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Laser and video projection for worker support

In the pursuit of batch size 1

Even though many production processes involve a high degree of automation now, there will always be tasks that require manual rework – may it be assembly or quality assurance. So how can these manual activities be linked more efficiently with digital processes? Here, dynamic laser and video projection provides valuable support. Self-industrial production with batch size 1 will soon no longer be a problem.

Fig. 1: The laser is projecting welds and laser contours precisely and directly onto the component, photo: ITER Organization.

For several years, there has been a clear trend in the manufacturing industry towards more variety of versions, individualization and shorter product life cycles, resulting in the complexity of assembly, quality assurance and manual reworking. Nowadays, machine operators have to cope with numerous different product lines and various equipment versions being produced on the line in any order. Such a high level of process variation increases the risk that operators will easily get confused or overlook necessary tasks. Highly adaptive digital processes are required to meet this challenge.

Highly adaptive digital processes as a solution

Traditionally, positioning, localization and inspection are performed using so-called positioning templates or test templates. However, since these are designed for industrial mass production, their scaling increasingly deteriorates as the number of variants increases. At batch size 1, they fail completely.

Dynamic laser and video projection replaces conventional templates with digital ones, allowing the position of components and other complex 3D information to be projected in 3D onto the workpiece in the right position (Fig. 1). In addition, work stages and notes can be superimposed in the correct sequence, simplifying the tasks of assemblers enormously and reducing the error rate, which in turn means lower costs. Another advantage is that workers can move freely around the object thanks to intelligent control software and tracking processes.

Specific areas of application – from development to quality assurance

Dynamic laser and video projection also provides support not only in terms of assembly, but in quality management, for example, it can visualize measurement data on a workpiece and make differences between target/actual variances more visible. This eliminates the need for complicated

manual transmission, which reduces interpretation failures by humans.

Projection technology also improves the interaction of all those involved in product development and prototype construction because, based on its support, complex issues can be presented transparently, for example through ”X-ray views“ of hidden elements or through measurement data visualizations. Thus, relevant aspects can be viewed together on the component and discussed with each other.

Dynamic laser and video projection – what it’s all about

A projection system of this type consists of a laser or video projector, one or more cameras, if required, and corresponding software. The software controls the projection and analyzes camera data, CAD data, or information from other connected systems (Fig. 2). To position the projector correctly, the software continuously calculates precisely where it is in relation to the object and adjusts the projection accordingly.

Fig. 2: Software controls the projection and evaluates camera data, CAD data or information from other connected systems; photo: EXTEND3D.

Static referencing is sufficient for work where only a few position changes are necessary. It can be automated, for example, by a camera-based scanning process and corresponding sensor technology.

If a workpiece has to be repositioned frequently, dynamic tracking is recommended. This method continuously recalculates the alignment of the object and the projector. There are two variants: tracking with or without a marker. In the marker-based method, the worker applies stickers to the workpiece or marks off certain features using a measuring adapter. Using such target points, position changes can be precisely tracked. Tracking without using a marker, on the other hand, requires no manual preparation and works on the basis of CAD data. This method is particularly recommended for processes with short cycle times.

Interfaces for process integration

Dynamic laser and video projection solutions are available as mobile stand-alone systems or for fixed integration into a production line. As to its essential functions, the solution should support industry-standard CAD formats and be able to read and process 3D data from the design department or from downstream data processes. In addition, a generic exchange interface for CSV files is often advisable for the seamless integration of customer data formats. Other proprietary formats or databases should be connectable with little effort.

Projection solutions for fixed integration into the line also require a generic interface to the conveyer and process control techniques so that they can be integrated into the process automation. To do so, they must be able to receive commands from the master computer, a programmable logic controller (PLC), a manufacturing execution system (MES), or another control system.

Laser or video projection – which is better?

There is no clear winner here. Which method is best eventually depends on the respective application.

Laser projection offers particularly high contrast but only simple colour representation, and it achieves an accuracy of up to 0.1 millimetres per metre of operating distance. Therefore, it is very well suited for tasks where maximum precision is required and a reduced, contour-like display is sufficient – for example, when positioning or inspecting bolts, brackets or trimmed sizes. In addition, the laser allows projection even in bright environments or areas that require an IP54 protection class. Due to the collimated beam, the laser projection also has a very high depth of field and is therefore also suitable for highly perspective representations with projection incident angles of sometimes only 20–30 degrees to the surface, which

is conducive to integration in confined spaces. Industrial lasers of laser class 2M can also be operated without safety goggles and specially trained laser safety officers.

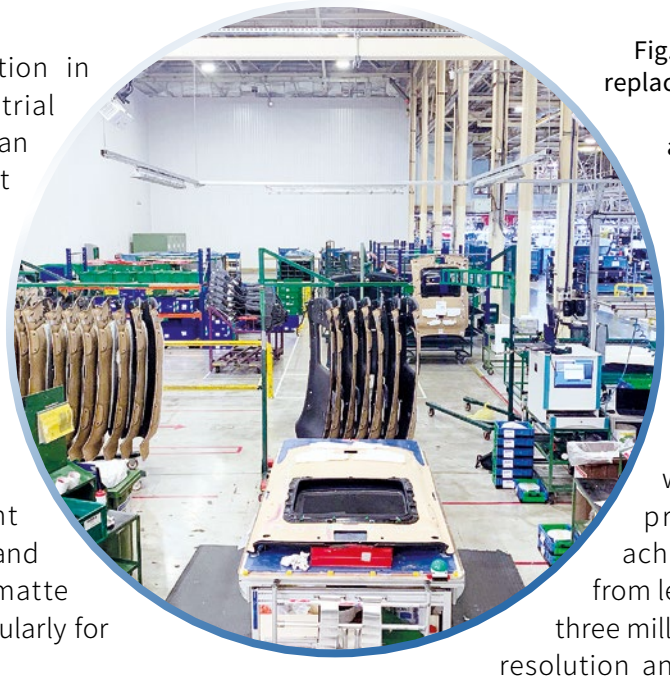

Fig. 3: Dynamic video projection replaces traditional stencilling and facilitates, for example, the assembly of cable harnesses, photo: EXTEND3D.

Video projection, on the other hand, is less expensive but less versatile, requiring a controlled environment protected from sunlight and ideally also brighter, matte workpiece surfaces, particularly for larger projection areas.

The big advantage of video projection is that it can also project colors, textures and surfaces. Therefore, it is possible to convey more information at the same time. Therefore, complex visualizations up to photo-realistic representation are no problem. The projection is precise down to one pixel in the image, which means that for larger projection areas, the achievable accuracy ranges from less than one to as much as three millimetres, depending on the resolution and projection area. Video projection is particularly well suited for design processes and for applications in assembly and quality assurance where area information is required, such as the installation of cable harnesses (Fig. 3). Flicker-free representations of entire CAD layers are also possible.

	Laser projection	Video projection
Contrast	High	
Ambient conditions	No specific requirements	Requires an environment protected against sunlight and brighter, matte workpiece surfaces
Color display	Low	High
Precision	Up to 0.1 millimetre per metre working distance	Under 1 up to 3 millimetres
Complexity of the displays	Low: reduced, contour-like display	Complex visualizations up to photo-realistic representation
Suitable applications	Work where maximum precision is required and a reduced, contour-like display is sufficient – for example, when positioning or inspecting bolts, brackets or trimmed sizes	Design process, assembly and quality assurance use the cases information where surface is needed

Table 1: Comparison of laser and video projection

Fig. 4: In the finish booth, the projection shows the worker the area that needs to be reworked, photo: EXTEND3D.

Practical example: Improved quality in automotive painting

In order to optimize manual rework in the paint shop, a Bavarian automotive manufacturer relies on dynamic laser and video projection in combination with an image recognition system. First, an image recognition system automatically analyzes the body framework or painted vehicles. With the help of an AI using sensors and cameras, the system determines exactly whether and where the paint job requires manual finishing. The vehicle is then sent to the finishing booth for manual finishing (Fig. 4). Here, five WERKLICHT laser projectors are used in combination, each of which is assigned to a clearly defined area on the outer skin of the body. A system PC next to the finishing booth controls the projection with the aid of the 3D software by WERKLICHT receiving the data from image recognition. The system projects the damaged areas directly onto the vehicle, so the workers can immediately see where they still need to sand and polish.

Outlook

With the help of open interfaces, it will become increasingly easier to integrate laser and video projection into Industry 4.0 projects. Artificial intelligence will also play a greater role in this area, for example, to automate the initialization of tracking. Then nothing stands in the way of an efficient batch size 1 production. ■

Benefit of dynamic laser and video projection

- Proper projection of the part positioning, among other things, onto the workpiece
- Fading-in work stages and notes
- Free positioning in spaces
- Visualization of measured values for target/actual comparison
- Enabling X-ray vision as a basis for improved cooperation in product development