Fraunhofer IPM

WIRE-HR

Automatic optical inline inspection of strip materials

WIRE-HR detects tiny defects during the cold forming process of wire using up to six cameras.

In the production of continuous material such as wires, cables, strips and also tubes, rods and profiles, it is not uncommon for surface defects to occur. The WIRE-HR inline inspection system from Fraunhofer IPM relies on very fast, hardware-based image processing in combination with pulsed LED lighting for the quality inspection of wire surfaces in the wire drawing process. This makes it possible to detect and classify defects down to a size of 50 µm using imaging.

Detecting micro-defects

During cold forming of wire, a blank is drawn in several stages through tapered drawing dies at feeding rates of 10 m per second and faster. The dies are subject to severe wear and can therefore damage the wire's surface. Typical defects are draw marks, cross grooves and chatter marks with structure sizes ranging from several millimeters down to 50 µm and less. Common image processing systems fail to detect these micro-defects reliably when inspecting fast-moving wire surfaces.

The imaging WIRE-HR inspection system fully examines the wire surface at feeding rates of up to 30 m per second, thus detecting defects in real-time. A particular new feature of the WIRE-HR system is the possibility to automatically detect and classify periodical defects – as caused for example by transportation rolls. This is achieved by dedicated, highly parallelized, low-level image processing and extremely powerful LED flash lighting.

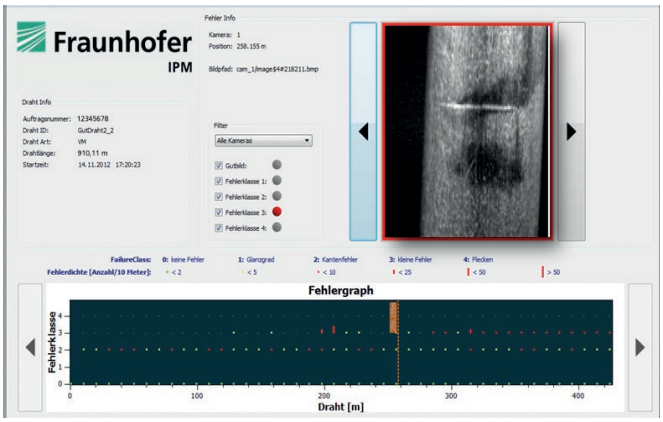
WIRE-HR is used by numerous wire manufacturers for quality assurance.

Recognize, classify and document defects

WIRE-HR quickly and reliably recognizes surface defects such as draw marks, cross grooves, or chatter marks, identifies periodic defects, and indicates their period length. The system classifies the defects and transmits the data to a data base together with information on the wire position, which is measured by an encoder. The wire is inserted easily into the robust, production capable sensor housing by an adjustable conical »trumpet«. The graphical user interface provides an overview of all relevant information about the state of the drawing process and the surface quality of the wire under inspection. Specific defect classes can be linked by the user to extra output channels, e. g. to turn on a warning light or even to stop production. In addition, WIRE-HR provides comfortable means for documentation

Advantages at a glance

- 100% inline inspection of the wire surface
- Feeding rate of up to 30 m per second (min. defect size 50 µm)
- Inspection of round, flat and rectangular wires
- Inspection of wires with various degrees of gloss
- System adjustable to diameter and edge length (diameter of up to 12 mm, rectangular wires up to 20 × 5 mm²)
- Customer-specific developments for other geometries



The software documents the surface inspection as wires are being drawn. All defects can later be examined with the »viewer« that is included.

Live image of the production process: The period length of recurrent errors is shown at the bottom right.

of measurement results by defect classes, defect positions and images of the wire surface and is delivered with a comprehensive CE and UL documentation.

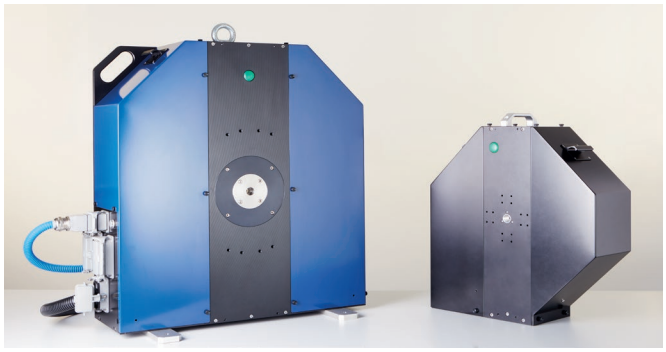
Individual adjustment

The correct lighting is crucial for processing images of moving objects. A specially adapted LED dark field illumination for each camera shortens exposure time to a few microseconds. This creates a still image of the fast-moving wire, so that an optical resolution below 30 µm is achieved over a measurement field width of 12 mm – even in the direction of movement. The system can be adapted to various customer-specific measuring tasks, e. g. larger wire diameters or special geometries such as rectangular wire, flat wire or strip material.

Real-time processing

In contrast to other test methods, such as eddy current or stray light testing, WIRE-HR acquires images of the complete wire surface. This proves to be an enormous advantage for defect documentation and analysis (see info box »Image based defect detection«). The image processing system developed at Fraunhofer IPM relies on strong parallelization of the evaluation algorithms to allow real-time evaluation of the images from up to six cameras.

The WIRE-HR technology solves a number of inspection tasks that cannot be handled by existing image processing systems.



The compact, robust measuring head with special flash lighting is custom adapted to the production process.

Image based defect detection

Established testing methods for wire production, such as eddy current or stray light testing, yield rather abstract measurement signals. These signals do not always allow unambiguous conclusions on the actual defect class. Image based systems such as WIRE-HR boast the additional possibility of an intuitive judgement by the operator by means of an image: The system signals a critical defect, immediately displaying the corresponding image on the monitor so that necessary measures can be taken in time. Especially in the case of rare or new kinds of defects, the image-based method enables defect evaluation, classification and documentation and might help to eliminate the causes behind them.

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