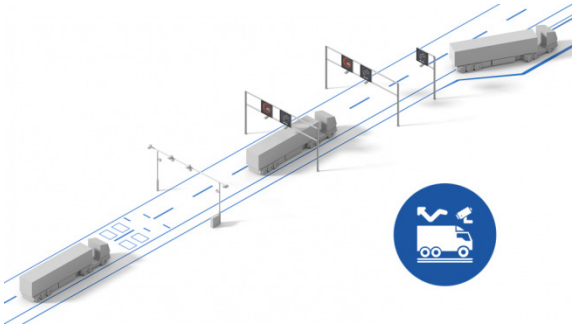


•The analysis presented in the article is a part of research and development work on intelligent Weigh in Motion system (**iWIM**).

•On the one hand, the aim of the analysis was to indicate the differences in the values observed for selected vehicles with the laden mass below 3.5 tonnes - **the obtained results shows** that even using data from one sensor **there is a possibility of determining the type of vehicles** (e.g. SUV, SW, LCV).

•On the other hand, the aim was also conducting the test of the device operation, which was created within the R&D project.

Conclusion



- The scope of the presented analysis was **significantly limited** by the permissible speed at the installation site (speed limit 30 km/h).

- The next steps are to **build a dedicated test station** on a selected section of the national road.

- Importantly, the **recorded data will be supplemented** with information from the **additional strain gauge and polymer sensors**.

- Ultimately, the system is also intended to enable assessment of the **impact of external factors** such as dynamics of vehicle movement, meteorological conditions, surface condition, road foundation temperature etc. on the vehicle weighing process.