Automated sewer cleaning with CANopen

Components used in municipal vehicles are exposed to extreme temperatures, humidity, dust, dirt, and vibrations. With the Ecomatmobile series, ifm offers CANopen-capable automation products for these harsh environmental conditions. Bucher Municipal uses them for its sewer cleaning vehicles.

Figure 1: A sewer cleaning vehicle of the company Bucher Municipal with the uncoiled jetting and suction pump for sewer cleaning (Source: ifm)

Bucher Municipal is a global supplier of special vehicles such as refuse collection vehicles, sweepers, and winter maintenance equipment. In the Danish city of Silkeborg, the company manufactures sewer cleaning vehicles. Brian Munk Andersen, R&D Manager at Bucher in Denmark, explained the structure and function of this vehicle type: "Sewer cleaning units from Bucher feature two pump systems. The jetting pump cleans sewers and tanks. With the vacuum pump, we can suck sludge and industrial waste into the tank mounted on the vehicle."

With two ifm control units for mobile applications installed outside the vehicle, the vehicle operator can perform a variety of work steps: rotate the boom, unwind, and rewind the hose, switch the pumps or empty the sewage water tank. The displays of the dialog modules show the relevant system parameters and process values and assist the user in performing the work steps. A control unit inside the vehicle – also supplied by ifm – ensures that the individual processes run smoothly. "The intelligent control of our sewer vehicles ensures efficient processes and enables maximum focus on the task, guaranteeing the highest possible added value for our end users," said Andersen.

Ifm as a partner

For several years now, the automation specialist ifm has been supporting Bucher Municipal as a partner for sensor components and control technology. Brian Munk Andersen: "At Bucher, we have a constant focus on innovation and development. That's why we use automated and intelligent solutions. When we entered into a cooperation with ifm in 2016, we were looking for a reliable supplier of control solutions. Ifm offers a wide range of components for our product – from sensors to displays and I/O systems to controllers.

Throughout the development phase, we worked closely with ifm to develop a solution and choose the ideal products. Our vehicles have to operate reliably in very varied conditions such as cold, heat, dust, and dirt. This places particularly high demands on the components. Together with ifm, we have created a good and reliable solution with many automated features that offers the operator high quality and safety standards when our machines are on the road."

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Figure 2: The robust 12-inch display CR1200 installed in the external control cabinet of the vehicle for visualisation and setting of all machine parameters (Source: ifm)

The central CAN products in detail

The core element of the system is the Ecomatcontroller CR711S, a robust PLC (programmable logic controller) for mobile applications. What makes it so special is that it has two independent internal PLCs – one of them a certified safety controller. Powerful integrated multi-core processors allow even complex control functions to be processed quickly. The application programs can be divided between the two internal PLCs if necessary. Consequently, the safe program part can be executed without interference from the general program execution. This ensures reliable operation even with complex control functions. The controller can be used in safety-related applications up to ISO 13849 PL d and IEC 62061 SIL CL 2.

In addition to its many multifunctional inputs and outputs with diagnostic capabilities, the Ecomatcontroller features four CAN interfaces and two Ethernet ports. The CAN interfaces support all important protocols such as classic CANopen, CANopen Safety, and J1939 as well as the transparent and preprocessed data exchange. The CiA 301 CANopen application layer and communication profile version 4.2 as well as CiA 401 device profile for generic I/O modules version 1.4 are supported. The control functions are easily integrated into the application program thanks to Codesys programming (version 3.5).

At Bucher, the controller is additionally connected to a GSM (global system for mobile communications) radio module. Andersen: "In many cases, our remote connection ▷

Figure 3: The Basicdisplay CR0451 indicates the most important parameters on the control panel (Source: ifm)

Interview with ifm: "CANopen is our preferred network"

Dietmar Brüss, Product Manager Control Systems at ifm explained the CAN News-letter why the company relies on CANopen and spoke about the possible future connectivity developments for ifm's devices.

Dietmar Brüss (ifm)

Q: CANopen is your preferred network technology. What are the main benefits?

A: If customers have to decide which CAN-based higher-layer protocol they should use in their application, ifm advices to use CANopen. CANopen is internationally standardized (EN 50325-4), widely used, and accepted. Also the ifm tool chain for programming and configuration supports CANopen as one of the standard communication channels. Additionally, the available CiA CANopen device profiles (e.g. for I/O modules, inclinometers, encoders) are implemented in the related sensors. This simplifies the task of integrating the devices in a CANopen system. The freely-programmable controller can be flexibly configured via CANopen off-the-shelf tools.

Q: Are new CANopen device profiles needed?

A: For devices offered by ifm the CANopen device profiles are already available.

Q: Is cybersecurity an issue for future applications?

A: This is increasingly an issue for applications in which a wirelessly-connected device has to access/control in-vehicle networks. I think, because of the cost reasons, the application securing functionality would reside in the Edge gateway (e.g. HMI, IPC, modem) allowing access to the in-vehicle application network. Thus, no additional effort would arise for single devices (sensors, controllers, etc.).

Q: Would it be helpful to standardize gateways to in-vehicle networks?

A: Due to the free-programmability of our controller and displays, we can react on customer's requirements. For the application engineers integrating our devices into the vehicle, it would be a huge benefit. Standardized CANopen gateways would allow a unified access/control of the in-vehicle networks. No adaptations to a specific vehicle would be required. This saves development time and costs.

Q: Are you planning to migrate to CANopen FD?

A: Currently, neither ifm nor our customers are realizing any project using CAN FD or CANopen FD. All of our new products are capable to support CAN FD and CANopen FD. When the market in general or a big customer would require to support a corresponding solution, implementation in the hardware would be relatively simple. Regarding software, to realize a commonly-used tool-based solution would be a challenge. Such programming environments as e.g. Codesys do not support CAN FD at the moment.

Q: Does CAN XL provide features you like to use?

A: At the moment, we see no customer demands on a higher bandwidth. Formerly, in some (very few!) projects, we considered to implement an additional Ethernet-based two-wire network (Broadr-Reach). Finally, the customers decided against it, because effort and gain are not in a reasonable relation to each other. For diagnostics, maintenance, and programming all current devices provide a four-wire Ethernet interface as a standard. This is a clear market requirement and is also used by all our customers.
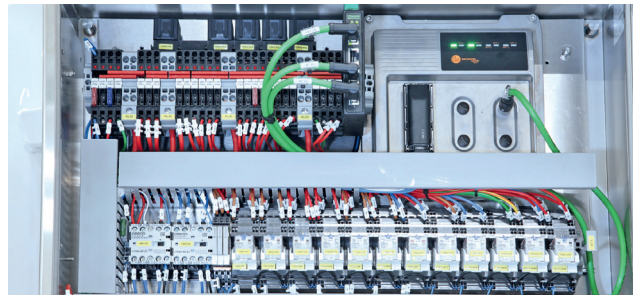

Figure 4: The core element at the top right of the control cabinet: the powerful Ecomatcontroller CR711S with two integrated PLCs (1x standard, 1x safety) (Source: ifm)

allows us to solve issues while the vehicle is still on the road. This saves our customers a lot of time. Only in cases where remote troubleshooting is not possible the municipal vehicle needs to be checked at one of our many service centers."

I/O modules

Various sensors and actuators are installed on the sewer cleaning vehicle to monitor and control the different work steps and process values. Using decentralized I/O modules, they communicate with the controller via CAN. Brian Munk Andersen explained the benefit: "With CAN units installed at different positions on the truck, we reduce wiring and also achieve greater reliability and an easier operation of the equipment."

The type CR2032 control modules each have 16 ports that can be configured multifunctionally, for example as digital inputs or outputs or as PWM outputs for controlling proportional valves. A controller integrated in the modules enables decentralized evaluation of the sensor signals in advance. This pre-filtering of the data not only reduces the data flow on the CAN network to the controller, but also simplifies the application program on the PLC. The robust metal housing is designed specifically for the harsh outdoor use of mobile machines and offers protection rating IP67 for high ingress resistance of the connectors. The CR2032 supports the CiA 301 CANopen application ▷
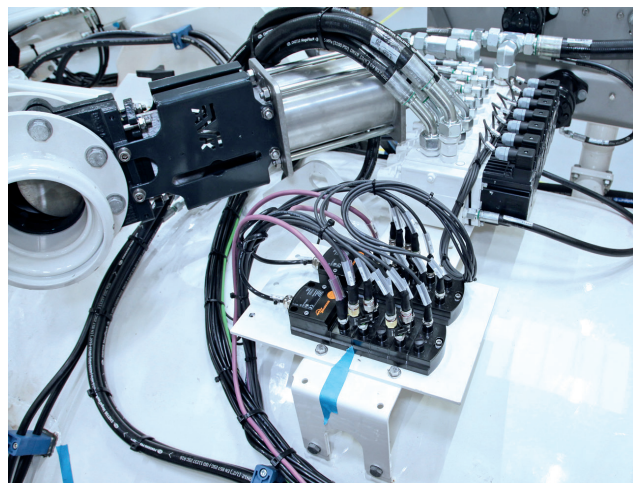

Figure 5: Decentralised CAN I/O modules outside the vehicle connect the sensors and actuators to the controller (Source: ifm)

layer and communication profile version 4 as well as the CiA 401 CANopen profile for modular I/O devices version 2.1

Dialog modules

A range of displays for mobile applications are mounted outside the vehicle as human-machine interfaces. Brian Munk Andersen: "On the large display in the main cabinet, the operator can control the entire system and make the basic settings. After this, the system can be operated via the remote control or the operating panels."

Dialog modules are programmable graphic displays for controlling, parameter setting, and operation of mobile machines and installations. They can be used in conjunction with a mobile controller or as a stand-alone solution. Data and device functions are safely transferred via CAN interfaces. The displays feature many freely programmable backlit function keys. The units offer increased EMC (electromagnetic compatibility) levels and an e1 type approval for operation on public roads. Thanks to the high protection rating of the housing, the modules are suited for outside panel and surface mounting as well as for cabin installation. Just like the other ifm components for mobile applications, the displays are vibration resistant and have protection rating IP67. The CR1200 and CR0451 (name: Basicdisplay) displays come with TFT LCD colour screens. The CR1200 provides a resolution of 1024 pixels x 768 pixels while the CR0451 provides 320 pixels x 240 pixels. Both displays come with a CAN interface and support CiA 301 CANopen application layer and communication profile version 4 as well as CiA 401 CANopen profile for modular I/O devices version 1.4, or J1939.

Conclusion

Ifm offers a comprehensive portfolio of products for efficient and reliable automation of functional units on municipal vehicles. Brian Munk Andersen concluded: "With ifm's solution, we can create a highly automated system that offers us superior reliability and makes the lives of those operating our equipment a lot easier." All of the named products are part of the Ecomatmobile series. ◄

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