Press Release

Ensuring quality in 3D printing – with Sensors and Artificial Intelligence

Scientists from Hanover and Aachen develop an app for automatic monitoring of print quality in Additive Manufacturing

Hanover/Aachen, Germany, March 9, 2021 – 3D printing enables a batch size 1 production, meaning no products are alike because each part is individually designed for the customer. Among others, this is interesting for the medical technology sector. Additively manufactured dental splints, hearing aids and even implants can be perfectly adapted to the body of an individual patient and still be produced cost-effectively. One challenge for companies, however, is quality assurance. Personalized medical devices are subject to strict safety requirements. Manufacturers must be able to guarantee that there are no invisible cracks or pores in the component and that the geometric requirements and desired material properties are achieved. Scientists from Hanover and Aachen are working on a solution to support small and medium-sized companies in particular in the approval of patient-specific medical devices from the 3D printer: They want to develop an app that helps with quality assurance.

The more individualized the production, the more difficult quality assurance becomes. In the case of goods manufactured in large series, it is often sufficient to carry out quality tests on a few randomly selected products in order to be able to draw conclusions about the entire batch. This is not possible with single-item products. Here, each component must be examined in detail to ensure quality.

Detecting possible defects in patient-specific 3D printed products during production is the goal of a new research project being conducted jointly by scientists at the Institut für Integrierte Produktion Hannover (IPH) gGmbH and the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University.

The researchers want to equip an industrial 3D printer with sensor technology to seamlessly monitor the printing process. The sensor data will be evaluated in an app using Artificial Intelligence via a quality model to reliably detect production errors. The scientists at the IPH and the WZL are focusing primarily on medical technology, because in this industry the degree of individualization of products and the associated quality requirements are particularly high, and proof of a quality assurance system must be provided as part of an approval process. In the research project, the IPH is responsible for sensor technology and data collection, while the WZL is responsible for creating the quality model and programming the app.

Quality in 3D printing is influenced by many factors: the type of material used, the ambient temperature, the temperature at which the filament is melted, the printing speed, the vibrations of the print head and quite a few other parameters. "Additive Manufacturing processes are very sensitive to external influences," says project engineer Anne Rathje from IPH. "Our goal is to get more safety into the process and avoid errors." Particularly treacherous, she says, is that many errors are no longer visible from the outside once the component has finished printing. "For example, if the print head clogs briefly in between and then continues to print normally, you won't see it later," Rathje says.

For the research project, IPH is using the X500PRO industrial printer from German RepRap GmbH. The printing material used is the plastic acrylonitrile butadiene styrene (ABS), which has a comparatively high strength but is very sensitive to temperature.

The scientists want to use various sensors to monitor the print quality. Conceivable options include sensors that measure the temperature of the build plate or build chamber, infrared sensors that can be used to determine the temperature directly at the print head, vibration sensors and optical measurement technology, which IPH has already investigated in the Quali3D research project.

Acoustic signals – in simple terms, sound recordings – are also useful for quality monitoring. These could be used, for example, to determine if the print head is clogged or if the filament breaks in the system. "You can hear that," says Anne Rathje. "The challenge, however, is to process the signals in such a way that ambient noise is filtered out" – for example, the whirring of the motor in the 3D printer, the noise of the computer or a slammed door. To distinguish important from unimportant sounds, the researchers want to use Machine Learning, a form of Artificial Intelligence. By training the program with as many sound recordings as possible, it learns better and better how to reliably detect errors based on acoustic signals.

Ultimately, the goal is to develop an app that automatically evaluates all sensor data. "Our goal is to reduce the effort involved in quality assurance in 3D printing and also to enable laypersons to monitor the print via an intuitive app," says Anna-Lena Knott from the WZL. Users do not have to interpret the sensor data – the app monitors the entire printing process, documents errors and provides feedback on print quality. In the event of serious errors that could render the component unusable, the app stops the printing process and informs the user. The print settings can then be adjusted and specialist personnel called in if necessary.

The IPH and the WZL are working closely with industry on the research project. The project advisory committee includes manufacturing companies from medical and dental technology and other industries, as well as manufacturers of 3D printers. Interested companies still wishing to participate in the research project should contact Anne Rathje (0511 279 76-228 or rathje@iph-hannover.de) and Anna-Lena Knott (0241 80-20600 or a.knott@wzl.rwth-aachen.de). The kick-off meeting for the project launch is expected to take place in mid-April 2021 as an online meeting.

The research project, titled "Sensor and app-based validation of process and product quality for effort-reduced certification of personalized medical devices (SAViour)," will run until January 2023 and is funded by the German Federal Ministry for Economic Affairs and Energy. Further information can be found at saviour.iph-hannover.de.

About the IPH

The Institut für Integrierte Produktion Hannover (IPH) gemeinnützige GmbH (which literally translates into Hannover institute of integrated production) researches and develops in the field of production technology. The company was founded in 1988 out of the Leibniz University of Hannover. IPH offers research and development, consulting and qualification in the fields of process technology, production automation, logistics and XXL products. Its customers include companies from the tool and die, mechanical and plant engineering, aerospace and automotive, electrical and forging industries.

The company is based in the Marienwerder Science Park in the northwest of Hanover and currently employs around 70 people, about 30 of whom are scientific staff.

About the WZL

The Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University enhances the innovative strength and competitiveness of the industry with trendsetting basic research, applied research and the associated consulting

and implementation projects in the field of production technology. In the research fields of manufacturing technology, machine tools, production engineering, gear technology as well as production metrology and quality management, practical solutions for rationalizing production are developed with industrial partners from a broad range of branches.

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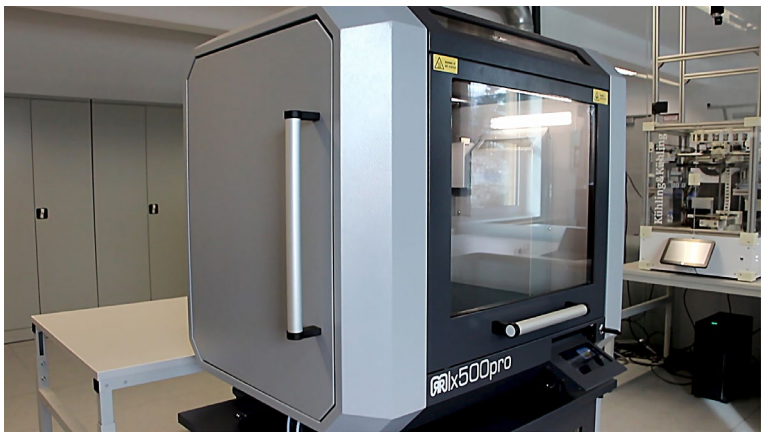
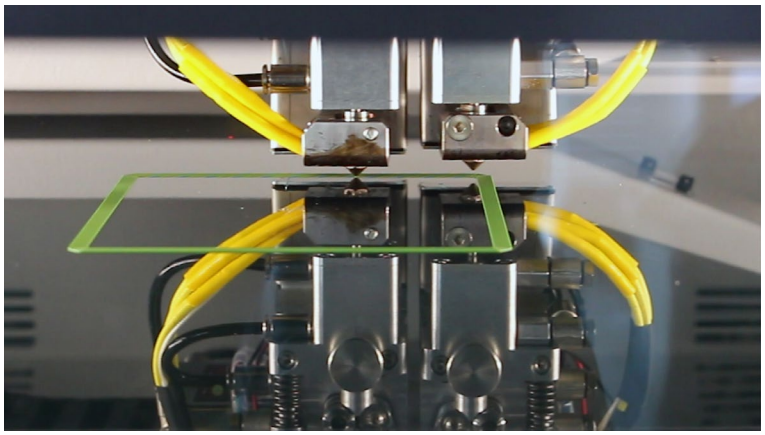
Images

3D-printed dental splints: Medical products can be individually adapted to the patient's body thanks to Additive Manufacturing and still be produced cost-effectively. (Picture: © Ulbricht Dental-Technik)

3D printers in the dental lab: Rainer Ulbricht Dental-Technik GmbH already uses Additive Manufacturing and participates in the SAViour research project. (Picture: © Ulbricht Dental-Technik)



Professional 3D printing system: In the research project, IPH uses the X500PRO industrial printer from German RepRap GmbH and equips it with sensor technology. (Picture: Désirée Binder / IPH)



Quality monitoring: The scientists will attach sensors to the printer to detect faults such as a clogged print head. (Picture: Désirée Binder / IPH)