Service robots: Modular and battery-powered

Service robots are not yet produced in high volumes. It is still a research domain for university and institutes. Nevertheless, the first modules are under development for commercial service robots.

The number of service robot applications is countless. They range from high volume applications such robot vacuum cleaners and robotic lawn mower via service robots used in hospitals to distribute medicine to single service robot prototypes as prison guard in Korea. Most of the advanced developments take place in Far East. China, Japan, and Korea are the countries with the most research projects in this business. Of course, military service robots such as drones are not considered. In 2014, more than 25 000 service robots have been sold worldwide. The annual increase is about 10%.

But there are not just robots serving human beings: In 2014, also about 5 000 milking robots were sold. In addition, about 6 000 so-called field robots for farming purposes were produced. Medical robots are also not booming yet. The only high-volume service robot markets are those robots for personal and domestic use mentioned above including toy robots. Some sources counted 4,7 million units in 2014. Disabled assistance robotics have not really taken-off (about 4 500 in 2014).

The market for service robots will increase. Between 2015 and 2018, there will be sold about 150 000 service robots according to the IFR (International Federation of Robotics) statistical department. The market for robots for personal use will increase to 35 million units, but they are not modularized and equipped yet with embedded CAN networks. Although, some of them may use some CAN point-to-point links internally.

A growing sector is mobile platforms in general use. Service robot suppliers estimate that about 16 000 mobile platforms as customizable multi-purpose platforms use will be sold in the period 2015 to 2018. Also, sales of logistic systems will increase considerably in this period. More than 14 500 units are estimated, thereof, about 13 300 automated guided vehicles. About 700 robots for rescue and security applications will be sold between 2015 and 2018 mainly surveillance and security robots. Robots for professional cleaning will increase to about 6 650 units in the same period, mainly systems for floor cleaning. About 7 800 medical robots will be sold plus 4 000 robots for inspection and maintenance.
Collaborative robots as they are under development for the factory floor may change the situation. Even if they are not regarded as service robots, they have the same functional elements and safety requirements. They collaborate with human beings. They are not caged. They require some modularity to be adapted easily to different applications. They are battery-powered.

**Modular robots require standardized interfaces**

Many service robots are battery-powered. Each gram counts. This means the service robots should be made of light-weighted modules. This applies also for electronic modules. In some applications, size matters, too. CAN is an ideal network technology for service robots. CAN hardware has a small footprint, consumes not too much power, is reasonable in price, and robustness as well as reliability is high.

The CAN Newsletter has reported already about several service robots using embedded CAN networks. Several CiA members have supplied CANopen-based motion controllers such as Elmo, Faulhaber, and Maxon. Sensors to observe the surroundings have been applied by Sick, for example.

In the modularization of service robot electronics, ROS (robot operating systems) plays an important role. The ros_canopen package provides support for CANopen devices an ROS programming environment. It contains the ROS interface, profile-specific support for CiA 402, a...
CANopen NMT master function with device/object management, and a CAN layer abstraction. However, the ROS approach doesn’t specify any service robot module.

**Hierarchical module approach**

Some Far East countries with the support from a few European countries have submitted a New Work Item Proposal on the modularization of service robots (ISO TC 299). The proposal is not limited to electronic communication interfaces, there are also mechanical and electrical elements included. The proposal distinguishes between software and hardware modules, which is mainly an implementation issue and not a functional criteria to identify the purposes of a module. Unfortunately, there is no hierarchy of modules specified. This means, high-level (complex) modules such as a motion unit and a mid-level module such as a wheel controller are mixed with single-device modules such as a CiA 402 motion controller.

What is necessary is a clear structured hierarchy of modules. Starting with high-level units. Those units comprise mid-level controllers, which by themselves are made by single-device units. This means, there are three levels of embedded networks. To make it simple, all of them are based on CANopen. Of course, depending on the application requirements, they can also use other communication technologies. CiA has developed originally such a virtual network for rail vehicles and construction machines. If powerful system design tools support this approach, it is very flexible and simplifies system integration. With CAN FD and its higher throughput capability, many of the embedded network requirements can be fulfilled. Service robots are not high-speed applications, because they have to interact with human beings, who are by definition slow. Nevertheless, safe operation is required.

Such a hierarchical module approach would allow reusing modules in different applications. Service robot prototypes are already used to serve in fast-food chains, while others experiment with room service robots in hotels. Both serve food and beverages. The surroundings are different and may require additional functionality. Still some functions are the same and can be solved using the same modules with the same communication interface. ISO should specify a framework (platform) and the application functions for such modules. CiA is willing to develop with interested parties related profiles with process data, configuration parameters, and diagnostic information. One of the first mid-level modules to be standardized could be a robot wheel controller.

The platform idea is not new. Most of the important carmakers have introduced them during the recent years. Ion Far East, in particular in Japan, the automotive industry sponsors (e.g. Nissan and Toyota) the service robot industry. Self-driving or in other words autonomously driving service robots require obstacle detection capability and collision avoiding functionality. These two topics are also hot in the car industry. Brain Corporation is one of the pioneers in this business. It develops the brains of self-driving vehicles including service robots. Self-driving vehicles include robotic floor care equipment. You could regard them also as service robots.

To develop such service robot module interfaces is something what requires joining the industries resources. The development of the self-driving algorithms is relevant for competition, but the communication interface is not. This is like in human communication, the common language needs to be “open”, but the written text is property of the author.

**Medical surgery robots**

In healthcare, one of the most interesting applications are robot assisted surgery and therapy with about 1000 units sold in the last year. They are the most valuable service robots with an average unit price of about one million US-$, including accessories and services. Therefore, suppliers of medical robots also provide leasing contracts for their robots.

In some of these medical surgery robots, CAN-based control systems are used. For example in a robot, which comprises an optical navigation system, a workstation to run the 3D mandibular reconstruction surgery design software, and a main workstation to run the application and robot control. The robot task communicates with the robot via a CAN network and performs basic functions, such as receiving joint feedback. The control task implements the supervisory control layer. Its functions are to provide force and motion control. It also provides the interfaces to the force sensor and the navigation system.

**Author**

Holger Zeltwanger
CAN Newsletter
headquarters@can-cia.org
www.can-newsletter.org
FAULHABER Motion Control

It’s not a trick. It’s engineering.

FAULHABER Motion Control Systems Series MCS 3242 / 3268 ... BX4

It is hard to believe how much intelligent and high-performance drive technology we have conjured up in the compact FAULHABER Motion Control Systems. Their robust construction in accordance with IP 54 meets even the most severe industrial requirements. And, equipped with RS232, EtherCAT and CANopen interfaces, they secure future connections. Ready for networked industry? With FAULHABER, it's not a trick.

www.faulhaber.com/mc/en

Easy commissioning with the new Motion Manager 6