Press Release

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ON THE TRAIL OF CRACKS IN STAINLESS STEEL

AIT and voestalpine BÖHLER Edelstahl develop intelligent testing method that automatically finds defects in high-performance steel products

The voestalpine BÖHLER Edelstahl GmbH & Co KG produces high-performance steels and nickel-based alloys for the international aerospace, automotive and oil & gas industries. An intermediate product in the production of stainless steel products are so-called "billets" - these have a square cross-section and are rolled for further processing. It is crucial for the quality of the end products that these rolled billets do not have any defects on their surface, such as slag inclusions or cracks. These would enlarge during rolling and impair the properties of the end products.

If such a defect is detected on the surface, the billet is ground further until the surface is flawless. The optimum grinding treatment and the number of grinding passes required are currently decided by employees:inside who visually scan the surface for defects. "Only those with a trained eye and many years of experience can recognize slag inclusions or distinguish the finest cracks in the steel from grinding marks," reports Petra Thanner, a researcher at the AIT Austrian Institute of Technology. Over the past four years, she has led a project in which work was carried out on behalf of voestalpine BÖHLER Edelstahl GmbH & Co KG in Kapfenberg on an automated process for detecting surface defects in rolling billets. The task is further complicated by the fact that billet surfaces are differently colored and curved depending on the grinding conditions, that the steel surface can be very shiny (which makes camera images difficult to evaluate) and that the inspection has to be carried out directly in the harsh production environment of the rolling mill. "Many an attempt to automate this time-consuming process has failed in recent years due to this plethora of different challenges," reports Siegfried Kleber, head of the process development group at voestalpine Böhler Edelstahl.

Multiple lighting angles

Nevertheless, the experts at AIT in cooperation with voestalpine BÖHLER Edelstahl have now jointly succeeded in developing an innovative testing method and bringing it to industrial maturity.

To do this, the researchers borrowed from the way a person inspects an object. "In most cases, defects in the sub-millimeter range can only be detected under a certain viewing or illumination angle. Therefore, when a person inspects an object, they look at it from different directions," explains Thanner, who conducts research at the AIT Center for Vision, Automation & Control (VAC). This is mimicked by the "Inline Computational Imaging (ICI) technology" developed at AIT: Here, a camera is permanently installed above an inspection object, which moves underneath. The scene is illuminated from four different directions; these are selected in such a way that the difference between cracks and normal grinding marks stands out as clearly as possible.

The raw camera images, on which the defects each have different shadow effects, are further processed in the next step using photometric methods: In this process, in addition to detailed and high-contrast 2D images, an exact 3D model of the surface is also calculated, in which surface defects become even more clearly visible.

Artificial intelligence detects cracks

Artificial intelligence (AI) methods are used to classify these structures either as normal grinding grooves or as defects: An artificial neural network was trained with countless camera images that had previously been manually labeled as to which type of surface structure they were. The AI system learned to reliably detect unwanted defects and to color-code them in the camera images. "The main advantage of our system is that the moving object is recorded with just one camera at several viewing angles and this data is intelligently linked," summarizes Markus Clabian, head of the High-Performance Vision Systems Competence Unit.

The inspection system developed by AIT has now been implemented as a pilot system at voestalpine BÖHLER Edelstahl: In a compact housing that protects the sensors and electronics from the harsh environmental conditions, it inspects the surfaces of the four billet sides directly next to the grinding chamber with an accuracy of 50 micrometers at a speed of 24 meters per minute.

AIT delivers holistic solution

The results are clearly displayed on a screen. With the help of this assistance system, employees no longer have to leave the test stand for the time-consuming visual inspection. This not only makes the work easier for the people concerned, but also enables better utilization of the machines, as it is no longer necessary to shut down the grinding system during the inspection. "The employees:inside were already heavily involved in the development and are now using and further developing the system," reports Plant Manager Peter Markiewicz.

This process once again proves the efficiency of the ICI process developed at AIT, which is already being used in many application areas, such as banknote inspection or in the semiconductor sector. "We can offer our industrial partners holistic solutions - that is, from (optical) sensors that record the data to algorithms that independently decide whether it is a surface defect or not, as in this case," emphasizes Andreas Vrabl, head of the AIT Center VAC.

About the Center for Vision, Automation & Control

The Center for Vision, Automation & Control (VAC) at the AIT Austrian Institute of Technology is a research unit that uses the possibilities of automation and digitalization to initiate and drive innovations for industry. With the Institute of Automation and Control Engineering (ACIN) at the Vienna University of Technology, the Center has an internationally leading scientific cooperation partner in the field of systems and automation engineering. Therefore, it can accompany the entire innovation process from basic research to industrial implementation. This involves the acquisition of information by (imaging) sensor systems via sensor fusion, the combination of physics-based models with machine learning and data analysis concepts, the use of this information in fault detection and isolation, optimization and control, through to cognitive decision-making for autonomous systems. www.ait.ac.at/vac

About AIT

The AIT Austrian Institute of Technology is Austria's largest Research and Technology Organization (RTO) and plays in the top league worldwide in many infrastructure topics. With its seven centers, the AIT deals with the central infrastructure topics of the future and sees itself as a highly specialized research and development partner for industry. AIT's research and technological developments realize fundamental innovations for the next generation of infrastructure technologies in the fields of Energy, Low-Emission Transport, Health & Bioresources, Digital Safety & Security, Vision, Automation & Control and Technology Experience. These scientific research areas are complemented by expertise in Innovation Systems & Policy. As a national and international hub at the interface between science and industry, AIT makes innovation possible thanks to its scientific and technological expertise, experience in the markets, close customer ties and an outstanding research infrastructure.
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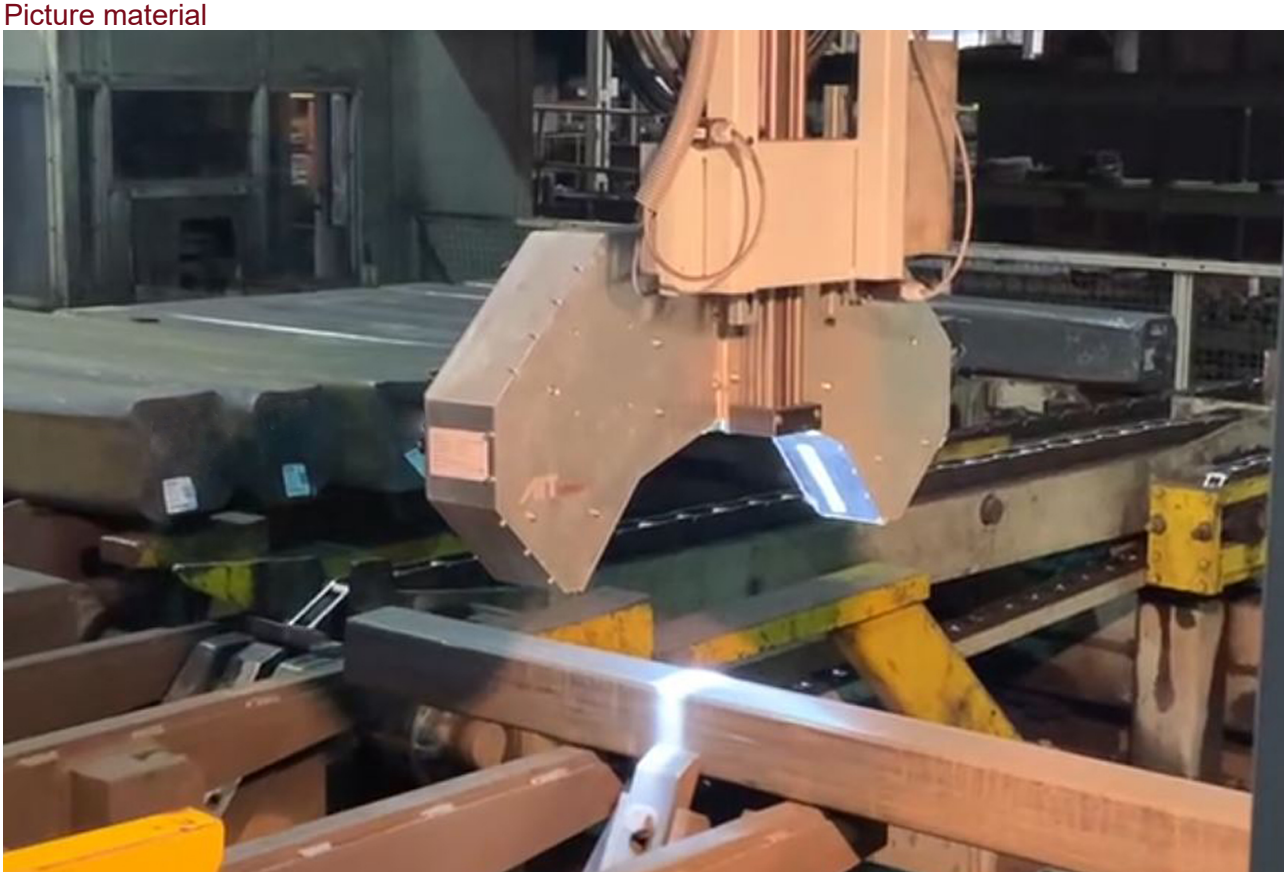

Photo credit: AIT
Caption: The AIT inspection system during the inspection of a so-called rolling billet made of steel.