PCCL
Polymer Competence Center Leoben

MEASURING THE VISIBLE

High-speed robot vision of 3D components

CONTENTS

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Executive Summary

„Measuring the Visible“ is a groundbreaking technological innovation in the field of optical surface perception measurement.

It is ideally suited for comprehensive inline inspection during the production of both simple and complex 3D components. The technology can be used to examine a wide range of materials, including plastics, metals, wood, and transparent substances.

Measuring the Visible was developed at the Polymer Competence Center Leoben GmbH (PCCL) in Austria. PCCL is a COMET K1 research center dedicated to high-level, application-oriented research. Within this framework, funded collaborations and project partnerships with industry are not only possible but highly encouraged. Research projects benefit from particularly attractive financial support through public funding. The COMET program is financed by the Austrian federal government, regional governments, participating companies, and research organizations.

Visual Inspection – Still Up to Human Judgment?

Manual visual surface inspection remains a crucial part of quality control in many manufacturing environments. However, this process comes with significant challenges:

- One of the key issues is **subjectivity**. Scratches, dents, and other surface defects often vary in shape, size, and position, making consistent evaluation difficult. Different employees may assess the same component differently, leading to inconsistencies and potential quality issues.
- In addition, the process places both **physical and mental strain on inspectors.** Examining parts for hours at a time requires intense concentration, which can lead to fatigue and a higher likelihood of human error. At the same time, high production volumes and increasing demands for precision further complicate manual inspection.

- Another key challenge is the lack of **reproducibility**. While automated processes can deliver precise and traceable results, manual inspection depends heavily on the inspector's experience and daily condition.

To address these issues, some companies have adopted **rule-based systems**. However, these solutions also have their limitations. Rule-based approaches tend to be rigid and inflexible, relying on predefined criteria. When confronted with unexpected or complex surface defects, such systems often reach their limits.

These challenges highlight why many manufacturers are actively seeking **efficient, reliable, and scalable solutions** to improve their inspection processes—and to stay competitive in the long run.

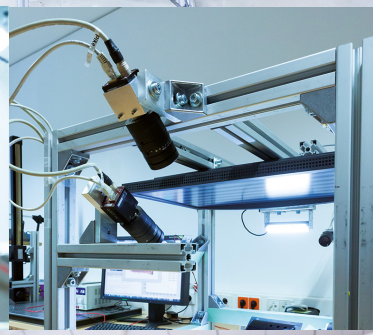
Redefining Quality with AI-Powered Surface Inspection

With over **20 years of experience** in 3D surface inspection and as Austria's leading research center for plastics engineering and polymer sciences, the **Polymer Competence Center Leoben (PCCL)** offers innovative solutions for quality optimization and surface inspection of materials and freeform 3D components.

Our expertise in **machine vision and machine learning** enables us to detect and classify surface deviations with high precision. Leveraging robot vision and artificial intelligence, our inspection systems deliver results that closely approximate human perception—while allowing for fast, fully automated inspection of complex 3D parts.

Our **customized solutions** are suitable for a **wide range of materials**, including plastics, metals, wood, and transparent substrates. They ensure reliable differentiation between natural surface textures and actual defects, resulting in significantly reduced scrap rates and improved production efficiency.

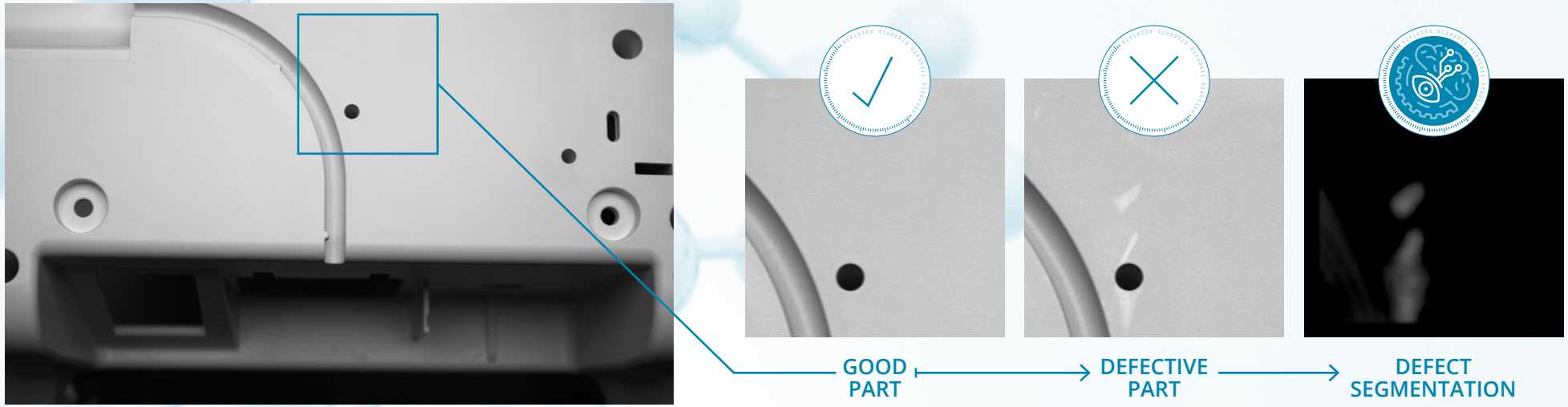
At PCCL, we are committed to both **implementing** our inspection solutions in today's industrial environments and exploring fundamentally **new possibilities** for the inspection systems of the future.



Case Study: W&H Form – Medical Device Components and Automotive Parts Made from Plastics

In the production of medical device housings, the highest quality standards are essential. Our innovative surface inspection strategy takes quality assurance to the next level: thanks to **one-class classification** methods, the time-consuming and costly process of defect labeling is no longer necessary. Instead, the system **autonomously learns** the characteristics of flawless components and reliably detects deviations with high precision.

Thanks to **precise defect segmentation**, even the smallest flaws – such as cracks, surface irregularities, or inclusions – can be detected and highlighted. This not only ensures comprehensive quality control, but also facilitates **root cause analysis** and **targeted rework**.



The developed methodology enables even the smallest **gloss variations and surface defects** to be made visible. This allows for precise localization of flaws in rejected components and provides valuable insights into **process-related errors**, enabling targeted rework and process optimization.

Our approach reduces manual effort, increases **production efficiency**, and lowers the reject rate. Thanks to its high **scalability**, the solution can be integrated into existing production lines—optimizing the entire quality inspection process.

Case Study: Pankl Racing & Krenhof – Steel and Titanium Connecting Rods

In the production of titanium connecting rods for high-performance sports cars, the reliable detection of surface defects is critical. At PCCL, we collaborate with industry partners to develop innovative measurement and inspection technologies—including optical systems, AI-based analysis, and non-destructive testing methods—to enhance **safety, quality, and cost-efficiency** in manufacturing over the long term. The goal of our research is to develop technologies capable of detecting even the smallest irregularities, such as scratches, notches, coating defects, or burrs. This case study places particular emphasis on the **critical shaft area of the connecting rod**, where even minor defects can significantly impact the structural integrity and safety of the component.

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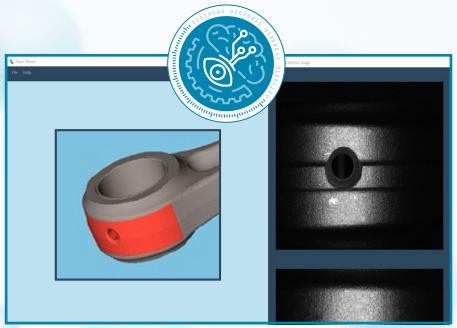
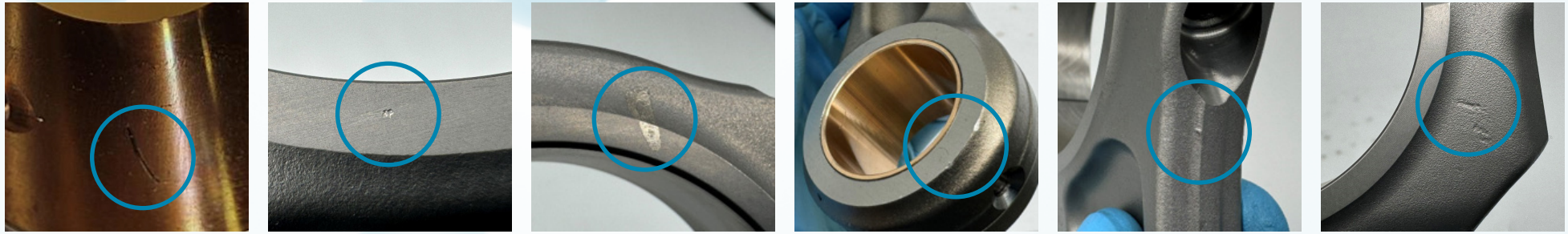
To reliably detect **rare defects**, we are actively working on the targeted integration of **synthetically generated defect images** into training datasets. The goal of this approach is to develop inspection systems that maintain high performance and robustness—even when faced with infrequent or previously unseen defect types.



As part of our research projects, we are also developing **user-friendly visualization tools** that enable intuitive analysis. Potential defects are displayed directly on an interactive 3D model of the component, accompanied by a clearly structured overview and representative defect images.

Our research aims to create **precise and scalable inspection solutions** that perform reliably under real-world production conditions. In close collaboration with industry partners, we strive to develop technologies that not only enhance the operational safety of critical components such as connecting rods, but also contribute significantly to the overall **performance** and **safety** of the final products.



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Interested? We look forward to hearing from you!

Take the next step toward more efficient and reliable quality control! We will show you how our customized, AI-powered surface inspection solutions can address your specific challenges. Whether it is reducing scrap, optimizing processes, or meeting strict quality standards, our experienced team supports you with innovative technologies tailored to your needs.

Get in touch today to develop a solution perfectly aligned with your requirements. Invest in the future of quality assurance – smart, precise, and reliable.

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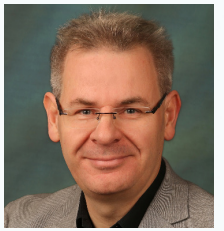

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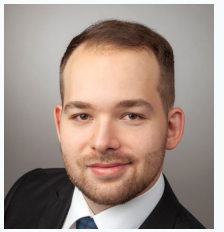

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