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Abstract:

The AI Group of the Freie Universität Berlin has been focusing its research efforts on the development of autonomous vehicles for urban transportation since 2006. The team started off with retrofitting a Dodge Caravan with drive-by-wire technology and sensors to participate in the 2007 Urban Grand Challenge. The autonomous car, Spirit of Berlin, reached the semi-finals and demonstrated staggering potential of unmanned vehicles for the future of transportation. Since then, research has continued with a new car, designed to meet the challenges of unmanned vehicles driving side by side with humans

Detailed research information:

The Artificial Intelligence Research Group of the Freie Universität Berlin (FU) is internationally renowned for their autonomous robots since 1998. Over the years, several generations of small and mid-sized robots were built which took part in the annually held international RoboCup (robotic soccer) competitions. The FU team, the FU-Fighters, won the World Championship twice in the small-size league and a second place in the middle-size league. The FU-Fighters dominated the European competitions for several years, winning the European championship five times.

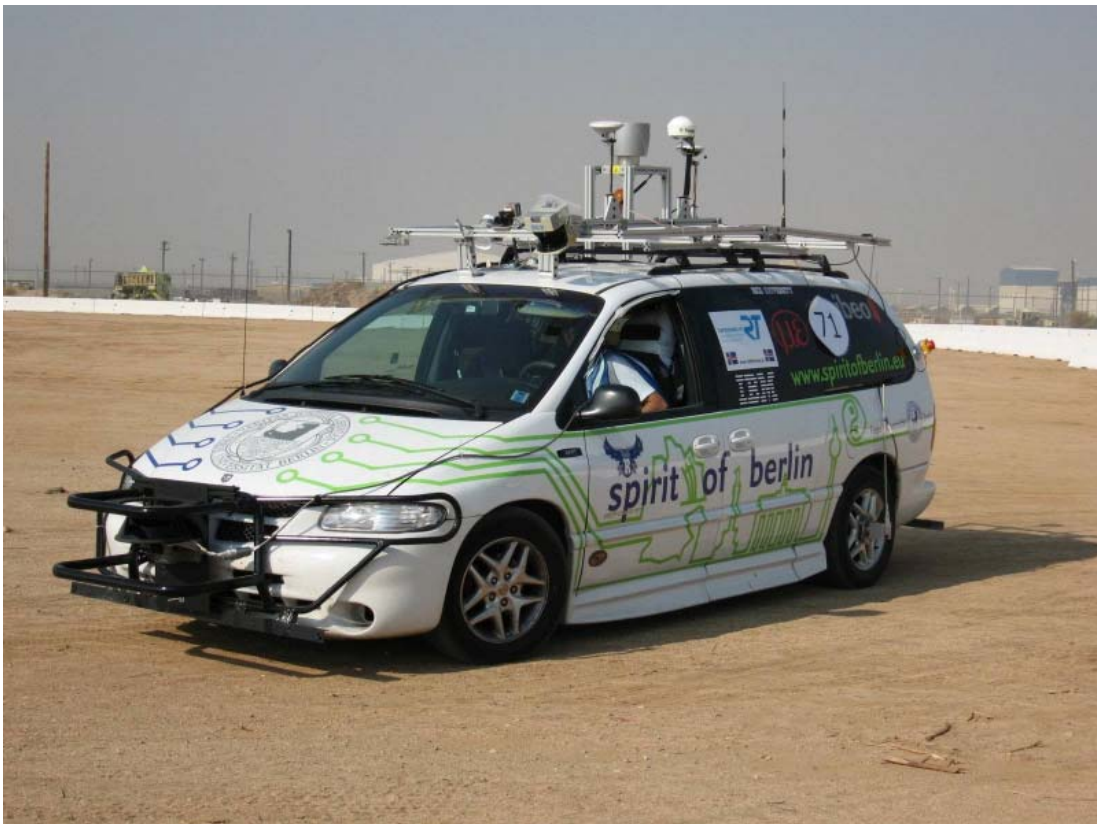
In 2006, the focus shifted to autonomous vehicles for urban transportation, based on a consideration of the areas in which autonomous robots could play a role in the not so distant future. The 2007 DARPA Urban Grand Challenge was the perfect environment to develop an autonomous car.

The 2007 team was a joint group of researchers and students from Freie Universität Berlin, Rice University, and the Fraunhofer Society. The team leaders were Prof. Javier Rojo, faculty member at Rice, and Prof. Raul Rojas, faculty member at the Freie Universität Berlin. The rest of the team was composed of graduate and undergraduate students from the Freie Universität Berlin, and researchers from the Fraunhofer Society in Sankt Augustin.

Furthermore, Stanford University offered the rare opportunity of to witness first hand the development of their entry to the Urban Grand Challenge. The team of 2007 can be seen in picture.



The young team from Berlin started off with retrofitting a Dodge Caravan with drive-by-wire technology, radar and laser scanners as well as computer vision in order to participate. The car, named Spirit of Berlin, is depicted below.



It had been modified so that a handicapped person could drive it, using a linear lever for brake and gas (the lever controls all intermediate steps between full braking and full acceleration), and a small wheel for steering the front wheels. The rest of the car's components can be controlled through a small, contact sensitive panel. The car was brought to EMC in Louisiana

where additional electronic was installed, so that it could be controlled using a computer that was connected to A/D converters. EMC also installed the interface for an E-Stop-Signal. The car was shipped from Houston to Berlin, where the bulk of the hardware and software development was done, before reshipping the car back to Houston in Spring 2007. Spirit of Berlin successfully reached the semi-finals and demonstrated the staggering potential of unmanned vehicles for the future of transportation.

Industrial cooperation with American and German companies also helped the development process: IBM provided the team with a blade server for the necessary computing power. The Berlin police department approached the team to develop a security surveillance vehicle for large warehouses and enclosed areas (such as abandoned airports). The project was soon picked up by the media and became publicly featured in the US and Mexican press as well as on German television which can be seen in below pictures.



The Urban Grand Challenge provided a lot of insight on the state of the art of research of unmanned vehicles and the development of future autonomous cars. Technology is rapidly converging, so that autonomous cars will become a reality in a few more years. Most high-end vehicles now have a myriad of microprocessors connected through a CAN or optical bus. The important actuators in such vehicles can be controlled using computers (brake-by-wire, steer by-wire, etc.), while errors can be diagnosed by reading data stored in the controller's memory. Cars have evolved to become robots, yet a human is still steering the wheel.

Building a safe autonomous automobile requires advances in the fields of computer vision, external perception (radar or laser scanning), global localization with and without GPS information, driver models, vehicle dynamics, learning algorithms, and many more. Therefore, findings in the fields of autonomous vehicles will also boost insights in nearby research areas, such as artificial intelligence, pattern recognition and machine learning. The development of autonomous vehicles will be an evolutionary process, with driver assistance systems being introduced initially to help humans drive more comfortably and safely. Adaptive cruise control, automatic parking, collision warnings, are just some of the technologies already available. New technology will emerge from robotic competitions such as the Urban Challenge.

The research at the Freie Universität Berlin will continue with a brand new car to meet the challenges of unmanned vehicles driving side by side with human road users. The goal will be to develop a robust middleware system for unmanned vehicles so that they can navigate autonomously in daily road traffic. Additionally, economic potential for unmanned vehicles will be studied to develop autonomous solutions for special business cases. A conceptual drawing of the new car named "Made in Berlin" is shown below.

