View from the top

Not only vehicles but also the production facilities for the locations worldwide are made at the main plant of the German car manufacturer Opel in Rüsselsheim.

3D camera replaces several sensors for position monitoring

The automotive manufacturer Opel in Rüsselsheim relies on innovative technology in production. At a welding robot various stamped and deep-drawn metal sheets are welded to form a supporting element of the bodywork. A 3D camera monitors the position and the fixing of the sheet metal parts.

The operator places several prepared sheet metal parts on top of each other so that a welding robot can weld them together at several points to form one piece. Toggle clamps are used to fix the sheet metal parts. They are L-shaped levers which fold down and fix the sheet metal in the equipment from the top.

Usually dozens of sensors are installed at that point to monitor the correct position of the clamps and the presence of the workpieces. Because only if the component is detected as "present" and all clamps have been signalled to be "closed", would the controller release the welding process.

Using the O3D sensor from ifm, we can replace the conventional sensors and detect positions visually.

The 3D sensor simultaneously monitors several positions.

At Opel people thought about how to optimise this position detection. The idea: The O3D sensor from ifm looks at the scene from above.

Claus Moog, Supervisor Operation Planning, Electric & Commissioning at fixture and plant engineering at Opel in Rüsselsheim: *"In 2017, we considered how to design our tools more cost effectively and efficiently. At first we started with analysing the market of different vision sensors and eventually came across the company ifm. Using their O3D sensor, we can replace the conventional sensors and detect positions visually."*

Several prepared sheet metal plates are welded together to form a subassembly.

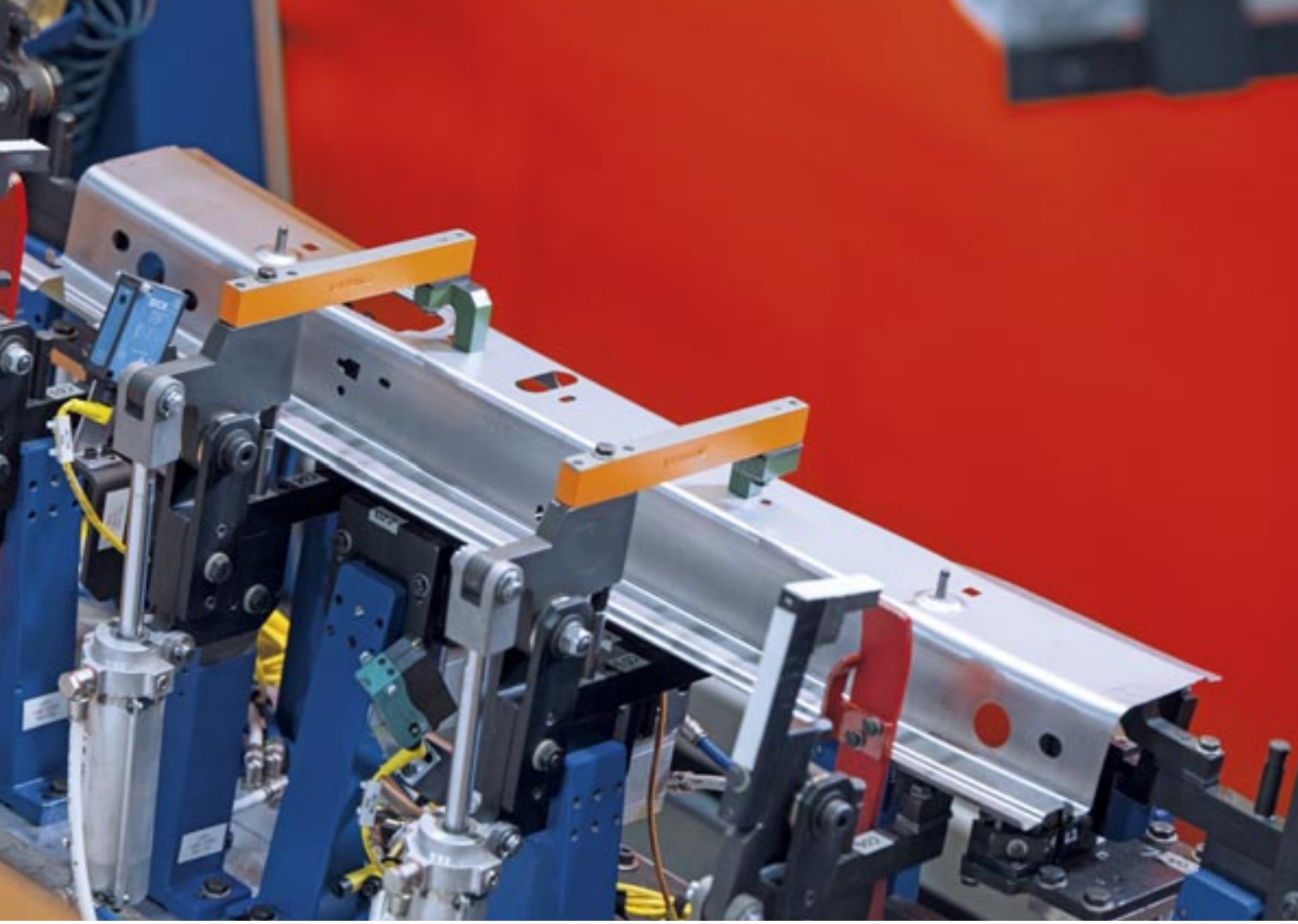
> *The use of the O3D sensor provides us with completely new possibilities.*

The O3D sensor

ifm's O3D302 vision sensor is a 3D camera with integrated image evaluation. The resolution of the PMD image sensor is 176 by 132 pixels. For each of the 23,232 pixels the sensor supplies a precise distance value – up to 25 times per second. In contrast to laser scanners, the ifm 3D sensor has no moving parts. Therefore, it is especially robust, small and cost effective.

Since the 3D image is evaluated in the sensor, external image evaluation is not needed. The distance between the clamp and the sensor is evaluated via definable positions in the camera image (called ROIs, region of interest). The integrated evaluation detects if the tension lever is "open" or "closed". The events are transferred to the controller using the integrated Ethernet interface via TCP/IP, PROFINET IO or EtherNet/IP. The live camera image can also be provided.

Using the "Vision Assistant" software, the user can easily set the sensor parameters, define ROIs or configure the output function, for example. This software is available both for Windows PCs and for iPads.



The individual components are fixed by means of a clamp in the fixture. Their positions ("open", or, as in this photo, "closed") are monitored by a 3D sensor from the top.

Looking down from above

Two of these sensors are installed above the welding system, one in the placement area (component placed), the other in the actual welding area. Both look down from above to the sheet metal to be welded and their clamps in the installation equipment.

Fabian Gulla application engineer for image processing and robotics in plant construction at Opel, explains the function of the sensors, *"We use the sensor for distance measurement. To do so, we have defined several regions of interest which we detect. For once, there is the clamp and its end positions, and then there is the component as such, i.e. present or not present. You could, of course, also detect this using several one-dimensional photoelectric sensors if you align one sensor to each area. The advantage of the O3D is that you only need one sensor and can then redefine ROIs in the software. We have aligned the ROIs to the end positions of the clamps and the workpieces and then we simply use the distance measurement for detection: 'Is a component present' or 'Has the clamp reached its end position?'"*

Cost savings

Instead of many sensors only one single 3D sensor simultaneously detects the position at several points in the equipment. Using the O3D vision sensor, approx. 80 % of the conventional sensors can be replaced in this plant.

Claus Moog: *"Usually, 30 to 40 sensors would be installed on the tool. Now we need only 10 sensors for the detection of actuators in concealed installation positions, which the vision sensor cannot detect. That means we could replace a major part of the sensors. We could achieve cost savings amounting to about 20 to 30 %.*

Welding system in the area of body-in-white.

ifm VisionAssistant for parameter setting and visualisation of the O3D camera.

Free installation space: No more sensors are required in the area of the welding tongues and weld spatter.

Furthermore, we have compared how much power conventional sensors use and how much the O3D consumes. Here again, significant cost savings result."

There are even more saving potentials by reducing cabling, installation accessories and I/O points at the controller.

Visualisation

For transparency in the process, Opel have installed a monitor for visualisation in the plant. Besides graphic process visualisation, the O3D can also provide a live image.

Fabian Gulla explains: *"The standard display shows the operator which components are to be placed and if the components are correctly positioned in the tool. Currently, these are graphics that have to be designed and animated by a programmer and are composed of several images. Different markers are added which show the operator which components are still missing and which he still needs to place. Thanks to the live image, the advantage of the ifm sensor is that we have assigned end positions to the clamps and components, which are visualised in the image. The red-green colour change symbolises to the operator if a workpiece has been placed and if the clamp is open or closed. This does not mean any more programming work because the sensor parameters have to be set anyway and the live image is provided by the sensor."*

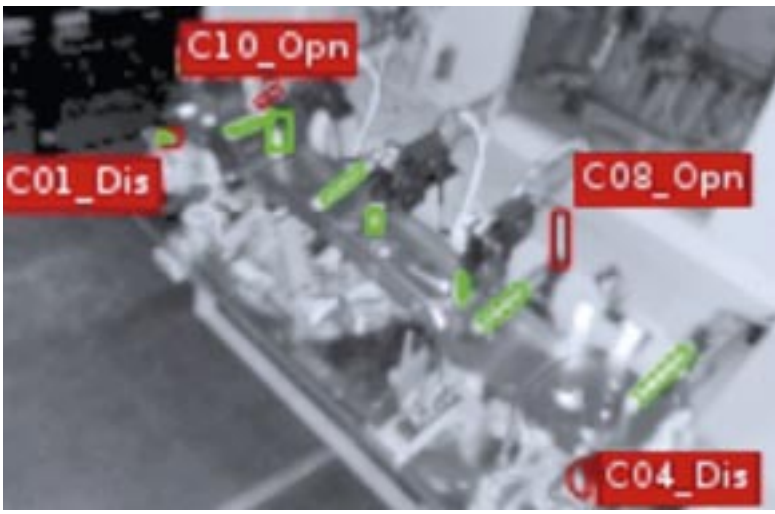
Space saving

Due to the fact that instead of several sensors, now only one sensor is needed for the detection of several positions and this sensor is installed high above the plant, there are advantages for the construction of the plant.

Claus Moog: *"The use of the O3D sensor provides us with completely new possibilities; for example, we have more construction space and more space for accessibility to welding tongues. Furthermore, we can eliminate the susceptibility to failure of conventional sensors. Since the sensor is installed high above the welding area, weld spatter cannot reach it which would damage it over time as is possible with conventional sensors installed close to the welding tongues."*

> *We believe that the use of vision sensors will establish itself in the future because using the vision sensors we can create artificial intelligence which is not yet possible like this today.*

Visualisation ensures transparency and indicates the operating steps to the operator.



The live image of the 3D sensor with regions of interest marked in colour.

Prospects

The experience made in this pioneer plant at Opel is overall positive. This will influence future developments in plant construction.

Claus Moog: *"We believe that the use of vision sensors will establish itself in the future because using the vision sensors we can create artificial intelligence which is not yet possible like this today."*

Fabian Gulla adds, *"In the context of cameras we will be able to make enormous progress. For example, robot grippers and suckers can be made considerably more flexible and therefore considerably more intelligent. However, this does not only concern the subject of cameras but, for example, also technologies such as IO-Link, artificial intelligence, deep learning or machine learning. At any rate, there will be many new things. It is always a question of consideration: What makes sense, what fits my price-performance segment and: Do I generate added value for the company or the application at the end of the day?"*

The O3D vision sensor was introduced in close cooperation with the developers of the vision sensor.

Fabian Gulla: "*The cooperation with ifm is very good. We had several meetings directly with the developers. So we could gain insight into important findings such as 'how does the sensor work?', 'what do I have to note?', 'what size must my clamp be so that it can be reliably detected'?"* .

Conclusion

Fewer sensors, simpler plant construction, no interference due to weld spatter – the vision sensor as a monitoring system provides numerous advantages and considerably reduces the plant cost. Other production plants can also be equipped with the vision sensor and thus optimised.