

TERAHERTZ FILM THICKNESS MEASUREMENT FOR THE SELF-PROGRAMMING PAINTING CELL

1 *Robot-guided terahertz measuring head with three positioning sensors for measuring the layer thickness on a car body*

The painting process presents many entrepreneurs with great challenges, as automation and individualization of the products do not yet match when it comes to painting technology. In many industries, well over half of all components are therefore painted by hand - the variety of variants is simply too large.

Programming a painting robot is only worthwhile if numerous identical parts have to be spray-painted. The automatic coating system SelfPaint offers companies a compromise between automation and individualization for the first time - and also offers numerous potential savings: 20 percent less coating, 15 percent less energy, five percent less production time - its advantages over the previously dominant manual coating process are enormous. And for the first time it is also suitable for individual pieces.

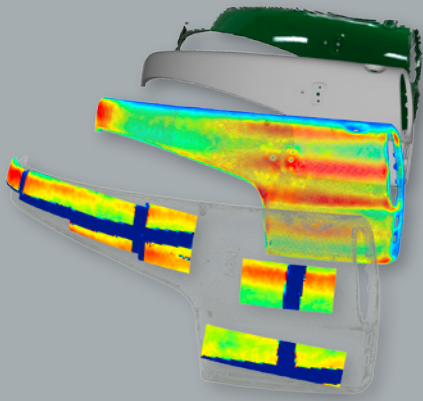
We developed the self-programming painting cell together with the Fraunhofer Institute for Manufacturing Engineering and Automation IPA and the Swedish Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC.

Algorithms calculate optimal robot path

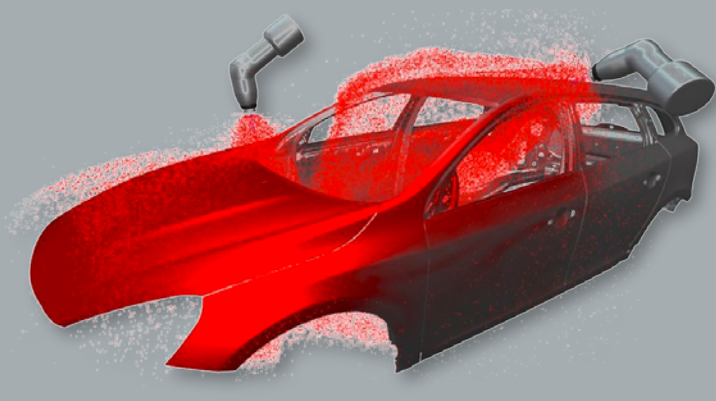
The automatic painting process consists of five steps. First of all, the component is scanned in three dimensions, whereupon the scan data form the basis for a fluid dynamic simulation. Algorithms simulate the trajectory of the coating particles and determine which coating and air quantities are optimal for the desired coating thickness. In a third step, the system uses this simulation data to determine the best possible robot path for the painting process. Now follows the actual painting process, which is controlled in the last step using terahertz technology. In the project we realize the three-dimensional recording of the component and the terahertz layer thickness measurement.

Three-dimensional object and position detection

In order for the painting cell to know the position of the object for simulation and painting, it must be recorded in three dimensions. However, systems designed for industrial use for 3D object acquisition are usually designed for very precise topographic measurements of unknown objects, which makes them expensive.



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If object geometry information is a priori available in the form of CAD data, very cost-effective products from the field of consumer electronics can be used. All that is needed here is to determine the position of the components in the room.

The self-programming painting cell uses 3D sensors that were originally developed to control video games - a global mass market. The accuracy of the position detection is more exact than the deviations of common components from the CAD data and is therefore within the manufacturing and positioning tolerances. This high resolution is made possible by tailor-made algorithms for data processing. The pure three-dimensional image, which is captured by the sensor and is available as a point cloud or network, cannot normally be used directly for position detection. However, if filters are used that make use of the imaging properties of the sensor system and automatically remove faulty information from the measurement, the point clouds can be reworked so that they are of high quality. High enough to perform fully automated 3D position detection for paint simulation and painting.

Terahertz technology for quality control

In the final process step of automated painting, the quality is finally checked: Is the thickness of the coating as desired? For this quality-control we use terahertz waves. With this technology developed by us wet and coloured lacquers can be measured without contact. The quality of the paint layers can already be checked during or after the painting process.

The method used enables non-contact measurement of even single layer thicknesses of a multi-layer system, which is also used in many painting processes. Substrates – the basis of the coating layers – do not have to be metallic, but can also consist of other materials. The measuring systems for this quality control have reached and proven industrial maturity in recent years.

In everyday painting, everything will soon be automatic: The component is scanned, painted and checked for quality by robots - without the intervention of an employee.

2 *Sequence of the automated painting process (from back to front: 3D recording of the component, adjustment with CAD model, simulation of the painting result, result of the terahertz measurement - blue areas masked for comparison measurements)*

3 *Multiphysical simulation of a high rotation atomizer with contact charging for calculating the droplet trajectory using a Volvo V60 body as an example*

