roboauto

Robot Quido

Roboauto team is group of enthusiastic individuals with interest in artificial intelligence, especially in self driven cars. Roboauto project aim to develop robotic car prototype as a platform for testing new approaches of road recognition, car control etc.

The team is organized under patronage of Technical University of Brno.

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This paper describes robot Quido, which won Robotour 2011, and its navigation architecture. Quido was developed by a team of researchers from Roboauto project, Brno University of Technology, to promote the state-of-the-art in autonomous driving of car-like vehicles. The main contribution of this navigation architecture lies in the idea of putting together several relatively simple approaches to solving particular problems in autonomous navigation and increasing the robustness of the whole system by high-level reasoning. Success in this competition is one of the results of intensive two-year development effort of Roboauto team, the primary goal of which is the development of a fully autonomous passenger car for urban environment.

Hardware platform

Robot Quido is a nonholomic car-like mobile robot designed and manufactured by Roboauto team. Quido is based on a remade electric-powered monster truck chassis CEN Racing Matrix5 (750x330x450 mm) with Ackermann steering. The basic chassis was extended by construction frame built of aluminium profiles, which carries most of the sensory systems. The distance between the front and rear axles is 540 mm and the maximum steering angle is +/-16 degrees, which implies a minimum turning radius of 2.4 m. The total weight of the car is about 35.4 kg without any load.

Quido is propelled by one brushless motor Turnigy Areodrive C5065 rotating at up to 1620 rpm. The motor speed is controlled electronically by Turnigy Brushless ESC 60A in "rock crawler" running mode. Two maxi hitec-servos HS 805 BB are used for steering control. All motors are powered by a rechargeable 2-cells LiPo battery with 4.9 Ah.

A serial optical encoder with 24 ticks per rotation is used for speed feedback and gauge travelled distance. The steering angle of rear axle is measured with 0.4 degree resolution by four hall sensors. Next, the robot is equipped with high-precision tri-axis inertial sensor ADIS16355 for continual localization. The head angle is obtained from compass CMPS 03. For global localization, the robot has one GPS receiver GlobalSat BR-355.

The robot perceives the surrounding environment using three laser scanners SICK LMS 100/111. The data from them are used in terrain classification process and in collision avoidance system. For the reverse movement, the robot is equipped with two ultrasonic sensors SRF 08. All sensors, as well as the rest of electronic devices, are powered by the rechargeable Thunder-sky LifePO4 12V20Ah battery.

The main control unit consists of a personal computer composed of m-ITX motherboard Asus M4A88T-I Deluxe with six-core AMD processor Phenom II, 4 GB operating memory and 64 GB SSD disk, mounted in plastic frame. The plastic frame also includes a wifi-router for wireless communication with the robot and for the connection to devices with Ethernet interface (laser rangers etc.).

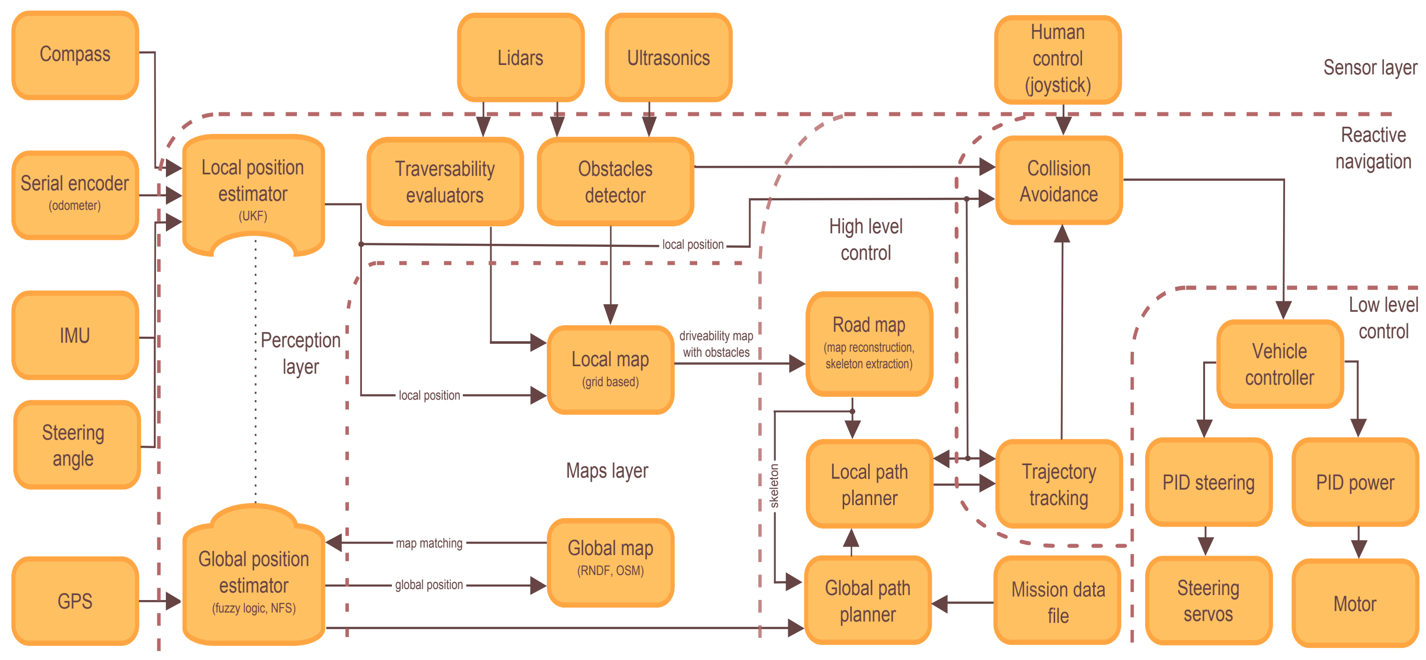

Figure: Navigation architecture

Navigation architecture

The navigation concept is based on parallel concatenated processing; thus, the communication between modules in different layers is sorted and buffered (see Figure \ref {navig_arch}). The navigation system does not have any centralized arbiter. All modules are executed at their own pace and can run on different computing platforms and communicate via TCP/IP protocol. There is no internal synchronization mechanism. Instead, all distributed data are globally time stamped. Time information is used for example in integration process from multiple data sources, as well as for watchdog units. Besides TCP/IP, the inter process communication is based on shared memory and signals/slots mechanism.

The concept of navigation architecture consists of approximately twenty-five modules which run separately and concurrently in the six layers. The layers correspond to the following functions: sensor interface, perception, mapping, road estimation and path planning, reactive layer, and low level control.

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