A Clear Run for the Karlsruhe Measurement Tram

KIT and AVG Aim to Improve Local Rail Transport with Smart Sensors and Machine Learning

The Karlsruhe measurement tram is now recording mechanical and electrical variables as well as different environmental parameters during regular passenger operation. (Photo: AVG/Michael Krauth)

In a joint research project, Albtal-Verkehrs-Gesellschaft mbH (AVG) and Karlsruhe Institute of Technology (KIT) have equipped a tram with comprehensive measurement technology. The tram will generate data on environmental influences, usage and rail condition, among others. The aim is to optimize local rail transport using methods of machine learning with regard to safety, energy efficiency and comfort. The Karlsruhe measurement tram has now commenced operation.

By regularly checking their tracks using measurement trains, transport companies in Karlsruhe guarantee the safety of their passengers. However, a research project carried out by Albtal-Verkehrs-Gesellschaft mbH (AVG) in cooperation with the Division of Railway System Technology within the Institute of Vehicle System Technology at KIT (FAST) now shows that in the age of digitalization measurement trains can do much more than just examine tracks for existing damage: “We have equipped a tram with the latest measurement technology,” says Professor Peter Gratzfeld from FAST.

KIT Mobility Systems Center: Solutions for tomorrow's mobility

Monika Landgraf
Chief Press Officer
Head of Corp. Communications

Kaiserstraße 12
76131 Karlsruhe, Germany
Phone: +49 721 608-21105
Email: presse@kit.edu

Press contact:

Kosta Schinarakis,
Corporate Communications
SEK
Phone: +49 721 608 21165
Email: schinarakis@kit.edu

“This measurement tram will now produce data for our project which we will evaluate using current IT methods such as machine learning. Our goal is to improve the safety, energy efficiency and comfort of local rail transport and to minimize wear.”

According to AVG Technical Director Ascan Eger, this cooperation project creates some real added value for AVG: “With the help of these installed sensors, we get a lot of valuable information on how our vehicle behaves in day-to-day use and which external influences it is constantly exposed to. The more we learn about the vehicle, the better we’ll be able to optimize not only our trams but also the infrastructure and operation.” The Karlsruhe measurement tram will be used in regular passenger operation from now on.

Focus on safety, energy efficiency and comfort

To identify damage to the infrastructure sooner than with conventional methods in the future, acceleration sensors have been installed on the bogies of the measurement tram. Researchers want to use them in combination with GPS data to make reliable predictions on the wear and tear of the tracks. Energy efficiency could also be improved thanks to the measurement tram: although the braking energy from trams is already fed back into the overhead line network, it only contributes to energy savings if another nearby tram can use this energy for accelerating. Especially in peripheral areas where the network is less developed, up to 30 percent of the braking energy is lost as heat. By constantly observing parameters such as overhead line voltage, the power consumption of the vehicle and the loss of power at the braking resistors, the aim is to check which places would be suitable for potentially stationary units to store the braking energy.

Another important approach for optimizing local rail transport is passenger comfort, with acceleration sensors also fitted in passenger compartments. Excessive acceleration, especially when driving out of a curve, can be perceived as unpleasant, and the data from these sensors could help to improve driver training in the future. What’s more, the screeching that frequently occurs in curves with small radiuses is a noise issue for residents. Using measurement microphones in combination with GPS data, speed and other external conditions will help analyze why and where the screeching occurs most often.

Data mining to show unknown connections

The above examples are only a small selection of the large variety of data that can be generated thanks to the Karlsruhe measurement tram. For example, CO_2 sensors and instruments for measuring sunlight and humidity have also been installed. “With the help of

data mining techniques, we also aim to examine the data for previously unknown correlations to increase safety and comfort, as well as reduce costs and energy consumption," says Gratzfeld. This means that passengers, operators and manufacturers alike will benefit from the Karlsruhe measurement tram.

More about the KIT Mobility Systems Center:
http://www.mobilitaetssysteme.kit.edu

As "the Research University in the Helmholtz Association", KIT creates and conveys knowledge for society and the environment. The aim is to make significant contributions to global challenges in the fields of energy, mobility and information. To achieve this, around 9,300 employees are working together on a broad disciplinary basis in natural sciences, engineering, economics, humanities and social sciences. Seine 25 100 Studierenden bereitet das KIT durch ein forschungsorientiertes universitäres Studium auf verantwortungsvolle Aufgaben in Gesellschaft, Wirtschaft und Wissenschaft vor. Innovations at KIT bridge the gap between knowledge and application for the benefit of society, economic prosperity and the preservation of our natural resources.

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This year KIT remembers its milestones and long tradition in research, teaching and innovation with its **anniversary logo**. On October 1, 2009, KIT was created from the merger of its two predecessors: in 1825, the polytechnic school which later became the University of Karlsruhe (TH) was founded, and in 1956 the Kernreaktor Bau- und Betriebsgesellschaft mbH which later became Forschungszentrum Karlsruhe GmbH was founded.