PRESS RELEASE

No Data – No Problem
Fraunhofer ITWM Generates Synthetic Data

The »Virtual Inspection Planning« team at the Fraunhofer Institute for Industrial Mathematics ITWM and the BMW Group have successfully completed a joint research project investigating the use of synthetic image data, for development of automated surface inspection. This supports the inspection process using Artificial Intelligence and the standardized detection of defects. The project used synthetic image data to develop Machine Learning methods for inspecting highly specular metal surfaces. The experts, including representatives of the Fraunhofer ITWM and BMW Group from both Munich and Steyr InnoLab, presented their findings during a workshop at the BMW Group plant in Steyr, Austria.

Development of robust Machine Learning (ML) solutions requires a lot of annotated data, which is typically challenging to obtain. Synthetic data can remedy this shortcoming. In machine vision, this trend is particularly pronounced in scene-level applications (pose detection, object detection, motion detection, etc.). However, when it comes to detail-oriented applications such as visual surface inspection, it is much more difficult to generate synthetic data in a reliable and realistic way.

Synthetic Data in Visual Inspection

The aim of the project was to examine the usefulness of rule-based synthetic data generated by Fraunhofer ITWM in the development of automated surface inspection systems using Machine Learning. The rule-based approach to data synthesis is based exclusively on mathematical modeling and not on generative Artificial Intelligence and is integrated into the Fraunhofer ITWM's in-house software »V-POI«. This makes it possible to virtually simulate and expand inspection scenarios and to generate pixel-accurate and labeled data sets of any size.

Combining Joint Expertise

In the project, the BMW Group was responsible for developing the Machine Learning solution and carrying out a performance comparison between the real and synthetic data. The main task of the Fraunhofer ITWM researchers was to model surface textures and defects and to generate the photorealistic, synthetic image data set. The synthetic data generation parameters were adjusted to simulate the images obtained by the existing surface inspection system.

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Pioneering Technologies in Surface Inspection

The study shows that the training results when using only synthetic images generated by the Fraunhofer ITWM synthesis pipeline are comparable to those when using only real images. The synthetic images contained acquisition scenarios that describe both the real setup and the extended edge cases. Furthermore, it became clear that training on the combination of real and synthetic data offers an unpredented advantage that even outperforms the results obtained when training only on real data.

Together, Fraunhofer ITWM and the BMW Group are advancing the field of machine vision for surface inspection by testing state-of-the-art synthetic data technology in a real industrial environment. Parametric control over data content, enabled by mathematical modeling and rule-based synthesis, is the future of AI-driven surface quality inspection. It offers possibility to make the inspection more robust, reliable and precise, even when availability of real data is limited.

Further Information:

www.itwm.fraunhofer.de/v-poi
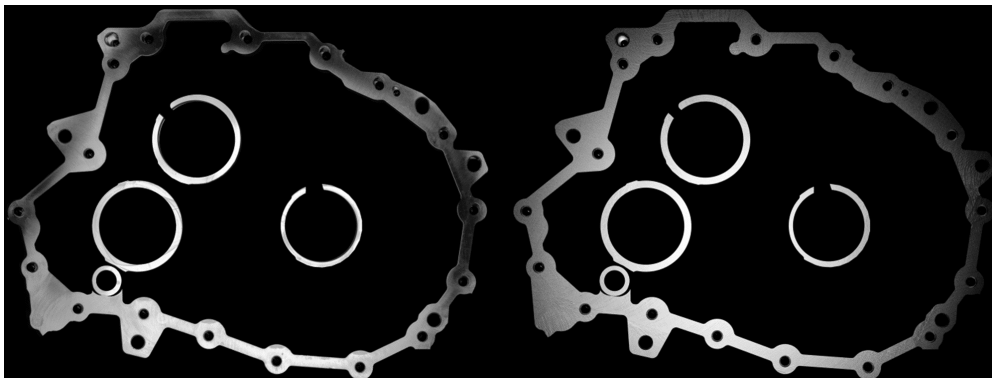
Comparison between a real image from the production line inspection system at the BMW Group (left) and a synthetic image generated using Fraunhofer ITWM technology (right). © Fraunhofer IT

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About the Fraunhofer Institute for Industrial Mathematics ITWM

The Fraunhofer Institute for Industrial Mathematics ITWM in Kaiserslautern is one of the largest research institutes for applied mathematics in the world. We see it as our task to further develop mathematics as a key technology and to provide innovative impulses. Our focus is on the implementation of mathematical methods and technology in application projects and their further development in research projects. The close cooperation with partners from industry guarantees the high practical relevance of our work.

Their integral building blocks are consulting, implementation and support in the application of high-performance computing technology and the provision of customized software solutions. Our various areas of expertise address a wide range of customers: the automotive industry, mechanical engineering, the chemical industry, energy and the financial sector. This also benefits from our excellent networking, for example in the Simulation and Software-based Innovation Center.

About the Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft, based in Germany, is the world's leading organization for application-oriented research. With its focus on future-oriented key technologies and the utilization of results in business and industry, it plays a central role in the innovation process. As a guide and driving force for innovative developments and scientific excellence, it helps to shape our society and our future. Founded in 1949, the organization currently operates 76 institutes and research facilities in Germany. More than 30,000 employees, most of whom are trained in the natural sciences or engineering, work on the annual research volume of 2.9 billion euros. Contract research accounts for 2.5 billion euros of this total.