High-precision radar for the steel industry

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Researchers of Fraunhofer FHR installing the radar at a strip mill in Eisenhüttenstadt. Credit: Fraunhofer FHR

Steel is the most important material in vehicle and machinery construction. Large quantities of offcuts and scraps are left over from rolling and milling crude steel into strip steel. New radar from Fraunhofer researchers measures the width of the strip during fabrication to an accuracy of micrometers and helps to minimize scrap.

Measuring dimensions precisely is crucial for production engineering –

for instance in the production of steel. Several tons of the material are processed in a steel mill every day. 20 centimeter white-hot ingots of cast steel are rolled out into thin sheet steel kilometers in length and subsequently wound into rolls. The plate steel roars through the rolls at speeds of up to 20 meters per second, But the strip often ends up too wide during this process. The excess edges need to be trimmed off afterwards – and that means a high material losses. New millimeter-wave radar of the Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR in Wachtberg provides assistance here. It measures the width of sheet steel during processing to an accuracy of micrometers. This permits the rolling facility to self-adjust so that less scrap is produced with considerable savings in costs.

Two radar sensors mounted at the side of the rolls measure the distance to the edge of the steel. In principle, the system can be compared with echo-locating by bats. The ultrasound signals that bats emit are reflected back by mice, branches, wires, and mosquitoes like echoes. Bats listen to the echoes from things located in front of them and distinguish prey from obstacles.

"Our radar sends out continuous electromagnetic signals that are reflected by the right and left edges of the strip. The transmitted and received signals are then compared to each other with the help of numeric algorithms. The width of the sheet can be calculated from this comparison," says Prof. Nils Pohl, scientist and head of department at FHR, in explaining the principle of how the system operates. The radar that determines distances of up to several meters with a precision of just a few micrometers, also measures very quickly – 5000 times a second. Silicon chips developed in-house make these values possible.

The system operates reliably in fog, dust, and smoke

An additional advantage: the system operates even under severe

conditions of dust, heat, steam, and fog. "The hot strip steel has to be water-cooled during rolling. This forms dense steam, especially in winter. Lasers and cameras also measure very accurately, of course, but they are not suitable for deployment in environments with high humidity and varying lighting conditions. Radar signals by comparison penetrate dust and fog very well," says Pohl.

Due to its low transmitting power, which is less than that of a cell phone, the radar can be operated in any environment without having to meet additional safety requirements. Since the sensors are mounted to the sides of the rolls, the system can be integrated easily into existing plants. There are presently three steel mills in Germany testing its operation.

In future, the high-frequency radar, which operates with electromagnetic waves above 30 GHz, will be mass produced. This means that the applications are not restricted to just the steel industry. The plastics sector could also benefit from the precision tool – for instance to measure the thickness of pipes. The possibilities and mode of operation of the system will be presented by the researchers from Wachtberg at a workshop on the topic of millimeter-wave radar at Fraunhofer FHR on May 5-6, 2015.

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