Let's talk about
mobile robots

ifm.com/cnt/mobile-robots

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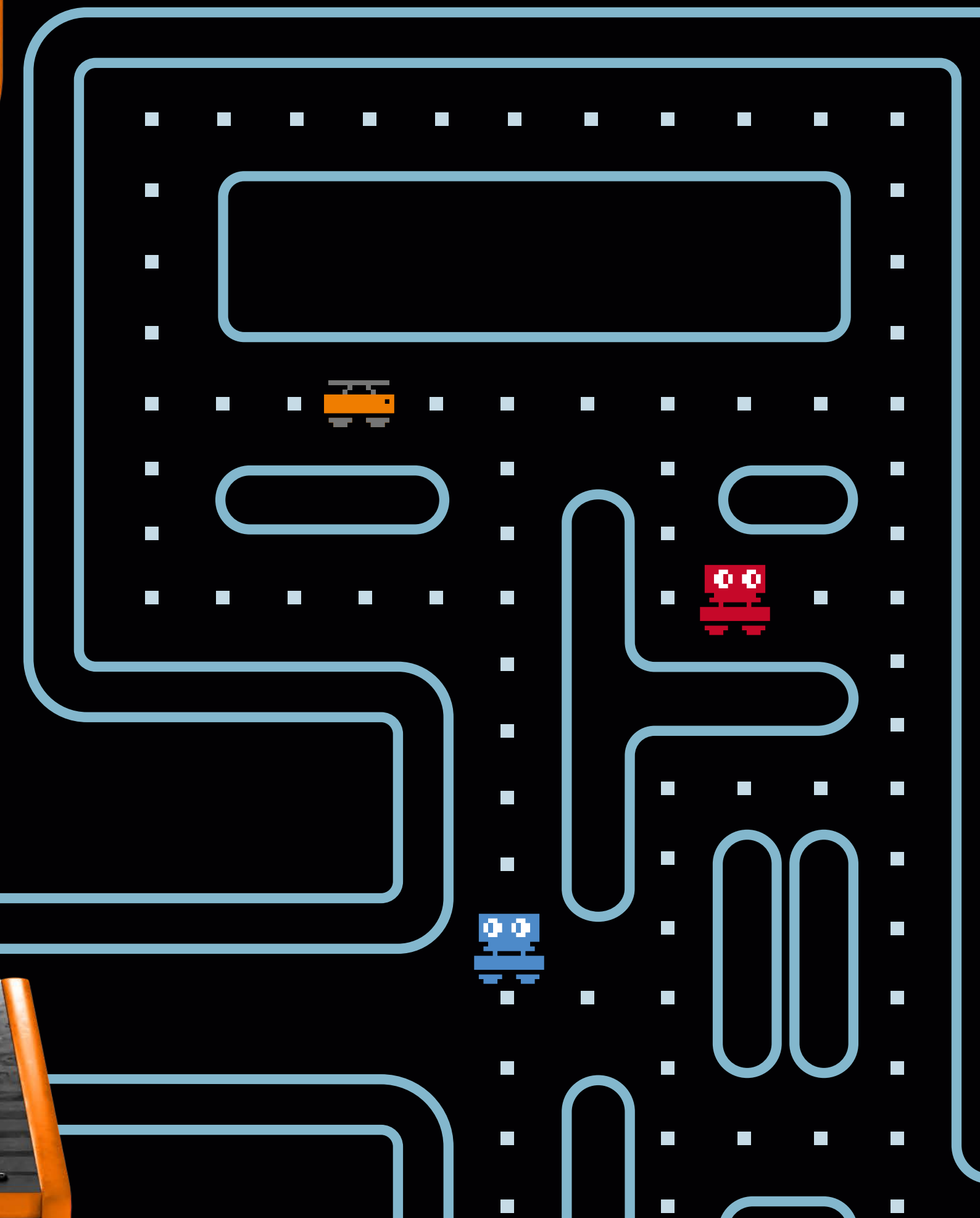
INTRALOGISTIC TROUBLE

Content

Let's talk about
mobile robots

Mobile robots are an asset to intralogistics in many ways. They bring efficiency to the flow of goods, relieve the burden on specialised personnel and reliably ensure a consistently high level of productivity – both within intralogistics and in downstream processes. Sometimes, however, the bustling work environment is strongly reminiscent of the famous arcade video games from the 80s and is full of obstacles that need to be avoided. In order to perform as expected and contribute to the company's high score, the mobile robot must have the skills to move effortlessly through the intralogistics labyrinth, avoid collisions and identify the goods to be picked up. It should also be able to communicate with the IT level to automatically accept and confirm orders or to report maintenance requirements.

As automation specialists, we have been developing solutions for mobile robots for many years and are continuously improving them with new innovations. We make it as easy as possible for our customers to implement our products and solutions. For this reason, we consider the mobile robot as an integral unit, but we differentiate between four levels from localisation and product identification to reliable motion control, perception of the environment and digitalisation that have different requirements but also have to be able to interact and communicate with each other without any problems.

This brochure introduces you to some of the people at the ifm group of companies who work on the future of mobile robotics every day, along with their approaches, ideas and perspectives concerning the four levels of mobile robotics. You will gain exciting insights and perspectives. If we have sparked your interest in a more in-depth exchange, we look forward to hearing from you.

Mohamed Hassoun, Vice President Global Industry Management

Intralogistics & Mobile Robotics

By the way: You can now find even more useful information about ifm's solutions for mobile robots at ifm.com/cnt/mobile-robots

Identification and navigation
"There is no single best approach"

Frank Neuwirth,
Director Product Management Identification Systems

Product identification and navigation technologies are essential for mobile robots to reliably find their way and their goods. Usually, RFID systems or code readers are used. Frank Neuwirth, Director Product Management Identification Systems at ifm, explains which method is used when.

Frank, why are code reading systems like barcodes or QR codes often used for product identification? What advantages do they offer?

Frank Neuwirth: Code reading systems like barcodes or QR codes are very common in practice because they are easy and inexpensive to implement. Basically, all you need is a printer to apply the codes to labels or directly to products. These codes can then be scanned using hand-held scanners or permanently installed readers. A major advantage is that a lot of information can be pu into one code ranging from the product number and serial numbers to handling and packaging information. This data can then be forwarded directly to higher-level systems, such as the ERP.

What additional steps do RFID systems require during implementation and what advantages do they offer in return?

Frank Neuwirth: With RFID systems, the transponders, the RFID tags, must first be attached to the products or containers, which initially requires more time, but is usually a one-off process. In addition, the transponders must be initialised, i.e. written with the relevant data. The great advantage of RFID is that the data can be read without physical or visual contact. This enables, for example, simultaneous detection of several products. If special RFID gates are installed at intralogistics hubs, this method can speed up processes considerably. RFID tags are also more resistant to dirt than optical codes.

What criteria should companies use to decide whether to use code reading systems or RFID systems?

Frank Neuwirth: This depends very much on the individual requirements and also on the circumstances. If established processes with barcodes already exist and work well, there is often no compelling reason to switch to RFID. The use of RFID is ideal when many products need to be scanned at the same time or the environmental conditions are difficult for photoelectric systems. Costs also play a role since RFID tags are generally more expensive than printed codes. There is no single best approach Every company must weigh up for itself which technology best suits its own processes and requirements. We are happy to advise our customers on this matter.

What specific advantages does IO-Link offer to integrate sensors in mobile robots?

Frank Neuwirth: IO-Link offers very simple and standardised wiring. A large number of different sensors and actuators can be connected via a standardised system. This considerably simplifies integration and set-up. IO-Link also enables comprehensive and centralised parameter setting and diagnostics of the connected devices. This simplifies configuration and maintenance. Another advantage of this open, digital communication technology is the large selection of components available on the market that can be seamlessly combined.

What alternatives are there to RFID waymarkers to navigate mobile robots and what are their limitations?

Frank Neuwirth: QR codes or other markings can be attached to the floor and read with a photoelectric device such as a code reader. Their disadvantage is, however, that they can easily be hidden or covered by dirt. There are also systems that orientate themselves to the surroundings, for example using laser scanning. However, these often require more complex set-up and calibration. RFID waymarkers have the advantage that they are robust against environmental influences and can be reliably recognised.

What are the future developments in localisation systems for mobile robots? What advantages do these new technologies promise?

Frank Neuwirth: Systems for precise indoor localisation without fixed waymarks are a promising approach. Small transmitters are mounted on the vehicles and antennas are installed on the ceiling. Thereby, the exact position of each vehicle can be be determined at any time. This makes route planning and traffic control much more flexible. If an obstacle is encountered, for example, alternative routes can be calculated. Such systems are currently being developed and could appear on the market in the near future.

More information on
Localization
ifm.com/cnt/mr-localization
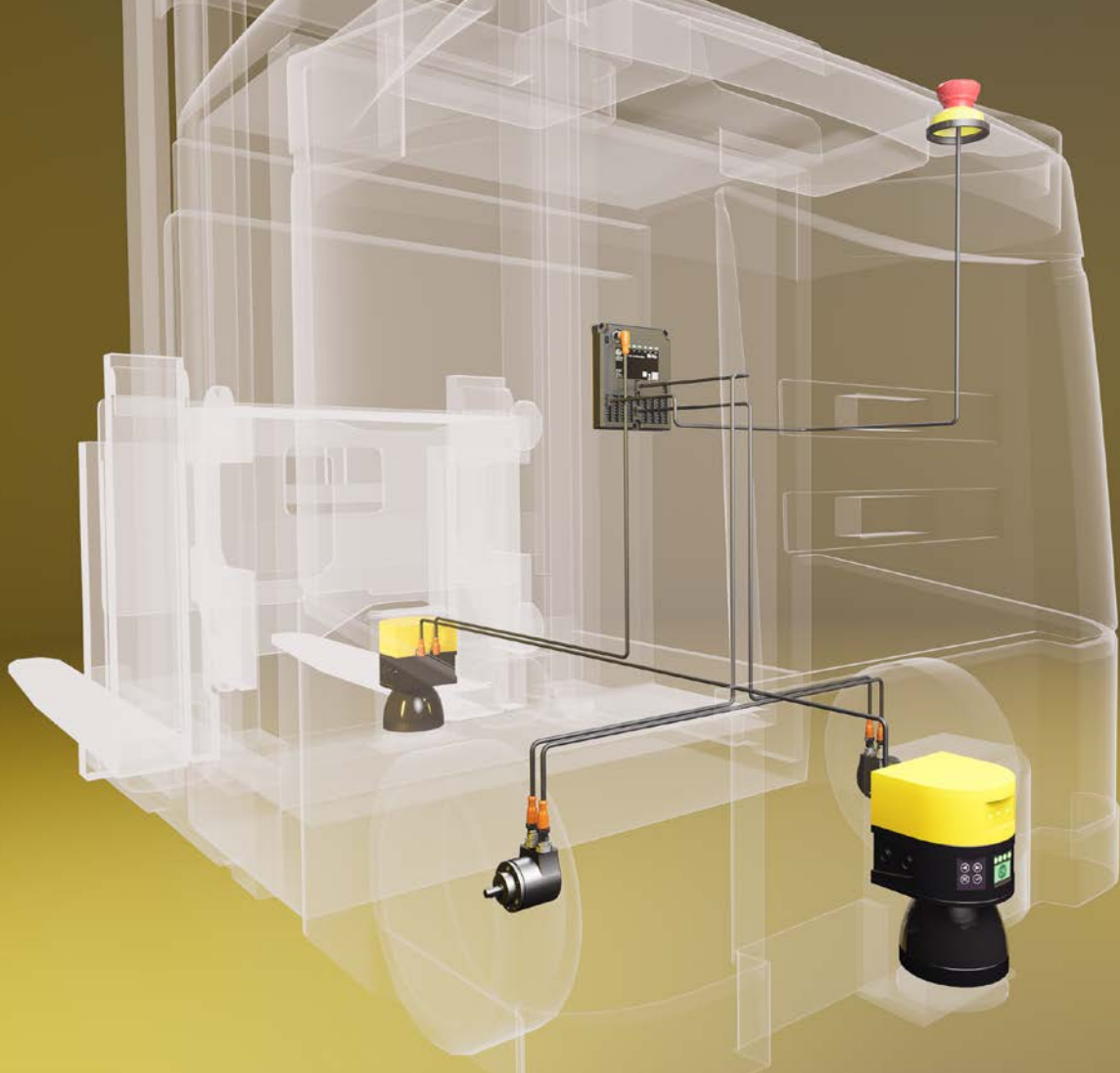
Georg Engelmann,
Director Product Management Mobile Controller
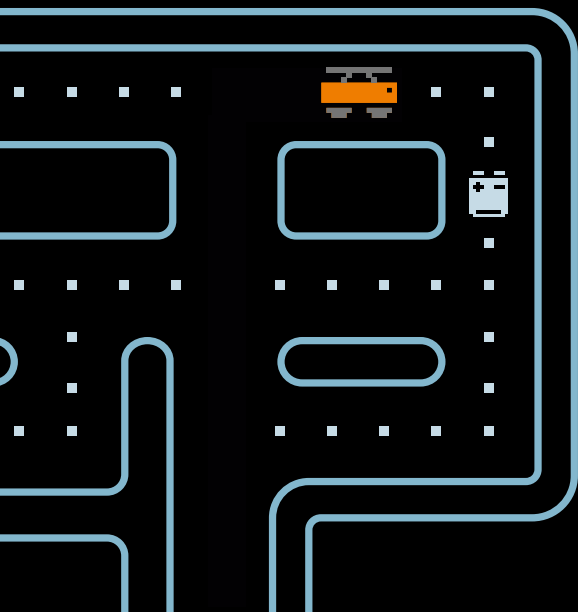
Two worlds that are very similar
and yet different

Mobile robots and mobile machines are similar. In this interview, Georg Engelmann explains the advantages that are already emerging from this and where he thinks bridges still need to be built.

Georg, briefly summarised: What do you, as an expert in control systems, consider to be the similarities between mobile machines and mobile robots?

Georg Engelmann: If you look at the control logic, there are a lot of similarities. Both systems are designed to process input signals, whether from sensors or user commands, and then perform corresponding actions. Take, for example, drive control: Whether we want to accelerate or brake a refuse collection vehicle or a mobile robot, the underlying process is basically the same. It is always a matter of reading and processing signals, applying a logic and then controlling the drive accordingly.

How important is the issue of robustness for mobile robotics?

Georg Engelmann: Mobile robots used in intralogistics may not be exposed to the same harsh conditions as traditional mobile machines, but they are still subject to significant mechanical stresses. The rotation of the wheels alone causes vibrations in the vehicle. In addition, the floors on which these robots move are often not perfectly flat. In the long term, such vibrations and shocks can cause problems, such as broken solder joints or other failures, if the components are not specifically designed for these operating conditions. This is where our 30 years of experience in the field of robust control technology comes in handy. Our controllers are fully encapsulated to prevent defects, but also corrosion, to the electrical system.

With ecomatBasic, ifm offers a controller that is particularly suitable for use in mobile robots. What are its special features?

Georg Engelmann: In addition to the aforementioned robustness, the ecomatBasic is also very compact, so that it requires little installation space. We have also equipped this controller with outputs featuring pulse width modulation. In contrast to purely digital outputs, braking operations, for example, can be carried out much more gently and precisely. This is an advantage that should not be underestimated, especially when fragile goods are being transported.

ifm also offers a major advantage in terms of software with a TÜV-certified library of safety modules. What is its concrete benefit?

Georg Engelmann: To sum up, the customer saves a great deal of time during programming and certification processes. We offer numerous confirmed fail-safe and reliable function blocks with which the customer can easily create safety-related programs. This starts with the integration of an E-stop button and extends to complex functions, such as trigonometric calculations where the programming and testing effort would be extremely high because many value ranges would have to be tested. All this has already been done with our library, so that under certain circumstances, the acceptance of the program code created using the function blocks by an external expert can be omitted.

Finally, let's take a look at the topic of communication. The world of mobile machines speaks above all CAN.

Georg Engelmann: This is indeed an area in which we are in close contact with our customers, listening carefully and accept our tasks. Many mobile robot manufacturers have an industrial background and use protocols based on Ethernet, for example. In a stationary environment, where there is less need to pay attention to storage capacities, there is no problem in processing protocols of around 50 megabytes. Mobile controllers with capacities of around 5 megabytes are currently not designed for this. This is also because, for example, especially in the motion control layer, i.e. in the motion control of the AVGs, these enormous amounts of data that can be transmitted via the Ethernet protocol are simply not required. This is not about data-intensive navigation calculations. The motion control layer with the claim of functional safety should be kept as clear and lean as possible. The safety-related sensors mostly speak CANopen Safety, a lean protocol that is precisely tailored to control of mobile machines and robots. So here two worlds, two different approaches and starting points come together. We must and will build bridges. We have already developed initial solutions, for example supporting parts of the CIP safety protocol, for example, to communicate securely with common safety lidar sensors and integrate them seamlessly into our controller. This is a first step that we are sure will be followed by many more in order to offer our customers maximum reliability, convenience and, of course, safety.

**More information about
Safe Motion Control**
ifm.com/cnt/mr-motion-control

O3R:
Sensor-camera fusion made easy

The O3R robotics platform offers a convenient way to combine information from 3D cameras, 2D cameras and sensors for seamless AGV environment monitoring. In this interview, Javier Massanell, Vice President Technical Development Camera System Management at ifm, explains the special features and future prospects of this innovative technology.

Javier, what was the original vision behind the development of the O3R platform and what advantages does it offer for mobile robots?

Javier Massanell: We have been offering 3D cameras for many years for mobile and stationary use. We recognised the growing demand for comprehensive digitalisation and automation in intralogistics at an early stage, particularly for easy-to-implement camera solutions for mobile robots. At the same time, powerful embedded computing power became increasingly available at lower cost. This is how we came up with the concept of a central processing unit to which several camera heads can be connected. This enables 360-degree environment detection and sensor fusion similar to autonomous driving. Our aim was to create a flexible platform on which we can offer 2D and 3D-based algorithms and functions, but also allow customers to implement their own algorithms and functions and fuse different sensor data.

Javier Massanell,
Vice President Technical Development Camera System Management

What makes the O3R platform special?

Javier Massanell: Our sophisticated algorithms for obstacle detection based on time-of-flight data are a major advantage. Thanks to years of experience, we have achieved an extremely robust detection with very few false alarms. Our function for pallet pocket detection is also unique. Furthermore, there is no comparable system on the market that enables such a simple camera fusion and integration of custom functions. Customers can implement their algorithms based on multiple data streams and additional sensors.

How do you enable customers to flexibly program and adapt the platform to their individual needs?

Javier Massanell: We rely on a Docker-based architecture. Customers can set up their own development environment in these containers and implement functions as needed. We provide extensive documentation and sample codes via our developer platform ifm3d.com. This is very useful for experienced software developers. We offer additional implementation support to smaller companies.

What technological developments are you planning for the O3R platform in the near future?

Javier Massanell: We are working on various aspects: On the one hand, we are expanding the VPU platform to include different performance classes. In terms of cameras, we are developing higher-resolution variants with a greater range. AI-based algorithms are an exciting field for optimising or expanding our functions. I think that in the future we will be able to offer our customers even more support and convenience when it comes to identifying objects such as pallets, people and even dolly trolleys.

The use of AI requires a lot of computing capacity. So the O3R is designed for a future with artificial intelligence?

Javier Massanell: Absolutely. Anything else would be unthinkable today. Advances in AI are breathtaking and opening up completely new possibilities that we want to explore for our customers and ourselves. Our platform provides the computing power and flexibility to integrate future AI innovations. A fascinating example of this is the combination of 3D and 2D data using AI to detect objects and indicate their distances and movements. Such approaches could be highly disruptive. The O3R platform is designed to accommodate such developments and to turn them into market-ready products. The exciting future of visual environment monitoring has only just begun.
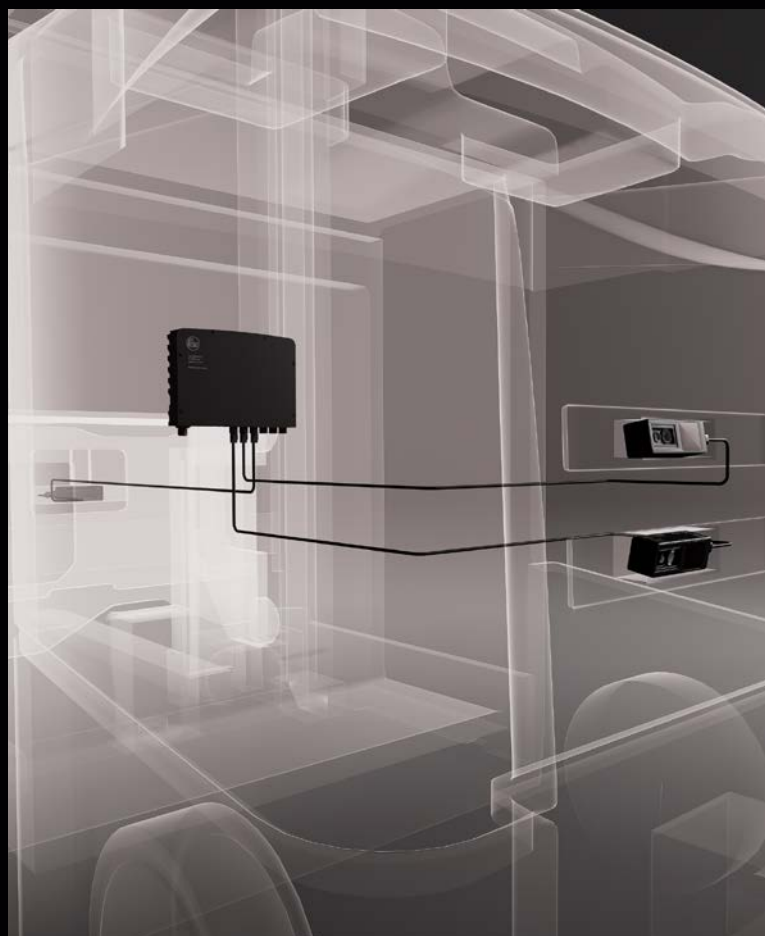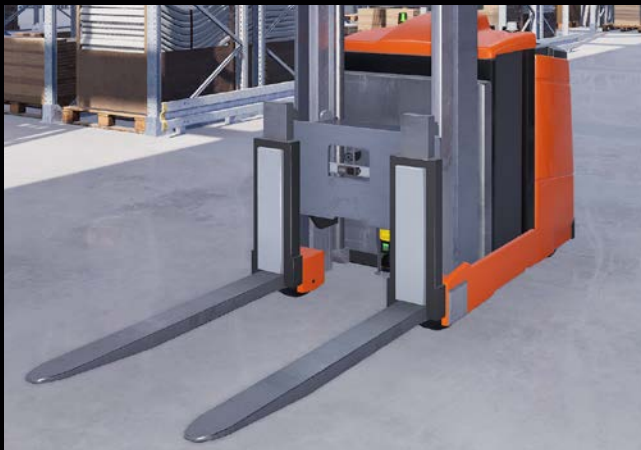
Tobias Rothermel,
Senior Key Account Manager Business Development,
pmdtechnologies AG

Jochen Penne,
Managing Director Member of the Board of Directors,
pmdtechnologies AG

"You can't simply improve measurement data by guessing."

pmdtechnologies ag, based in Siegen in North Rhine-West-phalia, is one of the pioneers in the field of time-of-flight based 3D camera technology. With a portfolio of around 450 patents and over 25 million ToF chips sold, they are one of the leading and most innovative companies in the industry. Tobias Rothermel and Jochen Penne explain what is special about pmdtechnologies' sensors, where they are used, and where AI can – and cannot – help with 3D environment detection.

Tobias, Jochen, Time of Flight or Photonic Mixing Device: What exactly will we be talking about today?
Tobias Rothermel: We are actually talking about both, because time-of-flight is the technology, photonic mixing device, or PMD for short, is the active principle that we have been using, developing and perfecting for more than 20 years – and which we incorporate in our name. In brief, we emit a continuous wave of infrared light that is reflected by the object and received and evaluated by the sensor. The closer the object, the shorter the time it takes for the detected light wave to be reflected. Pixel by pixel, a three-dimensional image of the area covered by the sensor is created. One of the special strengths of our chips is that we can largely mask extraneous light such as daylight or other light sources in the room directly in the pixel, which makes the distance measurement very robust.

Jochen Penne: That describes the development of the last 20 years well, which we have been driving forward together with Infineon as a partner for 15 years now. We have managed to increase the complexity and image sensor resolution more and more, from a single, very simply controlled pixel at the beginning, and to integrate a microprocessor to digitally control of the measurement sequences, memory and modern interfaces on the chip, for example. This means that today we can work with a very simple but highly effective design of the

measurement principle. This simplicity allows us to develop very compact solutions that are nevertheless powerful.

Your technology tends to work behind the scenes. Where is it worth taking a closer look to discover your chips at work?

Jochen Penne: Maybe some of you have already looked into one of our camera modules today: to unlock your mobile phone. We delivered the first ToF chip for a smartphone back in the day. Today, the principle is used across the board for biometric unlocking of phones or for cropping the foreground from the background when taking portraits. We are also represented at one of the largest manufacturers of robotic vacuum cleaners where we have replaced the previous lidar system. The reason is that thanks to our compact and efficient camera modules, the entire device can be built flatter – and can now be marketed as the flattest robotic vacuum cleaner in the world that can really fit under any couch.

Tobias Rothermel: Our camera module is also used in the automotive industry for environment detection and interior monitoring, for example to ensure that the driver is fit to drive or to operate the dashboard more safely via gesture control, without taking their eyes off the road. Thanks to the infrared light source of our module, our technology also works reliably in the dark, without dazzling or irritating people.

What about mobile robots as a field of application?

Jochen Penne Of course, we are also represented there. ifm electronic, as our main shareholder, has also recognised the industrial benefits of the technology and, together with us, has developed many 3D camera and 3D sensor solutions for use in mobile robots as well as mobile machines in outdoor applications. The O3R robotics platform is particularly suitable for AGVs or AMRs. It is also very powerful yet compact and is particularly optimised for industrial applications.

Another advantage that benefits both ifm and the customer is certainly pmd's broad positioning in terms of industries. We have sold around 25 million chips in the last 10 years. On the one hand, this is a testament to the quality of our chips, on the other hand, it also has a positive effect on the price structure. If we were to produce solely for the industrial sector, the quantities would be considerably lower, and, thus, the cost per unit would be noticeably higher. In addition, we experience faster development cycles in the other industries that also have an impact on the further development of our chips. The industrial sector benefits from state-of-the-art technology. Last but not least, customers can rely on the longevity of ifm products with pmd's 3D technology: Chip development is carried out in-house, within the group, which gives ifm independence from and an advantage over other manufacturers.

Finally, let's look at the topic of artificial intelligence. How do you assess the influence of the new possibilities on the future development of 3D cameras?

Jochen Penne Machine learning, neural networks, which is

nowadays called artificial intelligence is something we have been using for a long time to increase the added value of our time-of-flight cameras. Of course, the continuous increase in computing capacity in the smallest of spaces also increases the possible applications of Vision AI, to throw in another buzzword. Another important topic that is perhaps even more relevant at the moment is data fusion. The interaction of cameras and sensors to compensate for the respective weaknesses of one measuring principle with the strengths of the other.

Tobias Rothermel: What is also important to mention in this context is that artificial intelligence can never be used to extract high-end data from a poor data basis. You can't simply improve poor measurement data by guessing. Properly used, however, artificial intelligence can help to organise and interpret the huge flood of data and measurement information collected by time-of-flight cameras, overlaying it to generate even higher-quality output and insights. In conclusion, we can say that if we continue to develop the world's best 3D sensors, which is our goal. AI can help us to make the best possible use of these advantages for the respective applications.

More information about Perception
ifm.com/cnt/mr-perception

More information about pmdtechnologies AG
www.pmdtec.com

Sensor, machine, fleet: everything under central control

In order for mobile robots to fulfil the expectations placed on them in terms of efficiency and relieving the burden on skilled workers, the condition of a fleet must be kept under constant observation. Cloud-based solutions for fleet management help to recognise maintenance requirements and centralise necessary updates. In this interview, Gerrit de Waard from ifm explains how the mobile IoT cloud platform simplifies the management of mobile robots.

Gerrit, what is the aim of the mobile IoT platform and what does it offer?

Gerrit de Waard: Basically, we are not just talking about the cloud-based mobile IoT platform, but rather a complete solution that includes both software and hardware. As all components in this solution are harmonised with each other, integrating machine or AGV data into our cloud system is very easy. With just a few clicks, the data can be transferred to the cloud and analysed there.

How is the software structured? Which perspectives can I choose from as a user?

Gerrit de Waard: Our system is hierarchically structured to provide exactly the insight into the machine or fleet that is

needed. Device Management forms the lowest level. Here, individual devices or components of a machine or mobile robot can be configured, updated or provided with new firmware. One level above is Machine Management. Here, as the name suggests, the entire machine is considered as one unit. Machine-wide configurations can be stored, for example, how certain components should work together. In the near future, customers will be able to conveniently assemble entire software packages, including basic software, configuration and firmware, and transfer them to the machine. These are then automatically distributed to all relevant components, which considerably simplifies software maintenance of machines.

What does Campaign Management mean in concrete terms and how will it simplify the management of machine fleets?

Gerrit de Waard: Campaign management is the highest level of the hierarchy. The aim here is to manage updates or configuration changes for entire fleets of machines. You can store definitions at model level and then, for example, equip 100 machines of the same type with the identical firmware at the touch of a button. Especially with regard to cybersecurity, Campaign Management offers an easy way to quickly close

Gerrit de Waard,
Product Manager Telematics

The diagnostic data from the sensors can then also be transmitted and analysed.

What functions does your platform already offer for predictive maintenance planning?
Gerrit de Waard: Our system has a module that is dedicated to precisely this topic. Here, maintenance tasks can be proactively planned and, for example, e-mail notifications can be sent to maintenance teams or the purchasing department for the timely procurement of spare parts. This means that our software already enables efficient maintenance planning based on the recorded machine data, even without being connected to a higher-level ERP system such as SAP.

Is a connection to SAP systems basically possible?
Gerrit de Waard: Our entire platform is accessible via APIs. This makes it possible to link our platform to SAP without too much effort and to transfer machine information from our system. For specific projects, we are also happy to support our customers in developing specific modules that work seamlessly with SAP.

security gaps and distribute updates to the fleet, which greatly simplifies the management of large fleets, as it is quite common for mobile robots of different types or even different manufacturers to be used in intralogistics. Nevertheless, we offer a central administration centre at IT level for all these variants.

To what extent does your platform support companies in complying with laws such as UN-R155 and UN-R156?
Gerrit de Waard: These UN regulations concern cybersecurity and software updates for vehicles. Our platform covers the processes and documentation required by these regulations. Although we, as a supplier, are not directly responsible, we support OEMs and end users in designing their systems to be compliant with these standards and having them certified.

What plans do you have for integrating IO-Link sensor data into your platform?
Gerrit de Waard: We use the same technology for seamless communication from the sensor to the cloud as our colleagues in the factory area. This means we speak the same language as IO-Link components. Even if the deep integration is not yet fully implemented, it is our goal to integrate IO-Link sensors into our system in the same way as other components.

More information about Digitalization
ifm.com/cnt/mr-digitalization

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