Fraunhofer

TRENDS FOR THE CONNECTED FUTURE

CONTENT

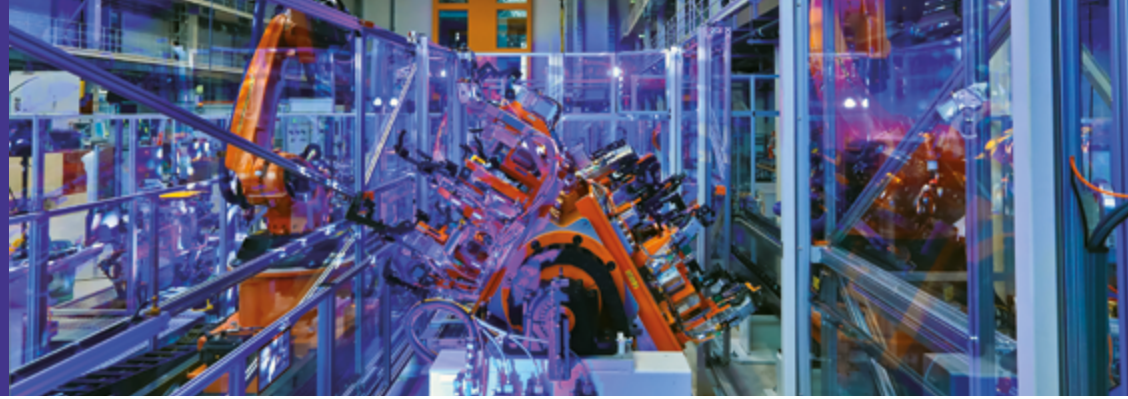
CONNECTED, DIGITAL, INDIVIDUALIZED

Digitalization is one of the most important topics for the economy of the future. Cognitive machines capable of transferring the knowledge they have learned to new situations will play a decisive role in the digital transformation. These systems plan processes, make predictions and even interact with humans. However, this billion-dollar market still requires considerable research and development. We are ideally equipped for this task by dint of Fraunhofer's strength in mechanical engineering – in robotics, automation technology and plant engineering – and in the field of information technology.

We are also strong in the field of sensors, actuators and data capturing. This know-how is an ideal starting basis for Industrie 4.0. In the future, entire production plants will be visualized at the virtual level. Multiple sensors record the operating status of the machines and pass the data on to the control center. Human operators have a real-time overview of the production flow and can intervene if required. It also becomes possible to manufacture individual and one-off parts without stopping production.

In this brochure, we shed light on cognitive machines and other key technologies as well as innovations in automation technology. For example we discuss the new wireless communications standard 5G, which creates the requirements for the tactile internet and will realize its innovation potential in the sphere of Industrie 4.0. Another innovative concept is the digital twin, which allows mechanical engineers to use the possibilities of digitalization to increase efficiency and quality. The technology facilitates optimized machine design, uncomplicated commissioning, short changeover times and error-free operation. In addition, we are responding to the growing demand for individualized industrial products with the "Go Beyond 4.0" lighthouse project.

Prof. Dr. Reimund Neugebauer



"GERMANY'S STRENGTHS LIE WHEREVER HIGH QUALITY IS NEEDED RATHER THAN GLAMOUR"

How is Germany positioned with respect to digitalization? Are we missing out on a market of the future? Prof. Dr. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft, addresses these questions.

Professor Neugebauer, laments about the lack of innovative strength here in Germany have become almost routine. SMEs in particular are too slow, goes the complaint, and cannot hold their own against the Anglo-American or Asian competition. What do you make of such clichés?

My view of the German economy is much more positive. In 2015, companies invested some 157 billion euros into the development of new products, more than ever before. Moreover, these investments are predicted to rise to 165.7 billion euros in 2017. Expenditure on innovation as a proportion of revenue increased to 3 percent, which is also a record high. These figures, taken from the recent study by the Centre for European Economic Research (ZEW), are enough by themselves to prove Germany's high innovative strength.

Where does it come from, then, this dismissive view so clearly at odds with the results of the ZEW study?

More than anything, it comes from the fact that our strengths lie wherever high quality is needed rather than glamour: high-quality and efficient manufacturing, for instance. Also, system-level software – embedded systems – is an area that plays to the strengths of German industry. These systems are used in several sectors, including the automotive industry. We're also strong in the fields of sensors, actuators and data capturing. This know-how is an excellent basis for the megatrend of Industrie 4.0. Behind this buzzword stands the vision of intelligent manufacturing whereby all machines and workpieces are networked and communicate with each other. The result is a factory capable of organizing itself and responding flexibly at all times to changing production needs and requests.

How is Fraunhofer helping to prevent the German economy from falling behind internationally when it comes to digitalization?

Our job is to translate visions like the one I just mentioned into market-ready solutions. To cite one example: the Fraunhofer Institute for Production Systems and Design Technology IPK in Berlin has developed a method for visualizing the entire real manufacturing plant at the virtual level. A variety of sensors register the operating status of the machines and transmit the data to the control center in industry-compatible standard formats and protocols. This creates a digital twin that allows human operators to monitor the complete production flow in near real-time and intervene if necessary. Small batch sizes and custom builds can be realized without having to stop the whole production line.

What are the prerequisites for the success of Industrie 4.0?

Genuine high-speed internet with low latency is absolutely vital. Here, Fraunhofer is working on the mobile communications technology known as 5G; at more than 10 gigabits per second, it's a hundred times faster than current LTE networks. This makes it possible to achieve latencies of 1 millisecond or lower. With 5G, a decisive platform is being created for real-time applications, which are essential for safe process con-

trol in areas such as digital factories, telemedicine, self-driving cars and smart homes. Several Fraunhofer Institutes are engaged in this complex project.

Such data-intensive applications in industry and business bring up questions about security.

Correct. And Fraunhofer has taken the initiative here, too. Together with industrial partners at the European level and with support from the German government, we initiated the Industrial Data Space project. Its goal is to create a secure virtual space where companies and business partners can work together on projects and exchange data without handing over control of their data. This works with the aid of software connectors that share the information only between partners with a certified ID.

Researchers at the Fraunhofer Institute for Applied and Integrated Security AISEC have developed security architecture and initial solution concepts for this key connector component. In this way, companies retain full sovereignty over their data. The lead partners for Industrial Data Space are the Fraunhofer Institutes for Material Flow and Logistics IML and for Software and Systems Engineering ISST. These are just a few examples of the tremendous high-tech expertise that Fraunhofer can bring to the table in collaborations with German industry.

Where do we need to catch up? What measures must we take if German companies are to retain their place among the best in the world?

We shouldn't try to gloss over the fact that there are weaknesses as well. Regarding e-mobility, we have to be careful that we don't lose touch with the leading players, and we must intensify our work on battery cell technologies for electric cars. In the area of smart data – analyzing and recognizing patterns in large amounts of data – U.S. companies currently have the edge. Consequently, the development of complex algorithms for data analysis and methods for machine learning, particularly for deep learning, should be a top priority.

This is one of the reasons why Fraunhofer has brought together 28 of its institutes in a Big Data Alliance: it not only researches new methods of machine learning (deep learning), but also helps companies optimize their business models with big data solutions. Another of our numerous initiatives is sponsored by the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS, which offers training courses specifically designed for data scientists and analysts.

Does German thoroughness sometimes get in the way of speediness? Do we have to shift up a gear for digitalization?

Training courses and preparation may actually be an area that is one of Germany's most important strengths: the ability to approach technological challenges carefully and methodically. If this German thoroughness gives the impression that we're too slow, we just have to sell ourselves better. Plus, we have a different innovation culture than what they have in the United States, for example. For the most part, German SMEs tend to be practitioners of a kind of evolutionary innovation, as opposed to starting something entirely new.

Fraunhofer's goal was and is to promote scientific and economic sustainability, through originality that empowers companies to make disruptive innovations and through projects that clarify system-relevant research questions. Fraunhofer will continue to contribute its scientific excellence and, in close collaboration with business, to develop technological innovations that serve as the basis for new digital business models. And as far as we're concerned, we're more than happy if this includes innovations that make it to the market sooner rather than later.

NEW IT SECURITY METHODS FOR INDUSTRIE 4.0

Traditional IT security approaches are hardly suitable to secure Industrie 4.0 production facilities. Fraunhofer is developing new methods that support the agile, decentralized and autonomous structures of Industrie 4.0.

Security tools for Industrie 4.0 have to secure not just trade secrets such as construction plans, manufacturing processes and entire business models, but also the people involved. At the same time, the tools must be able to quickly identify if hackers are manipulating the manufacturing process. Conventional virus scanners and attack recognition systems are limited in their capabilities. They are often far too slow to guarantee smooth operation of a production facility. They also require precise knowledge of the system architecture and the normal operating conditions of an IT environment. In comparison, the extreme agility of Industrie 4.0 IT structures allows them to constantly change their architecture, even when production takes place simultaneously in many locations.

IUNO project

The Fraunhofer Institute for Secure Information Technology SIT in Darmstadt is working on new and suitable security methods as part of IUNO, a project initiated by the German Federal Ministry of Education and Research (BMBF). One method detects irregularities in the communication networks of production facilities. The other monitors the integrity of the components involved in the manufacturing process, raising an alarm when it detects unauthorized attempts at interference.

A system based on machine learning is used to identify operating anomalies of a facility. The system analyzes the data flowing from all elements involved in the manufacturing process with the help of software-defined networking (SND). After a short learning phase, the system can tell if specific processes in the network are part of normal operation or if they represent a deviation. It manages to do this even without detailed knowledge of the production facility's system architecture or of how an attack takes place.

Hardware and software components as well as Trusted Computing (TC) technology protect the machinery and other elements in the production process. The control station displays any changes made to an element's desired state, thus exposing any attempts at manipulation and allowing countermeasures to be implemented. This technology also resets devices to operate reliably following an identified attack.

Cybersecurity Training Lab

Germany is facing a real shortage of IT security specialists. To ensure that the country does not fall behind in the arms race with cyber criminals, Fraunhofer has opened cybersecurity training labs across Germany. The goal of this initiative is to improve the expertise of IT teams and managers who work with the authorities and in companies. Several Fraunhofer Institutes and a select group of universities have collaborated on a modular, part-time concept that incorporates the latest research findings into the study program. The initiative, which is funded by the German Federal Ministry of Education and Research (BMBF), has already been launched in Görlitz and Weiden i. d. Oberpfalz.

http://s.fhg.de/cstl

SECURE DATA HUB

Twelve Fraunhofer Institutes are working on a secure data platform for German industry: Industrial Data Space. A project led by the Fraunhofer Institute for Software and Systems Engineering ISST demonstrates the benefits of this approach for more efficient truck dispatching. Meanwhile, the Fraunhofer Institute for Applied and Integrated Security AISEC is developing solutions for secure data exchange.

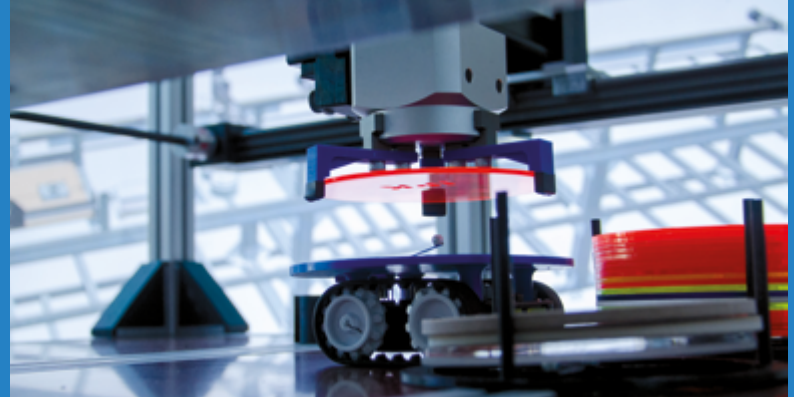
Accidents, roadblocks and traffic jams are everyday nuisances for truck drivers. Often, traffic chaos obstructs them from keeping to scheduled loading times – a stressful situation for truckers. Thanks to a new smartphone app, truck drivers will be able to respond to such scenarios in a more relaxed way in the future. Drivers can report their position, the traffic jam and their estimated arrival time. The trucking company's dispatcher is also connected via the app with the other drivers in the fleet and has access to the logistics service providers' data. In a matter of minutes, a new time window has been found for loading a different truck. Fast logistics planning is a real use case for the topic of logistics and supply chains, which the Industrial Data Space consortium is researching and implementing. The goal is to create a shared data space, where companies can connect securely with each other via standardized interfaces while retaining absolute sovereignty over their data.

Sovereignty over data

Industrial Data Space offers this sovereignty. According to plans, it will become a huge marketplace one day, where companies can offer and share data. Who is to be allowed to see what data, and who is not – and whether they have to pay for the privilege – is the prerogative of each data owner.

A connector developed by the Fraunhofer-Gesellschaft will establish a connection between the companies and the platform. This digital interface between the firms supports many protocols, such as those used in web services. For example, the security technologies underlying this connector were developed by researchers at Fraunhofer AISEC. The connector links the company's data and distributes it in the Industrial Data Space. Conversely, it forwards queries from there to systems inside the company. The connectors can be supplemented by apps in a wide variety of programming languages that filter and transform data. In the project, the Fraunhofer researchers want to develop prototypes of some connectors and apps for the reference architecture and illustrate their usage based on typical use cases. Companies will be able to use these use cases or else develop their own connectors and apps. "There will be different variants that all work together. This is guaranteed by Fraunhofer's reference architecture, including the certification process," says Prof. Boris Otto, head of research at Industrial Data Space and director of Fraunhofer ISST, which manages the use case for logistics.

Steel producer Salzgitter AG demonstrates how customer systems can be integrated at little cost and effort through the use of Industrial Data Space, taking the example of the transmission of warehouse data. Data exchange between customer and supplier systems is carried out on an automated, secure and encrypted basis via an automatic interface using smart data apps. Customers can query whether the type of steel they want will be in stock for their desired date, and the supplier system tells them how much is available. The mapping of master data is automatic. "Laborious manual data synchronization can be dispensed with entirely," says Prof. Heinz Jörg Fuhrmann, Chairman of the Executive Board of Salzgitter AG, explaining the benefit of Industrial Data Space.



INDUSTRIE 4.0: VIRTUAL TWIN CONTROLS PRODUCTION

Fraunhofer IPK is turning the vision of Industrie 4.0 into reality with an innovative approach. A digital twin simulates the entire manufacturing process and permits direct interaction with production at all times. Real and virtual merge to form an intelligent overall system.

Efficient production control is a key industrial technology. So at first, the notion of building two parallel factories instead of one may sound like nothing but doubling of effort. But what if one of the factories existed only in virtual form? This is the basic idea behind an innovative approach from the Fraunhofer Institute for Production Systems and Design Technology IPK in Berlin. The real factory is fully modeled at the digital level, creating a virtual twin that not only visualizes the production system with all its machines, but also reproduces the dynamic processes and the behavior of system components during production in real time. Using the virtual twin makes it possible to observe manufacturing in detail. Numerous sensors, virtual and real, continuously feed the operating status of individual workstations to the system. Production planners can simulate the manufacturing process in the digital model and then optimize or reorganize individual steps as required.

However, the digital twin does more than merely simulate the real production facility. The system is actually bidirectional. At the virtual level, you can intervene and make changes that can be simulated immediately. Conversely, you can load changes in the real system into the digital twin. Accordingly, a production manager can activate additional machines to process a workpiece or incorporate an additional work step when a custom build is required. To do this, ongoing production does not have to be stopped and reconfigured; the system instead reacts intelligently to every change and reorganizes itself.

A merging of real and digital production

The merging of real and digital production results in an overall system that monitors, controls and corrects itself during production. Whenever required, machines and software communicate with each other autonomously and keep production moving. If a fault arises – such as the failure of a subsystem – the system can decide independently how to resolve the problem. The production manager can see the change in production, but does not have to intervene. In addition, because the system continuously feeds the digital twin with data, it is possible to permanently check the quality of workpieces and end products. It is also possible to quickly manufacture small-scale series with individualized parts in such a way as to cause minimal disruption to overall production.

Fraunhofer researchers had to custom-design many of the technologies for the digital twin. "We want to do without proprietary components entirely and for all interfaces to be 100 percent compatible with industrial standards," explains Prof. Dr.-Ing. Rainer Stark, project manager at Fraunhofer IPK. The sensor technology used is just one highlight. The engineers use a combination of physical and virtual sensors, whereby the virtual sensors process complex data sets about the status of the system, which would not be measurable using physical sensors alone.

COMPONENTS WITH RESPONSIBILITY

Industrial manufacturing follows rigidly programmed processes, in which individual work steps and machines are precisely scheduled. Fraunhofer researchers are developing software for a more flexible production process: each component tells the machines what should be done with it and makes its own way through the process chain.

In today's manufacturing, many complex components – such as engine blocks – are processed by several machines in linked processes. The sequence of work steps as well as the requisite machines and devices are precisely defined in a sort of roadmap. If machines break down or components have to be prioritized at the client's request, the factory must reschedule production at great expense or retool the machines. Researchers at the Fraunhofer Institute for Production Technology IPT are developing a production system whereby each workpiece contains the information which steps it must take through production. In other words, the component behaves like an individual. First of all, information is saved for each component, prescribing what manufacturing steps it should go through. It is deliberately left open which machine is supposed to carry out the respective processing steps. Only when a processing step is actually pending does the system choose the soonest available machine out of all the machines with suitable capabilities for the task.

A crucial element of the system is that, for each step, it needs to be documented which task was carried out and what the component experienced: "Hole drilled with machine parameter A and tool X", "Edge ground with machine parameter B and tool Y". This is how the software documents the production history for each component, resulting in a digital twin. Components bear an ID code that allows them to be recognized. "Service-oriented architecture for adaptive and networked manufacturing" is how the researchers refer to their innovation.

Manufacturing one-of-a-kind products thanks to digital twins

The goal is to use this software to create a digital twin for each component. Thanks to these twins, factories always know how components were processed and which steps come next. This strategy is particularly important for companies whose production machines handle whole series of different components. In conventional manufacturing operations, systems must be stopped, reprogrammed and retooled before transitioning to a new product. With the service-oriented approach, by contrast, the product itself tells the devices what needs to be done. "By connecting components and machines, factories will be able to manufacture one unique product after another in the future," says Sven Jung, project manager at the Fraunhofer IPT. To this end, all process data for the respective component are made available in the form of a digital twin in a »Smart Manufacturing Network«.

Plug-and-produce

Another prerequisite for flexible production is that machines from different manufacturers can be integrated easily into the manufacturing network. At the High Performance Center for Networked Adaptive Manufacturing, the Fraunhofer IPT and its partners from research and industry are therefore working on the integration of the various manufacturer systems into an overarching software and data platform. This kind of plug-and-play, so familiar from everyday consumer technology, does not exist yet in industry.

Prof. Dr. Stefan Wrobel, Director of the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS

COGNITIVE MACHINES – A MARKET OF THE FUTURE

Cognitive machines are among the innovations that will have a major influence on the economy and society. Information systems with ever increasing intelligence are advancing into many areas of work and life. An interview with Prof. Dr. Stefan Wrobel, Director of the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS, about the effects, opportunities and risks of artificial intelligence in the workplace.

Professor Wrobel, cognitive machines are a billion-dollar market that still requires a lot of research and development. What are Fraunhofer's core competencies?

Fraunhofer is very strong in the core competencies for cognitive machines, i. e. machine learning, Big Data and Artificial Intelligence. We combine this with our expertise in engineering, robotics, automation technology and plant engineering.

Through what measures does Fraunhofer want to promote the cognitive machines megatrend in Germany and translate it into innovations?

We're aware of the particular responsibility that current developments entail. Consequently, the Fraunhofer-Gesellschaft has set up lighthouse projects in this area and is currently establishing research clusters, in which the leading institutes in the relevant subject areas work together to address these questions. Fraunhofer is focusing on research and fundamental innovations as well as on the transfer of scientific results in Artificial Intelligence and machine learning into industry.

Cognitive systems are conquering more and more application terrain and helping people make better decisions. What are the main development trends in robotics? What are the drivers of and obstacles to market penetration?

Meanwhile, robots have also become highly adept at precision engineering tasks. In other words, aside from carrying out physically demanding jobs such as lifting car bodies back and forth, the machines are also capable of executing complex manufacturing tasks.

Artificial neuronal networks play an important role in this regard. Current obstacles include the fact that users still lack know-how, and Fraunhofer sees itself as having an important job to do here.

What significance do cognitive machines have for the autonomous factory and for industrial manufacturing?

A substantial one. We can assume that in the near future, machines will be able to handle – or at least partly handle – everything that is a process: work process, planning process, booking process, logistics chain. These machines will also be able to master challenging cognitive tasks. With the development of Industrie 4.0 and the increasing integration of sensor data into industrial manufacturing, there is huge potential for self-learning and cognitive machines.

How will machine learning change the employment market? In what areas do you think big changes are possible?

It's likely that a significant number of jobs or tasks for which there is currently a lot of demand will soon be done by machines. And this very much includes jobs that require specialist knowledge, as in a whole range of design and planning tasks and in areas such as contract analysis.

How can the economic benefits of the new technologies be made available to society at large?

Productivity will grow, quality will increase, new products and services will become possible, and creativity will be unleashed. Increases in efficiency are to be expected, and if we make proper use of the potential this frees up, then there may be more time for human interaction. Jobs with strong social aspects are jobs that machines will not and should not do, not even in the long term.

The digitalization of society also has a clear moral dimension when it comes to things like surgical robots. What ethical questions need to be answered here?

In general, there is a whole range of ethical questions. Indeed, society needs to decide how to deal with intelligent machines, whether we can trust them and to what extent we should trust them. Questions of legal liability and also of morality arise wherever jobs are replaced, even if others are created elsewhere. In connection with debates around a solidarity-based society, for example, the idea of a universal basic income has been discussed as a way of offsetting the negative aspects of these developments – here science and society must work together to find the right answers.

GLOSSARY

Cognitive systems ingest digital information from sensor data and networks. These systems then apply learning algorithms to the information to derive conclusions, decisions and actions as well as perform verification and optimization functions in dialog with their environment.

Machine learning refers to techniques and processes whereby repetition of a task enables an algorithm or a machine to perform the task better and better with regard to a performance index.

Artificial Intelligence (AI) is a branch of information science concerned with giving machines capabilities that mimic human intelligence. AI can be achieved by means of preprogrammed rules or machine learning.

http://s.fhg.de/cognitivesystems

IMPLEMENTING PROCESS INDUSTRIE 4.0 WITH INTERCONNECTED PROCESS SYSTEMS

As far as the process industry is concerned, it's still a long road to Industrie 4.0. That is why Fraunhofer researchers and engineers are developing interconnected process systems that enable both maintenance assistance and predictive maintenance.

Industrie 4.0 will raise manufacturing to a new level: Systems will become intelligent and will interconnect, thus enabling flexible manufacturing. As far as the process industry is concerned, version 4.0 is still in its infancy in many companies – there are only sporadic research projects. This makes the modicum of research being done, such as a project at the Fraunhofer Institute for Factory Operation and Automation IFF that is being funded by the Federal Ministry of Education and Research, all the more significant.

The researchers and engineers are developing the interconnectivity of process systems in three dimensions: The first dimension spans the life cycle by using planning data for operational support. In the second dimension of vertical interconnectivity, sensors send their data to the cloud where the researchers and engineers in Magdeburg combine operational data with employees' experience for predictive maintenance. The researchers and engineers use data analysis methods that could be subsumed under Artificial Intelligence. The third dimension is horizontal interconnectivity with the supply chain. Interconnectivity is based on the system's digital map, i.e. its digital twin. A fluidized bed granulation plant that processes granules is serving as the technology demonstrator.

"GO BEYOND 4.0" LIGHTHOUSE PROJECT HAS BEEN LAUNCHED

The demand for tailored industry products is on the rise. In order to conduct the considerable amount of research required, Fraunhofer has launched the "Go Beyond 4.0" lighthouse project. Several of its institutes are combining their competencies to develop digital print and laser processes for customized mass production.

Automation, digitalization and connectivity of industrial mass production is a key challenge of the 21st century. Particularly companies in promising markets such as automotive, consumer electronics, manufacturing and lighting need to retain the economic advantages associated with the mass production of customized products. Fraunhofer's "Go beyond 4.0" lighthouse project links conventional manufacturing methods with cutting-edge technologies and digital production processes. Six Fraunhofer Institutes are combining their competencies in digital print and laser processes to make customized mass production a reality: the institutes for Electronic Nano Systems ENAS in Chemnitz, Laser Technology ILT in Aachen, Manufacturing Technology and Advanced Materials IFAM in Bremen, Applied Optics and Precision Engineering IOF in Jena, Silicate Research ISC in Würzburg, and Machine Tools and Forming Technology IWU in Chemnitz. Fraunhofer is developing three demonstrators for the automotive-manufacturing, aviation and lighting-technology industries: "smart door", "smart wing" and "smart luminaire". In addition, Fraunhofer has allocated eight million euros to this internal project.

http://s.fhg.de/gb40

5G: ULTRAFAST INTERNET

The new 5G wireless communications standard offers lightning-fast data transfer rates of 10 gigabits a second coupled with an incredibly low latency of no more than one millisecond – helping achieve the vision of a tactile internet. Multiple Fraunhofer Institutes are working on technologies that will allow for the real-time data transfer.

While today's 4G LTE standard might be enough for the average smartphone user looking to surf the web and stream videos, in this era of Industrie 4.0, 300 megabits a second is no longer enough. But help is on hand in the form of the new 5G wireless communications standard, which achieves download rates of 10 gigabits a second and an ultra-low latency of one millisecond. This paves the way for wireless machine operation in real time, with the machine responding so quickly that the user cannot perceive any delay. Experts call this the tactile internet.

Researchers at the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, HHI, have successfully demonstrated that these levels of performance are no mere pipe dream. "In fact, we already possess some very product-specific solutions," says Prof. Slawomir Stanczak, joint Head of Fraunhofer HHI's Wireless Communications and Networks department.

Fraunhofer experts are also involved in the joint IC4F (Industrial Communication for Factories) project, which is launching this spring. Together with partners from research and industry, they are developing a secure 5G communications and computing infrastructure with real time capability. Policy-makers have also grasped the importance of the topic; the project will be receiving 10 million euros in funding from the German Federal Ministry for Economic Affairs and Energy (BMWi).

Ultimate data transfer reliability

Reliability is key to the successful implementation of 5G, and researchers at Fraunhofer HHI are hard at work on new technologies in this field. "Mobile edge computing," for instance, ensures that the information generated by sensors is pre-filtered at the local nodal points before being transmitted over the network. The data packets are then pre-sorted when they arrive at the receiver, allowing them to be processed faster. This boosts the efficiency of the entire system.

This combination of rapid data transfer, ultralow latency and ultimate reliability opens up applications that might sound like science fiction to us today. Automated vehicles, for instance, could be in constant contact with each other and with traffic management centers, allowing them to travel in tight columns and accelerate and brake at the same time. Teleoperation could also become a reality thanks to 5G, with surgeons at the hospital in Chemnitz able to use a robot hand to operate on a patient in Cologne reliably and in real time. There will also be opportunities to innovate with 5G in the domain of Industrie 4.0. Potential scenarios include controlling robots via an ultrafast wireless connection that gives the user the feeling that they are standing right next to the robot and operating it using buttons and a joystick.

In a bid to establish the 5G standard on a European scale, Fraunhofer HHI is also involved in other projects such as FANTASTIC-5G. The goal here is to develop a flexible, universal and scalable interface for 5G wireless communication networks. Other cooperation partners include Intel, Nokia, Huawei and Samsung, and the project is receiving funding of eight million euros from the European Union.

http://fantastic5g.eu/

COMPLEX 3D DATA ON ALL DEVICES

A new web-based software platform is swiftly bringing the visualization of 3D data to every device, optimizing the use of, for example, virtual reality and augmented reality in industry.

If you want to be sure that the recipient you are sending documents and pictures to will be able to open them on their computer, then you send them in PDF and JPG format. But what do you do with 3D content? Fraunhofer Institute for Computer Graphics Research IGD from Darmstadt is presenting a solution to this problem in the form of its "instant3DHub" software. It allows engineers, technicians and assemblers to use spatial design and assembly plans without any difficulty on every device.

The software autonomously selects the data to be prepared, by intelligently calculating, for example, that only views of visible parts are transmitted to the user's device. These computations are especially useful for VR and AR applications, for example in car maintenance use cases, as at any given moment exactly those objects being focused have to appear on the display in real-time.

These technologies are also relevant for augmented reality if a link between CAD data and the real production environment is required. Ultimately, however, the solution is of interest to many sectors. Even in the construction and architecture field, where it can be used to help visualize building information models on smartphones, tablet computers or data goggles.

http://instant3dhub.org

CONNECTING MACHINES TO INDUSTRIE 4.0

A Fraunhofer solution integrates existing machines into modern production systems: the PLUGandWORK™ cube automatically generates a communication server for data exchange with other systems.

Today, the consistent implementation of Industrie 4.0 still often fails because older machines and manufacturing equipment that do not yet have the necessary interfaces are still in use. The Fraunhofer Institute for Optronics, Systems Technologies and Image Exploitation IOSB in Karlsruhe has developed a solution to this problem: the PLUGandWORK™ cube. In the first step, the solution creates the self-description of the machine on the basis of the XML data format Automation Markup Language. With this model, the cube automatically generates the communication server in the second step for exchanging information with other machines and the superordinate production control. In principle, the connection is very similar to the installation of a USB device, such as a printer, on the office PC. Use of a PLUGandWORK™ cube not only frees individual manufacturing devices from their isolation. It offers a further, decisive advantage: Data from the connected machines can also be stored on the cube. Data security is ensured: All data is transmitted in encrypted form, and only authorized devices can connect with the system.

Designed for medium-sized firms

Depending on the complexity of their data and parameters, up to twenty machines can be connected to a single cube. Even medium-sized companies with only a few machines can integrate them into the production control.

HIGH PERFORMANCE CENTERS: REACHING THE APPLICATION STAGE FASTER

High performance centers bring a region's universities, companies and research organizations together in one place. Establishing a high performance innovation system with international standing is the goal.

At high performance centers, the partners jointly develop a binding, fully elaborated roadmap for research and teaching as well as the transfer of innovation and knowledge. Companies of all sizes benefit from a combination of excellent research, teaching, education, training, knowledge transfer and commercial exploitation. From the beginning, there are strong industrial partners on board, who act as clients for the research in the joint projects. To date, Fraunhofer has identified 17 locations in Germany. Examples related to digitalization include The Berlin Center for Digital Transformation, Smart Production in Chemnitz, Simulation- and Software-Based Innovation in Kaiserslautern and Secure Connected Systems in Munich.

Digital transformation

In Berlin, four Fraunhofer Institutes cooperate with regional universities and businesses. The partners pool their expertise e. g. in ICT, data processing, data preparation and manufacturing as well as the development of electronic systems. Partners also research basic and interface technologies as well as solutions for four areas of application: telemedicine; mobility and cities of the future; industry and manufacturing; and critical infrastructures.

Smart production

In Chemnitz, the High Performance Center for Smart Production is being established. Two Fraunhofer Institutes, Chemnitz University of Technology and local industry are involved in the center. Organizations engaged in manufacturing, materials research, lightweight-construction research and electrical engineering collaborate on an interdisciplinary basis to develop new technologies regarding digitalization in manufacturing. For example, the "LinkedFactory" data integration platform creates a virtual factory based on data from multiple sensors in the production system, process and component.

Simulation- and Software-Based Innovation

Both Fraunhofer Institutes in Kaiserslautern as well as the University of Technology, the University of Applied Sciences and renowned application-oriented research institutions in Kaiserslautern pool their expertise in Simulation- and Software-Based Innovation. In cooperation with partners from industry, application-oriented research is carried out in the R&D labs into subjects such as applied system modeling, high-performance computing and Big Data, as algorithms and software systems. Meanwhile, the latest research results are translated quickly and efficiently into market-ready innovations at the Application Centers for MSO-Based Process Engineering, for Digital Commercial Vehicle Technology, and for Smart Ecosystems.

Secure connected systems

The High Performance Center for Secure Connected Systems combines the expertise of the three Fraunhofer Institutes in Munich regarding smart sensor technology, flexible and robust connectivity, and integrated security. A particular pursuit of the center concerns the following fields of application: smart health, Car2X communication and Industrie 4.0. The Technical University of Munich and the Universität der Bundeswehr München are the center's research partners.

http://s.fhg.de/highperformancecenters

SECURE CLOUD PLATFORM CONNECTS PRODUCTION AND IT

In collaboration with industrial partners and the Fraunhofer Group for Production, researchers at Fraunhofer IPA have created Virtual Fort Knox, an online marketplace that brings together manufacturing companies and providers of IT solutions. The hybrid cloud platform enables SMEs in particular to digitalize and design more efficient production flows and to develop new business models – very much in the spirit of Industrie 4.0.

In Industrie 4.0, manufacturing meshes with state-of-the-art information and communications technology. The driving force behind this development is the rapidly growing digitalization of business and society. Many medium-sized plant and machinery manufacturers are asking themselves how they can get their companies in shape for Industrie 4.0 and enter the brave new world of digital production. This is where Virtual Fort Knox, a cloud solution for the manufacturing industry, comes in. Researchers at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA have developed this open, federative IT platform in cooperation with Hewlett-Packard GmbH and other industrial partners. Virtual Fort Knox AG (VFK) was spun out in 2015, and the Fraunhofer-Gesellschaft has been a partner since 2016. "The advancing digitalization of production calls for modular, flexible software solutions that can be implemented quickly and without much risk," says Joachim Seidelmann, engineer at Fraunhofer IPA. "With VFK, it's possible to integrate IT services from different manufacturers with smart objects (Industrial Internet of Things) in manufacturing contexts. Based on the data this supplies, companies can develop brand new functions for optimizing production."

The solutions can be combined with existing IT applications and easily integrated into existing process flows. On the basis of this information, users can go on and undertake further measures, such as optimizing the planning of maintenance jobs or identifying weaknesses in production. The advantage for machine builders and software providers is that VFK allows them to offer their customers innovative services quickly and thereby develop new business models.

Happily, companies do not require the latest technology to make their manufacturing operations cloud-enabled. Seidelmann and his colleagues in Fraunhofer IPA's Application Center Industrie 4.0 are demonstrating how this works. For example, the researchers have fitted an analog lathe with additional sensors, making it possible to transmit production data to the cloud and incorporate the data into the digital workflow.

As secure as Fort Knox

Protected by thick concrete walls, security guards and access codes, Fort Knox, in the State of Kentucky, is where the U.S. Treasury keeps its gold reserves. In Virtual Fort Knox, data is the precious treasure to be guarded. A highly sophisticated security concept protects the information transmitted from machines, plants and other cyber-physical systems in the factory to the cloud platform. Moreover, because the server is located in Germany, Virtual Fort Knox complies with Germany's rigorous data protection laws. By virtue of these high standards, the VFK operators want to address the security concerns of medium-sized manufacturing companies who have been dismissive of previous cloud offers on account of the lack of transparency.

www.virtualfortknox.de/en/

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