Multisensor All-Rounder

Developing algorithms for 360° environment detection on a compact and robust prototyping system

Highly automated vehicles require reliable 360° environment detection. The high amount of data that is generated by the sensors, such as camera, radar, and lidar, has to be synchronously captured, preprocessed, and fused. Therefore, dSPACE now combines the required sensor and bus interfaces with the latest NVIDIA processor hardware to build a uniquely compact and robust prototyping system for function development in the field of automated driving: MicroAutoBox Embedded SPU.

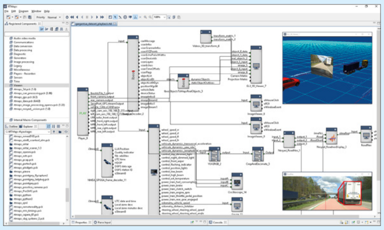
Ask any industry expert about the most important drivers of innovation in today's automotive industry, and they will say: highly automated and autonomous driving. Almost every OEM and tier-1 supplier as well as a high number of startups are already working intensively on these topics. And they are making progress that was inconceivable only few years ago. Current forecasts say that the first functions for highly automated driving will be available in series production very shortly. When they are, drivers will no longer have to constantly monitor these functions in specific traffic scenarios, such as automated driving on highways or autonomous parking. Moreover, research is already being conducted in the field of fully autonomous systems, such as robot taxis, which would render the "driving staff" obsolete.

Race Towards Autonomous Driving

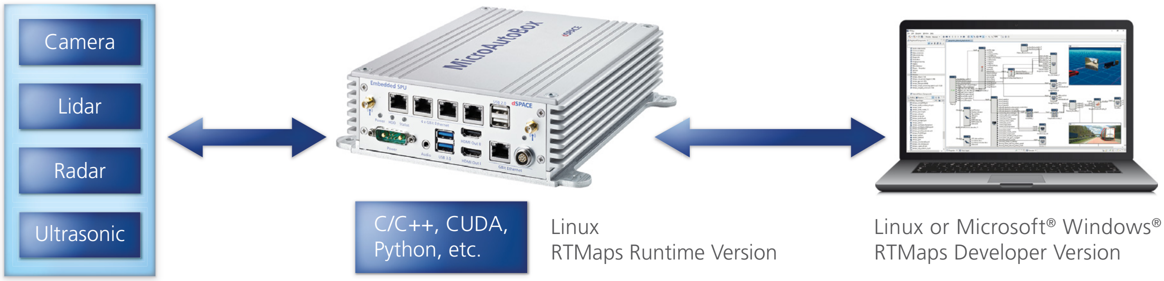
In this field, OEMs are practically racing each other to be the first to bring mature functions for autonomous driving to series production. But as innovation cycles are becoming shorter, the industry also faces the challenge of developing ever more complex algorithms in faster iterations, and test them in the vehicle very early on. This results in a very high demand for powerful prototyping systems that make function development convenient and much faster. The involved algorithms have to ensure that the 360° detection and assessment of the vehicle environment, which uses data from many environment sensors such as camera, radar, lidar, ultrasonic and GNSS sensors, is reliable at all times. Here, cameras and image data preprocessing play a central role. >>

RTMaps

RTMaps from Intempora, which dSPACE has distributed and used in its tool chain since 2016, is a component-based software development and run-time environment that lets users capture, time-stamp, synchronize, and process data from different sensors and vehicle buses. With the help of block diagrams and by integrating user-supplied C++, Python, or Simulink code, the tool creates a powerful environment for developing, testing and benchmarking complex algorithms for sensor and image processing as well as data fusion for multisensor applications. Extensive libraries for components such as cameras, radar sensors, laser scanners, and vehicle buses as well as data visualization, communication and preprocessing make function development easier. Due to the outstanding



performance on multicore x86 and ARM platforms as well as its high usability, RTMaps perfectly complements the dSPACE product portfolio.



Powerful and scalable: Embedded SPU used as a stand-alone system.

Challenging Sensor Data Processing and Fusion

A main challenge is preprocessing and fusing the high amounts of sensor and camera data. The associated algorithms are very computation-intensive and are usually performed on multicore CPUs and GPUs. The algorithms are typically implemented in the programming languages and frameworks of C++, CUDA, or OpenCL. This is why today consumer desktop PCs with an integrated graphics card are generally used to develop the algorithms in short iteration cycles. However, their high power requirements as well as their lack of robustness and reliability make them unfit for test drives in a real vehicle. If the hardware has to be installed in the trunk of a car, as is customary, a high amount of installation and wiring work is necessary. What is more, most desktop PCs do not have raw-data interfaces to the cameras used in production vehicles, such as GMSL interfaces. So how can you meet the high requirements for computing power and sensor interfaces while maintaining the compact size and robustness needed for in-vehicle use? dSPACE's answer to this question is a compact, robust and powerful Linux-based prototyping platform for the in-vehicle development of functions for autonomous driving: MicroAutoBox Embedded SPU (Sensor Processing Unit). Together with RTMaps, a graphical modeling environment for multisensor systems, it opens up entirely new possibilities for simplifying and accelerating the development of the underlying algorithms.

> MicroAutoBox Embedded SPU is a uniquely robust and compact solution for the vehicle-based prototyping of multisensor applications.

Profile: MicroAutoBox Embedded SPU

Product class:	■ Prototyping system for multisensor applications
Key functions:	■ Powerful multicore CPU with integrated NVIDIA® GPU ■ Interfaces for automotive bus networks, environment sensors, wireless communication, and GNSS reception ■ Intuitive graphical software environment RTMaps for the block-based implementation of algorithms ■ Optional data logging unit
Application field:	■ Function development for: ■ Advanced driver assistance systems ■ Highly automated and autonomous driving ■ Robotics applications ■ Data logging

High Processing Power and a Wide Range of Interfaces

MicroAutoBox Embedded SPU is based on the state-of-the-art NVIDIA® Parker architecture. It has a six-core 64-bit ARM CPU with an integrated NVIDIA Pascal GPU and 256 cores, which provides a processing power of up to 1.5 teraflops. But the high processing power is not the only unique feature of MicroAutoBox Embedded SPU. It includes interfaces to all

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Wide Range of Connection Options

Rear connectors:

1. **1x GNSS antenna connector:**
   Receiving global satellite navigation data (GPS, GLONASS, Beidou, Galileo). If the satellite connection is interrupted, the uBlox NEO-M8U GNSS receiver uses inertial sensors to determine the exact position.
2. **4x Gigabit Multimedia Serial Link (GMSL):**
   Connecting high-resolution cameras with GMSL interfaces for image processing. On request, a plug-on module can be used to support other camera interfaces.
3. **2x HDMI 1.4b inport:**
   Connecting high-resolution cameras with HDMI interfaces for image processing. On request, a plug-on module can be used to support other camera interfaces.
4. **2x LTE/Bluetooth antenna interface:**
   Support for wireless communication via LTE and Bluetooth.
5. **Bus interfaces**:
   Connecting up to four CAN/CAN FD, two LIN (master/slave) and two BroadR-Reach interfaces.
6. **1x Serial ATA interface (SATA III):**
   Connecting up to four SSDs for high-performance data capturing.
7. **I/O interfaces:**
   Providing four Digital In, four Digital Out, and four Analog In channels.
8. **1x SIM card slot:**
   SIM card slot for mobile communication.

Front connectors:

1. **2x WLAN antenna interface:**
   Support for wireless LAN IEEE 802.11 n/ac.
2. **4x Gigabit Ethernet interface:**
   Directly connecting Gigabit Ethernet-capable devices without a connected Ethernet switch. Each interface supports a data throughput of 1 Gbit/s.
3. **2x Gigabit Ethernet interface (via internal switch):**
   Directly connecting Gigabit Ethernet-capable devices.
4. **2x USB 2.0 interface:**
   Connecting USB 2.0-capable devices.
5. **1x power supply:**
   6 to 40 V DC
6. **1x jack socket:**
   Connecting microphones and audio output.
7. **2x USB 3.0 interface:**
   Connecting USB 3.0-capable devices, e.g., cameras.
8. **2x HDMI 2.0 outport:**
   Connecting two HDMI-capable displays. On request, one of the HDMI interfaces can be replaced with a module for controlling displays and driver information systems that will be used in the production vehicle.

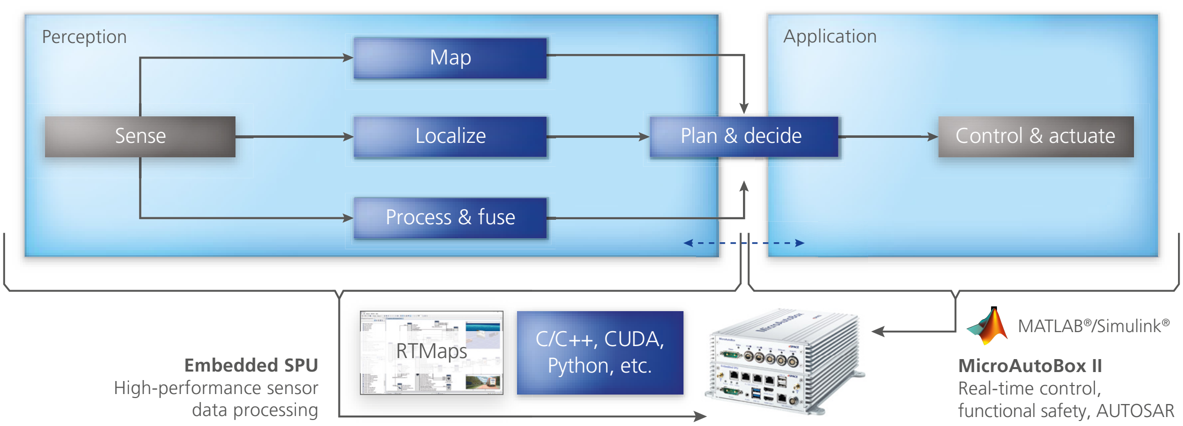
Technical Details MicroAutoBox Embedded SPU

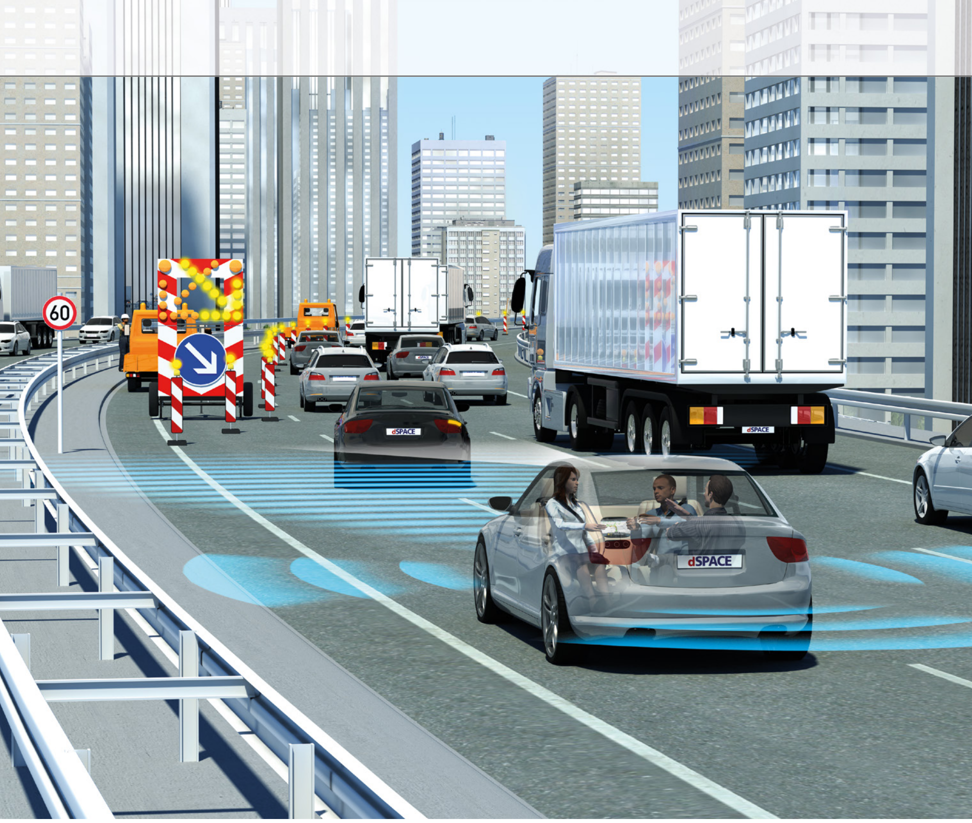
Parameter	Specification
Processor	■ CPU: Two NVIDIA® Denver 2 cores and four ARM® A57 cores (each with up to 2 GHz and 2 MB L2 cache) ■ GPU: NVIDIA Pascal™ with 256 cores at up to 1300 MHz
Memory	■ RAM: 8 GB 128 bit LPDDR4 RAM ■ Flash: 32 GB eMMC and 128 GB M2 card ■ Optional mass storage device
Operating system	■ Linux for Tegra by NVIDIA
Software support	■ Graphical development environment: RTMaps (Real-time Multisensor applications) ■ GPU programming language: NVIDIA CUDA® ■ Deep learning: NVIDIA TensorRT™, cuDNN® ■ Machine vision: NVIDIA VisionWorks™, OpenCV
Technical properties	■ Physical dimensions of enclosure: Approx. 200 x 225 x 50 mm (7.9 x 8.9 x 2.0 in) ■ Operating temperature range (enclosure): -20 ... +70 °C (-4 ... +158 °F)
Certifica-tions	■ MicroAutoBox Embedded SPU complies with current standards on electromagnetic compatibility as well as vibration and shock resistance, similar to MicroAutoBox II. Further details on request.

MicroAutoBox Embedded SPU is planned to be available in the third quarter of 2017.

common automotive bus systems, to environment sensors such as cameras, radars and lidars, to GNSS positioning, and wireless communication. MicroAutoBox Embedded SPU combines all this in a robust and compact housing for in-vehicle use. Another unique feature of MicroAutoBox Embedded SPU is that software developers no longer have to deal with the cumbersome programming of the individual sensor and output interfaces. Instead, they can focus completely on implementing their algorithms for sensor data preprocessing and fusion. To make this possible, MicroAutoBox Embedded SPU is closely integrated with RTMaps, a graphical modeling and run-time environment for multisensor systems (see info box on page 37). RTMaps is intuitive and provides all the interfaces of the Embedded SPU as ready-to-use libraries and I/O blocks. In RTMaps, developers have to implement only the actual algorithms in C++, NVIDIA CUDA®, Python, or via Simulink code integration. In addition, the system is ready for the use of dedicated software frameworks for deep learning (artificial intelligence) and machine vision.

Compact and robust prototyping system for developing functions for automated driving: Embedded SPU as an extension to MicroAutoBox II.





Stand-Alone Solution and Combination with MicroAutoBox or Other SPUs

MicroAutoBox Embedded SPU can be used as a stand-alone system or in one housing together with one of the standard variants of MicroAutoBox II. In combined use, the real-time application (real-time control, mechanisms for functional safety, integration of AUTOSAR Software Components) runs on the standard MicroAutoBox II while the Embedded SPU processes and fuses all sensor data needed for the control. To improve the processing power and increase the number of interfaces even further, it is also possible to connect multiple MicroAutoBox Embedded SPU systems to each other. In this case, RTMaps ensures clock synchronicity and the perfectly synchronous computation of all algorithms on the distributed systems. In addition, an optional data logging extension is available with an SSD memory of 8 terabytes, for example. The extension makes it possible to precisely record and replay the captured sensor data in perfect synchronicity.

Conclusion

Whichever combination a customer chooses: The synchronous capturing, processing, fusing, and replaying of large amounts of sensor data in such a robust and compact system makes MicroAutoBox Embedded SPU an exceptionally useful tool. Whether used for the development of highly automated, autonomous and self-driving vehicles or other robotics applications: The system consisting of MicroAutoBox II and MicroAutoBox Embedded SPU raises the bar for the in-vehicle prototyping of multisensor applications to an entirely new level. ■

> Together, MicroAutoBox Embedded SPU and RTMaps form a very powerful development environment for all types of multisensor applications.

Strategic Enhancement of the MicroAutoBox Product Range

For over 15 years, dSPACE MicroAutoBox has set the standard for in-vehicle rapid control prototyping for automobile manufacturers. With its focus on fast real-time control, it covers a wide range of automotive applications, from innovative combustion engine control and alternative drive concepts to modern driver assistance systems.
The next step is now taken by MicroAutoBox Embedded SPU, which particularly covers multisensor applications based on camera, radar and lidar sensors, for example. dSPACE thus specifically adds to the MicroAutoBox product range with a flexible and powerful system for sensor data preprocessing and fusion. Therefore, the Embedded SPU further strengthens the position of the MicroAutoBox product line as an industry standard for all prototyping applications, from A as in “autonomous driving” to Z as in “zero emissions”.