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Efficient urban driving – the Audi travolution project

The equipment and data specified in this document refer to the model range offered in Germany. Subject to change without notice; errors and omissions excepted.

Summary

Greater efficiency and lower emissions in urban traffic – the Audi travolution project

Waiting at red lights does more than just annoy drivers; it also pollutes the environment. In its drive to improve efficiency, Audi is going beyond the optimization of vehicle technologies and is developing concepts for regulated road traffic. In the travolution project, Audi engineers are developing a method that allows cars to communicate with traffic signals. This dialogue can reduce waiting times and thus fuel consumption, which also means lower emissions.

Audi launched the travolution project in 2006. For the first step, the company and its collaboration partners researched a new, adaptive computing algorithm for the control of traffic light systems in Ingolstadt. The implementation of this first stage already reduced fuel consumption by 17 percent by reducing waiting times at traffic lights. Savings total approximately 700,000 liters (*184,920.44 US gallons)* of gasoline and diesel per year.

In the second step, Audi is now enabling traffic light systems to communicate with vehicles. Communication is via WLAN and UMTS, and is currently possible with 15 test vehicles and 25 traffic signals with more than 150 traffic lights. Audi expects this technology to further reduce CO_2 emissions by approximately 15 percent.

The traffic light systems broadcast information that appears as graphics on the display of the vehicle's driver information system. These graphics inform the driver of such things as the speed the driver should drive to get a green light at the next traffic light. The driver can use the adaptive cruise control (ACC) system to delegate this function for optimal traffic flow to the control unit in the vehicle.

If the light is red, it informs the driver when it will turn green via the on-board computer. A signal or brief activation of the brakes informs the driver that he or she is approaching a light that is already yellow or red, or is about to change to red.

The travolution project also offers the ability to pay online for fuel and parking. After confirmation in MMI, the funds are automatically deducted from a credit card or charge card.

As a complement to travolution, Audi is also involved in the nation-wide sim^{TD} project, which stands for “Safe and Intelligent Mobility Test Bed Germany.” This project is funded by the German federal government and involves a broad-based consortium of diverse participants. A major test in Frankfurt am Main is addressing all aspects of Car-to-X communication. Audi heads one of the five sub-projects.

Car-to-X communication offers a number of additional solutions for enhancing safety and reducing fuel consumption. Audi is already generating great interest from many cities in its technologies, such as active traffic light communication.

Full version

New ideas for urban mobility – Audi improves efficiency and safety in road traffic

Efficiency is a central theme for Audi. The company has therefore gone beyond optimizing vehicle technologies and is conducting research into the idea of intelligently controlled traffic. In the travolution project being conducted by the brand with the four rings in Ingolstadt, cars can communicate with traffic lights. This networking makes the flow of traffic smoother and thus reduces CO_2 emissions. Audi is assuming a leading role in this field of technology, which is known as Car-to-X communication.

Today's technology: communicating traffic light systems

Road traffic today is still controlled largely with yesterday's technology – at the expense of the environment. When a car stops at a red light, it uses approximately 0.02 liters (*0.01 US gallons)* of fuel when it pulls away. This corresponds to roughly 5 grams of CO_2. In urban traffic, which in Germany is regulated by roughly 60,000 traffic signal systems, the 50 million cars in Germany emit roughly 15 million tons of CO_2 or approximately 20 percent of their total emissions.

These emissions can be reduced if the traffic lights initiate contact with the vehicles. This is precisely what Audi is targeting with the travolution project. Launched in 2006 at AUDI AG headquarters in Ingolstadt, the project has already produced many promising results. As the project stands now, the Audi experts expect CO_2 emissions at traffic lights to decrease by roughly 15 percent. This corresponds to an equivalent of approximately 900 million liters (*237,754,846.12 US gallons*) of gasoline per year if this new technology were to be deployed throughout Germany.

Audi is collaborating with a number of partners in the travolution project, including the City of Ingolstadt, Scheidt & Bachmann GmbH, TaxiFunk Ingolstadt, ADAC *(General German Automobile Association),* GEVAS software GmbH, the Technical University of Munich, Ingolstadt University of Applied Sciences and the University of Erlangen-Nuremberg.

For the first step, the Audi engineers and its partners researched a new traffic light algorithm that is designed to be self-learning. It controls 46 of the roughly traffic light systems in Ingolstadt. The results: Prior to the optimization, the vehicles had to stop at every fourth light on average; now it is only every fifth light. This saves 17 percent fuel per year. Given the volume of traffic in Ingolstadt, this amounts to roughly 700,000 liters (*184,920.44 US gallons*) – an amount with which 1,000 Audi A4 2.0 TDI cars could drive for a year, assuming annual mileage of 14,000 kilometers (*8,699.20 miles*) per vehicle.

This first stage of the travolution project, which was subsidized by the Bavarian State Ministry of the Economy, Infrastructure, Transportation and Technology, was concluded in 2008. Last year, the initiative “Germany – Land of Ideas” awarded its “Selected Landmark 2009” prize to the City of Ingolstadt for this project.

At the same time, Audi engineers began equipping the first Ingolstadt traffic light systems with a completely new, active communication technology in 2006. They have continuously expanded and improved this aspect of travolution to this day.

Current status: over 150 traffic lights

As of June 2010, 25 traffic light systems have been included in the trial, with preparations underway for an additional 27. The systems already active are primarily located on the Ringstrasse, which encircles the city, and Ettinger Strasse, which runs northward past Audi's Ingolstadt plant. Because each system comprises multiple lights, the project covers a total of more than 150 traffic lights.

Audi is developing two technologies for the communication between the traffic lights and the cars. Ten traffic lights use WLAN to broadcast its signals to the immediate surroundings; the other 15 send their signals to a server located in the Altes Rathaus (Old Townhall) downtown. The existing underground cables are used to transmit the data to the server; the vehicles retrieve the information via UMTS.

The 15 test vehicles from Audi – 13 Audi A4 allroad quattro and two Audi Q5 models – receive these data via a module equipped with a WLAN antenna and via a UMTS data interface. Each traffic light system continuously transmits a package of standard information that includes a description of the system's structure, a status report on the color of the individual traffic lights for the respective directions of travel and a preview of how the lights will most likely change in the new future.

The controller in the test vehicle uses this information to compute fuel-saving driving behavior for the driver. "Imagine that you are currently 150 meters (*492.13 ft)* away from a traffic light in your A4 allroad quattro," says Audi pre-development engineer Cornelius Menig, who heads the project. The light is red, but will change to green in 15 seconds. If you now continue driving at 50 km/h (*30.17 mph*), you will arrive at the light during the last few seconds of the red phase and have to stop, only to immediately start off again. If you reduce your speed to 35 km/h (*21.75 mph*), however, the light will be green when you get there."

The vehicles in the test fleet show the information on the display of the driver information system using a concept developed by Audi in field trials. The display has been expanded to include a popup line that shows the recommended speed. The driver receives the information for that traffic light for the line currently occupied, and the system also considers active turn signals. Alternately, the vehicle can also be located using predictive route data, such as that provided by the new Audi A8.

Even more efficient: smartACC

Two of the Audi test cars are equipped with Audi's adaptive cruise control (ACC). The travolution project turns the radar-assisted cruise control into a smartACC system. The traffic light system transmits the time of the next light change to the vehicle. The on-board computer uses this to then compute the optimal speed. If the driver then briefly pulls on the steering column stalk, this assistant brings the car to precisely this speed, and the driver is spared having to wait at the light.

The assistant to avoid red light violations integrates an additional function. It warns a driver who attempts to enter an intersection when the light is yellow or red or is changing to red while the driver crosses the stop line. Audi developed this feature in light of the fact that the authorities register nearly 300,000 red light violations in Germany each year. These violations result in roughly 7,500 accidents resulting in injuries and around 100 fatal accidents, in most of which the victims are pedestrians.

As with the audi braking guard from which this function has been derived, there are two stages to the red light warning depending on the situation. Stage 1 is a red light in the driver information system combined with a warning tone. In Stage 2, these are followed by brief activation of the brakes. The system slows the car slightly to encourage the driver to step on the brakes.

Despite all of the networked intelligence of the travolution project, it will still not be possible to ride the dynamic green wave at all times, such as during rush hour. When the test car is waiting at the light, the driver information system display shows the time remaining of the red phase. That calms the driver, makes modern start-stop systems more efficient and simultaneously increases awareness for starting off smartly when the light turns green. This does not happen in many cases today. A driver who remains stopped at a green light frequently results in massive delays in tightly timed stop-and-go traffic, much to the annoyance of other drivers.

Vehicles can report traffic jams and can generate an overall picture of the traffic situation in a city. This is achieved in the travolution project using empirical data, taxi floating car data (Taxi FCD) and information from the ADAC, which the vehicle can actively retrieve from the server via UMTS.

The travolution project also includes two additional convenience services – online payment at filling stations and parking garages. In both cases, the individual steps are visualized on the MMI on-board monitor, where the driver can also see how many parking spots are still available.

The car logs in to the fuel pump or the parking garage gate. The driver's credit or charge card is stored in the system. The driver confirms payment via the MMI, and the amount is deducted after refueling or parking.

This scope makes travolution the leading project in Europe and throughout the world in its field. Audi is very well informed about this topic for the future because Audi has been working on Car-to-X communication – the networking of the automobile with its surroundings - for ten years. Audi is a founding member of a European consortium in this field.

Car-to-X communication: Audi in the sim^{TD} project

As a complement to travolution, Audi is also involved in the nationwide sim^{TD} project, which stands for "Safe and Intelligent Mobility Test Bed Germany." This project is being funded by three German federal ministries. Five other German carmakers, two major suppliers, Deutsche Telekom and a number of scientific and public institutions have been collaborating on this project since 2008.

The large-scale trial, scheduled for four years, comprises five sub-projects, one of which is managed by Audi. 20 traffic light systems and 400 vehicles in the Frankfurt am Main metropolitan area, where the sim^{TD} trial is being conducted, are being retrofitted with the same technology as in Ingolstadt. The Ingolstadt specialists are also involved in the area of traffic information with road preview and extended navigation.

Audi is also involved in the field of driving and safety, where it is working on the intersection assistant. Here the cars exchange information with one another, and this communication is used to provide active warnings of collisions for a greater level of safety.

Networked knowledge: more safety, better economy

Car-to-X communication harbors significant potential for enhancing safety and reducing fuel consumption.

Cars can warn each other of breakdowns and weather-related events such as snowy roads detected by the ESP sensors. The owners can communicate with the vehicles from the comfort of their home or office to load a route into the navigation system, for example.

The City of Frankfurt am Main is very pleased by the current state of the project, according to Cornelius Menig, who heads the Audi sim^{TD} subproject. Audi is willing to serve as a consultant to interested communities and regions. Menig says, “Our objective is a strategic alliance between carmakers, suppliers, the telecommunications industry and the public sector. As for us: we’re ready to go today.”