

# Monitoring food with millimeter waves

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The millimeter-wave sensor can look through all non-transparent, non-metallic materials. Credit: Fraunhofer FHR

Has the packet been properly filled? Are there impurities in the chocolate? Have the plastic seams been welded correctly? Is there a knife hidden in the parcel? Answers to all these questions are provided by SAMMI, short for Stand Alone MilliMeter wave Imager. The millimeter-wave sensor is able to see through all non-transparent materials. Researchers at the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg have developed the device, which at 50 centimeters wide and 32 centimeters high is no larger than a compact laser printer.

SAMMI can happily deal with all non-metallic materials. “The system

detects wooden splinters lurking in diapers, air pockets in plastic, breaks in bars of marzipan, and foreign bodies in foodstuffs. It can even detect and monitor the dehydration process in plants and how severely they have been stressed by drought,” says Dr. Helmut Essen, head of the FHR’s millimeter-wave radar and high-frequency sensors department. This makes the scanner extremely versatile – it’s just as suitable for industrial product and quality control as for analyzing materials in the laboratory. Because the system can detect dangerous substances such as explosive powder hidden in letters, vulnerable people such as politicians or freight handlers can be protected by millimeter-wave radar.

SAMMI’s most striking feature is its ability to pick out the smallest differences in materials – differences that are invisible to x-rays. SAMMI can for example differentiate between the different fillings of chocolates, or between rubber composites that have similar or identical absorption qualities. Another advantage is that the scanner doesn’t employ ionizing radiation, which can damage health. It is also low-maintenance, not requiring the regular checks necessary with x-ray tubes.

But how does SAMMI work? Inside the system’s housing, there is both a transmitting and a receiving antenna on each of two opposing rotating plates. A conveyor belt transports the sample – perhaps a package whose contents are unknown – between the antennae, while these send electromagnetic waves in a [high frequency](#) of 78 GHz. Different areas of the sample absorb the signal to different degrees, leading the varying material composition across a sample to show up in distinguishable contrast. “Basically we examine the scanned objects for dissimilarities,” explains Essen. The content of the sample appears in real time on the scanner’s fold-out display. If the package contains a knife, even the grain of the handle is discernible. If the handle is hollow, the millimeter-wave sensor would show that, too. The device scans an area of 30 x 30 centimeters in just 60 seconds.

Our system can be operated without safety precautions or safety instructions, and since it weighs just 20 kilograms it's eminently portable. It can also be adjusted to various measuring frequencies," the scientist points out. In future, the researchers aim to "upgrade" the system for terahertz frequencies of 2 THz. "Then we'll be in a position not just to detect different structures but also to establish which type of plastic a product is made from. That's not possible at the moment," says Dr. Essen.

At present, SAMMI is only suitable for spot checks. However, the FHR researchers are working on adapting the [millimeter-wave](#) sensor for industrial assembly lines for the fast, automatic inspection of goods. They envision mounting a line of sensors over the conveyor belt, so that in future products can be scanned at a speed of up to six meters per second.

Provided by Fraunhofer-Gesellschaft

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