

Rectorate
Communication and Fundraising

University of Mannheim

Spokeswoman: Katja Bär
Phone: 0621 / 181-1013
baer@uni-mannheim.de
www.uni-mannheim.de

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The Future of E-mobility: Intelligent Navigation Systems Make Cars Greener

An interdisciplinary team of researchers at the University of Mannheim is involved in the development of a navigation system for electric vehicles, which not only extends the life of the vehicle batteries, but also prevents instabilities in the power system and promotes the use of renewable energy. The three-year project is funded with 630,000 euros under the EU program "Horizon 2020" at the University of Mannheim. It starts on 1 September 2016.

According to the German chancellor Angela Merkel, a million electric vehicles shall use the country's roads by 2020. However, electric cars still suffer from strong sales problems: In addition to the acquisition costs, the low range of the battery primarily deters potential customers. A research team at the University of Mannheim is now working to increase the attractiveness of electric vehicles by improving the battery life span. Within the scope of the project, the researchers focus on the user instead of technological innovations. Scientists from economics, psychology, and computer science, together with ten other European partners within the framework of the EU project "ELECTRIFIC", develop a highly complex navigation system. The system is intended to optimize the user's behaviour: "We want to offer a tool, which allows drivers to extend battery range and life span by choosing perfect routes and optimal moments for charging", explains Sonja Klingert from the Chair of Business Informatics II, who is the head of the project at the University of Mannheim.

"If I, as a driver, know that I am going to drive my kids to school, drive to work, and afterwards head to the laundry and to the supermarket, I often already have a particular sequence in mind", explains Sonja Klingert. In such situations, users tend to fully charge the battery before the start of the journey and, if required, reload the battery "quickly" on the way home. "Unfortunately, full charge and quick reloading both have a negative impact on the battery life in the long-term", said Klingert. The "Advanced Driver Assistance System" (ADAS), the navigation system which the researchers of the University of Mannheim are developing, is designed to avoid this behaviour: It knows the status of the battery and the planned route - by manual input or the analysis of past rides - and suggests battery-friendly charging times and places based on the Electric Vehicle Smart Algorithm (ELSA).

Risk factor electricity network

But that is far from being the end. "The system is able to do even more: It applies the latest information from the electricity network and proposes a route which enables drivers to use as much

electricity from renewable energy sources as possible”, states Thomas Schulze from the Chair of Software Engineering. The ADAS is furthermore intended to integrate the charging process into the electricity grid to preclude severe voltage fluctuations. This is a particularly important factor for the expansion of e-mobility: “In the future, the massive spread of electric vehicles will cause another problem: The situation if all vehicles charge at the same time could lead to instability and blackouts in the electricity network”, adds Schulze. Hence, the ADAS adjusts the distribution of the loading times of all electric vehicles to the load curve of the local electricity network and to the current weather forecast. It is less likely that many drivers recharge their cars at the same time if the system calculated the optimal stations for charging on the basis of individual factors. The ADAS could, for instance, recommend drivers to adjust their plans because of weather data: “If the sun will shine at 2PM at the supermarket, it may, under certain circumstances, be more appropriate to charge the vehicle earlier than initially planned”. This has several advantages: “The percentage of solar energy used for the charging station is significantly higher at that moment. Therefore, the energy which is ultimately used in the battery is more environmentally friendly. Since shopping already takes half an hour, the battery can be charged in the meantime”, explains Thomas Schulze, who manages the Software Engineering tasks of the project.

Challenge “Big Data”

The development of such a system is complex. This is also one of the reasons why the research team works across disciplinary boundaries. Psychological factors, for instance, matter as well: “In order to encourage the drivers to accept the offered recommendations, proposals need to be attractive and transparent”, explains Prof. Dr. Michaela Wänke, holder of the Chair of Consumer and Economic Psychology. “We are therefore cooperating with the Chair of Business Informatics II to develop psychological and economic incentive mechanisms to reward the driver for exemplary behaviour.” In addition to bonuses and price discounts at charging stations, it is also important to examine the way how the system presents alternatives to the driver and the order of these alternatives. Last but not least, the data pose a challenge: “We are dealing with enormous amounts of data and with highly sensitive data”, said Dr. Florian Kutzner, who is heading the psychological tasks in the project. Beside of weather information and battery capacity, the system also needs to access historical data about the driving behaviour and the topography in order to create attractive proposals and to calculate the energy consumption per trip correctly. At the same time, however, the self-determination of users with regards to their data should not be lost from view.

The project will start on 1 September 2016 and will run for three years. During the first year, the researchers initially gather requirements for the system and model the approach. During the second and third year, implementation and two test phases follow. After the development, the ADAS will be made freely available to the automotive industry.

The project participants

At the University of Mannheim, the joint project is located across faculties at the three Chairs of Business Informatics II (Business School), Software Engineering (School of Business Informatics and Mathematics) and Consumer and Economic Psychology (School of Social Sciences). External project partners include the French IT consulting company GFI Informatique, the University of Passau, the Deggendorf Institute of Technology, and the e-car sharing provider E-WALD GmbH.

About Horizon 2020

Horizon 2020 is the framework programme of the European Union for research and innovation. Its

goal is to establish a competitively viable economy EU-wide and to contribute to a sustainable development. The project "ELECTRIFIC" is sponsored with a total of 6.2 million euros within the challenge "Smart, Green and Integrated Transport". 630,000 euros go to the research team of the University of Mannheim.

Contact details:

Sonja Klingert
Project Leader
Chair of Business Informatics II
University of Mannheim
Phone: +49 (0) 160/1066 942
Email: klingert@uni-mannheim.de

Dr. Florian Kutzner
Chair for Consumer and Economic Psychology
University of Mannheim
Phone: +49 (0) 621 / 181-1689
Email: florian.kutzner@psychologie.uni-heidelberg.de

Thomas Schulze
Chair of Software Engineering
University of Mannheim
Phone: +49 (0) 621 / 181-3906
Email: schulze@informatik.uni-mannheim.de