100% Perfection in Automobile Production

GigE cameras keep a close eye on quality in underbody inspection

Far more than 1,000 cars a day roll off the production line at the factory of a leading automobile manufacturer in Southern Germany. Each car features an individual combination of color, engine configuration, options and accessories. But they all have one thing in common – every single part is in the right place, from trim strips to expanding rivets. Machine vision plays a key role in achieving this high level of accuracy: At various stations of the production process, high-speed cameras check that all components are correctly in place and none of them are missing.

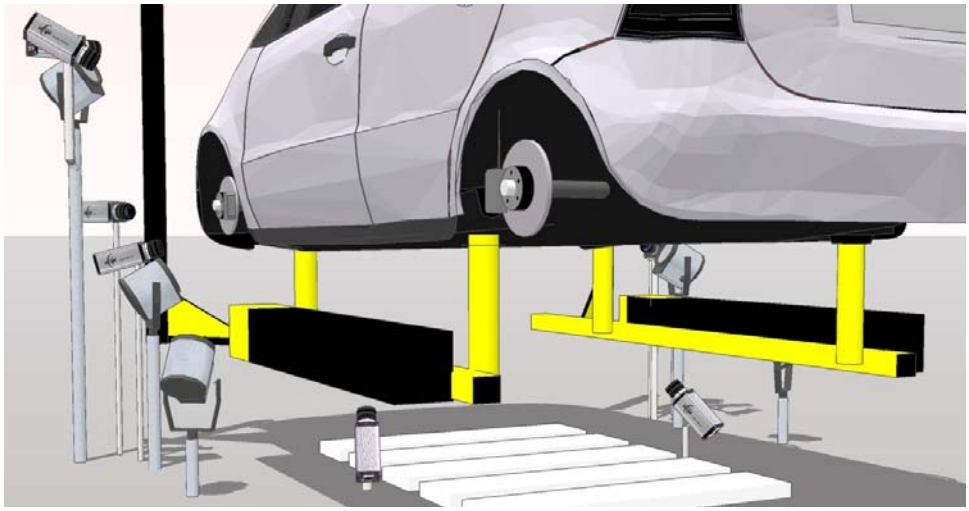


Figure 1:
The current underbody inspection systems are equipped with up to 12 GigE cameras from IDS.

VMT Bildverarbeitungssysteme GmbH, based in Mannheim, Germany, is a robot guidance and quality control specialist in the automotive industry and for years has been providing production units with optical inspection systems. Current underbody inspection systems are equipped with up to 12 GigE cameras from IDS Imaging Development Systems which reliably supply images for the 100% inspection.

The first VMT system is already used at an early stage of the car manufacturing process: Before the chassis and the body-in-white are mated, the numerous plastic plugs sealing more than 80 openings in the underbody have to be checked. They are essential for body assembly and paintwork because they prevent moisture penetration. Consequently, not a single one of them must be missing. The VMT inspection system makes sure of that with GigE CCD cameras from the IDS uEye series.

The inspection takes place while the vehicles are being moved at a speed of about 5 meters per minute.

The inspection takes place right during the manufacturing process while the vehicles are being moved along the production line by a conveyor system at a speed of about 5 meters per minute. As soon as the foremost point of the body passes the light barrier of the inspection system, the measurement and analysis

process starts. An incremental transmitter coupled to the conveyor continuously transmits the exact vehicle position to the inspection system, which uses this data to trigger the image capture. Depending on their positions, the system's industrial cameras capture multiple images of the underbody so that all areas can be successively inspected and analyzed as the car moves on.

The CCD cameras of the UI-6230HE-M type provide an excellent image quality even at short exposure times

Five high-frequency fluorescent lamps, which provide diffused lighting for an even illumination of the underbody, and additional halogen lamps for the wheel arches show the vehicle in the best light. Thanks to the highly sensitive monochrome CCD sensors, the cameras of the UI-6230HE-M type provide an excellent image quality even at short exposure times. The different paintwork colors of the car bodies, however, are a particular challenge for image capture and analysis. In every paint job, some of the overspray invariably gets on parts of the wheel arches or underbody. This makes image capture very difficult because conditions can frequently change between a highly reflective and a very dark background. Nevertheless, the black plastic plugs must be reliably detected. The uEye camera itself takes care of that problem. It sets the optimal exposure parameters for the capture by automatically adjusting the sensor gain using the Auto Gain Control function. This keeps the average image brightness constant without changing the exposure time.

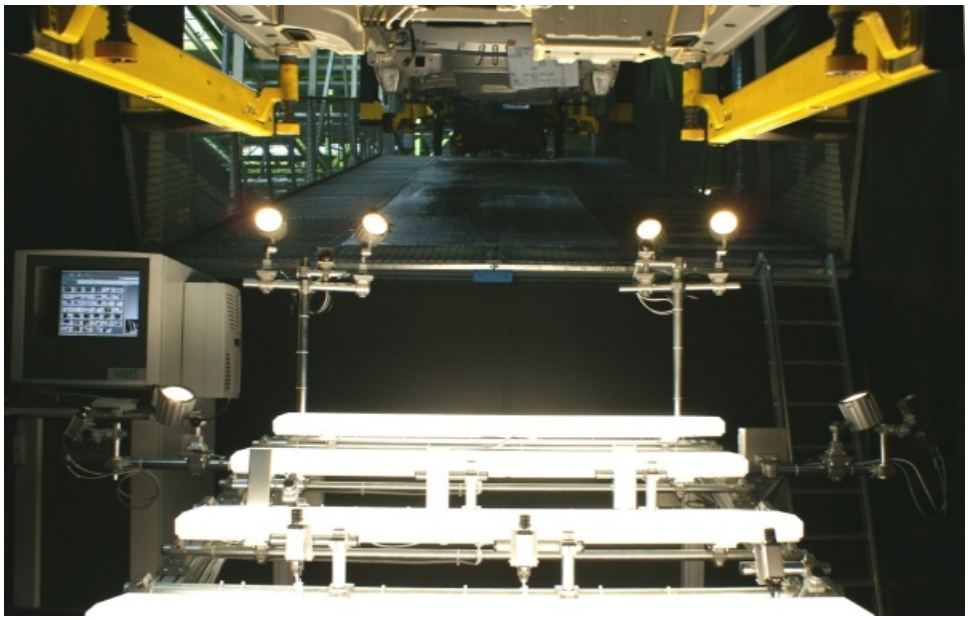
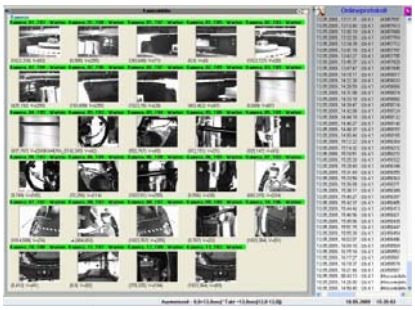


Figure 2:
Halogen and fluorescent lamps, which evenly illuminate the underbody, show the vehicle in the best light.

Two other systems along the manufacturing line, each equipped with 12 uEye GigE cameras, verify that all expanding rivets and screws have been fitted in the wheel arches of the nearly complete cars. On each side of the car, six cameras focus on the wheel arches and trim elements from different viewing angles. Via two GigE network cards and switches, the image data stream from the multi-camera system is transmitted to an industrial PC which analyzes the images. For the analysis, the VMT IS software mainly uses special algorithms developed by the German imaging specialist in order to provide an open environment for any customizations. The software design ensures easy extensibility: additional meas-

urements and even more cameras can be added at any time. For this reason, the engineers from VMT opted for cameras from IDS which allow flexible image capture programming based on a comprehensive software package (SDK). More than 140 functions in the uEye SDK can be controlled in C++/C# or VB-based applications. In addition to an ActiveX component and the DirectShow interface, IDS cameras also support the new GenICamTM machine vision software standard. Since driver compatibility is ensured between all cameras of the uEye series, no programming is required when switching to a different USB 2.0 or GigE model.



Figures 3+4: Images captured by the GigE uEye HE are stored for documentation of the measuring steps – an important feature in 100% inspection.

Besides image analysis, another essential function of the VMT IS application software is the documentation of the measuring steps. A ring memory holds up to 10,000 completed measurements including the associated images and results. These measurements can be reviewed and even repeated later, if necessary. This feature is particularly important for the 100% inspection required in automobile production. If the inspection system detects that a part is missing, it flags the measurement accordingly and issues an error message. The manufacturing line, however, has to keep running – and immediately fitting the missing part would delay the subsequent production. Therefore, a special station is provided later in the manufacturing process and allows retrofitting missing parts without causing a production delay.

After thorough teach-in and testing, the inspection systems were integrated in the production environment in March 2009. Due to the excellent results obtained with these systems and the GigE cameras, the use of additional VMT inspection systems is planned for other stations in the future.

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Contact:

www.ids-imaging.com
info@ids-imaging.com

www.vmt-gmbh.com