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3D recognition of transparent objects in less than two seconds

What used to take 15 seconds now takes less than two: thanks to new single-shot technology, the goROBOT3D system, developed by researchers at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF, will be able to measure three-dimensional objects even more efficiently in future – even if they are transparent or black. The institute will be presenting the technology for the first time at the automatica trade show in Munich from June 24 to 27.

What is clearly visible to the human eye poses a real challenge for robotic systems: transparent glass or plastic, reflective metals or deep black surfaces. So-called "uncooperative" surfaces are difficult for conventional sensor systems to detect. Researchers at Fraunhofer IOF are addressing this challenge with the goROBOT3D system, which uses intelligent thermal imaging to detect such surfaces.

Researchers at Fraunhofer IOF have been working on thermal 3D sensor technology for several years. They have now significantly enhanced this technology and achieved efficient optimization for automated object recognition. The measurement and evaluation time for transparent or deep black objects using goROBOT3D has been reduced from 15 to just under 1.5 seconds. To this end, a new projection method for thermal 3D sensors was developed at the institute.

Single-shot instead of serial recording

The method developed transfers a single-shot technology to thermal 3D measurement technology. "With our method, the surface of the measurement scene is heated in a structured manner. A statical thermal point pattern is emitted from the surface of the objects and recorded using two thermal imaging cameras. Using spatial cross-correlation, a 3D result can be obtained from the recorded image pair," explains Dr. Martin Landmann, research scientist in the Imaging and Sensing department at Fraunhofer IOF.

Instead of using fringe projections to generate the pattern as before, two diffractive optical elements (DOEs) now generate an irregular point pattern. Such DOEs use the principle of light diffraction to multiply the incident laser beam and divide it into a pattern. By cleverly combining the DOEs, the researchers were able to project the required point pattern onto the transparent object efficiently and within a very short time for the first time.

From point pattern to gripping command in milliseconds

Previously, a large number of image pairs had to be captured and evaluated for the processing of transparent materials – a time-consuming process. "Instead of capturing several hundred pairs of thermal images, as was the case with the previous method, our newly developed method can reconstruct the 3D information with just a single pair of images within a few milliseconds. This reduces the overall measurement and evaluation time by an order of magnitude," says Dr. Landmann.

The recorded 3D data is analyzed using artificial intelligence. Suitable gripping points and directions are derived and transmitted to a robot arm with a suction gripper. "We use a 'bin-picking' process for this," explains the Fraunhofer researcher. "In other words, the targeted gripping of objects from chaotic environments."

Production processes without cycle interruptions

The drastically reduced recording and evaluation time creates new possibilities for automated industrial processes, for example in production facilities or product design. Not only can robots reliably identify and grip transparent or dark objects, they can also continue working almost without interrupting the cycle. "While one object is being handled, the next measurement can already be taking place. This creates flowing production processes," emphasizes Martin Landmann.

Presentation at automatica 2025

Thanks to its modular structure, the single-shot technology can be flexibly integrated into a wide range of applications. Interested users can see for themselves: The technology will be presented at automatica in Munich from June 24 to 27, 2025. Visit Fraunhofer IOF at the world's leading trade fair for intelligent automation and robotics in Hall 4, booth 319.

About Fraunhofer IOF

The Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena conducts application-oriented research in the field of photonics and develops innovative optical systems for controlling light - from its generation and manipulation to its application. The institute's range of services covers the entire photonic process chain from opto-mechanical and opto-electronic system design to the production of customer-specific solutions and prototypes. At Fraunhofer IOF, about 500 employees work on the annual research volume of 40 million euros.

For more information about Fraunhofer IOF, please visit: www.iof.fraunhofer.de

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goROBOT3D in an exemplary bin-picking scene with objects that are difficult to recognize.
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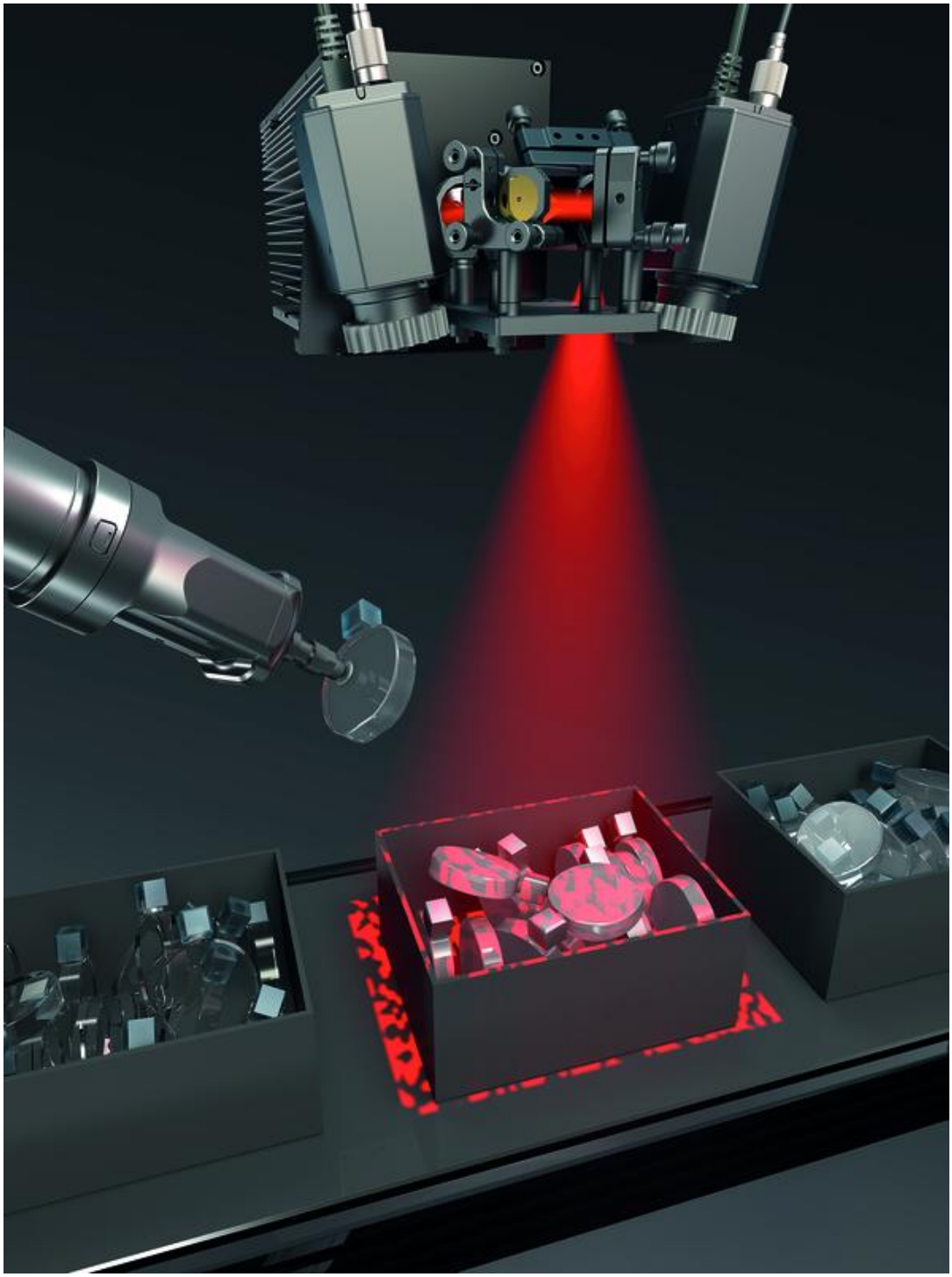

The measurement scene is irradiated with a thermal point pattern in the single-shot method. The 3D result is processed in just a few seconds.
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