PEOPLE AT THE CENTER OF DIGITIZATION

FRAUNHOFER GOES HOLLYWOOD
3D PRINTING FOR THE MOTION PICTURE INDUSTRY

CYBERSECURITY
INTERVIEW WITH EXPERTS

RESEARCH CENTER FOR ASIA
THE STORY OF A PIONEERS
Dear Partners and Friends,

Have you ever wanted to be able to expand your vision and see more than is visible to your eyes? To peek behind the curtain, so to speak? Perhaps to have a kind of X-ray vision and be able to see inside objects? Many will dismiss such ideas as mere science fiction, but in some cases it may be possible. To don X-ray goggles in order to search the house for a misplaced item is doubtlessly fantasy but, in other areas, expanded visual possibilities have already become reality. For example, consider an industrial production plant. The assembly and maintenance staff wear special glasses that let them see not only the machine to be worked on, but also background information on the machine that is displayed in the line of sight. This concept is called "augmented reality," or AR for short.

Key Topics Bundle our Research

Before we go into the subject of augmented reality, let us expand our vision in another way and take a look at the institute’s general strategy. Our researchers look for the best way to efficiently address the requirements of the industry. This also includes giving our subject areas the needed momentum. This, in turn, requires people to look at things from different angles. Therefore, we recently bundled our research activities under four key topics that form the basis of our work and link various subjects across departments. One of these key topics is "Visual Computing as a Service – the Platform for Applied Visual Computing." We have established the basis of this universal platform for visual computing solutions and continually expand it. This technological approach forms the foundation for the other key topics. Under the key topic "Individual Health – Digital Healthcare Solutions," we examine the data that accumulate in personalized medicine with the help of our visual computing technologies. Under the key topic "Smart City – Innovative, Digital, and Sustainable," we examine how the life-cycle of
urban processes can be supported. And under the key topic “Digitized Work – Man in Industry 4.0,” we primarily zoom in on supporting people in the new digitized production environment. An external evaluation shows that these topics hit the mark, and we have the expertise needed to successfully implement them. At the CeBIT 2017, visitors had the opportunity to learn more about our four key topics.

Digitized Work Thanks to AR and VR

At CeBIT 2017, we will focused on digitized work, whose importance will grow significantly in the context of Industry 4.0. The objective is to enhance the flexibility of products in order to individualize them. Augmented and virtual realities offer a wide range of opportunities for syncing digital and real environments. The breadth of the augmented and virtual reality spectrum can be seen from the numerous research projects of Fraunhofer IGD. For example, intelligent AR and VR solutions can support technical staff with complex explosion models of large machines, whose display we enable on less powerful devices. Moreover, these solutions can facilitate inspections, enabling the staff to check whether all parts of an engine have been positioned correctly.

Enhanced Cybersecurity

Yes, digitization plays a key role – with all imaginable benefits. However, there is another side to the coin: the havoc that cyberattacks are able to wreak grows at the same rate as the digitization, so the headlines often feature reports about hacker attacks and malware. Even the German parliament is not immune to such attacks. For example, hackers penetrated the parliament’s IT network and had constant access to the system from the outside – and remained undetected for months. Therefore, the IT systems must be duly protected, and cyberattacks must be warded off with suitable technologies. In Darmstadt, we have established a bastion of cybersecurity that includes the Fraunhofer High Performance Center for Cybersecurity and the Center for Research in Security and Privacy (CRISP), in which both Fraunhofer SIT and we are involved. The focus is on “security at large,” i.e. the research on security for large systems, from the components to their interaction in integrated security solutions. In this connection, the handling of big data necessitates visual solutions. For example, this will enable us to discover attacks more speedily by visually condensing IT network logs and extracting relevant information. In an interview presented in this annual report, three experts explain how Fraunhofer IGD can contribute to cybersecurity with visual computing.

We hope you enjoy the information.
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24 CYBERSECURITY – INTERVIEW WITH EXPERTS

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Smart living: A smart floor makes life easier in many situations, including helping to detect falls. With little effort, the enhanced CapFloor 2.0 turns your living space into an intelligent home.

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It is not often that a Fraunhofer invention impresses a real Oscar winner. LAIKA makes use of 3D color print technology from Fraunhofer IGD.

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Smart environments and biometric procedures can support us in our daily life. Dr. Andreas Braun of Fraunhofer IGD is familiar with the needed sensor technology, especially if it is supposed to be invisible and unobtrusive.

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Professor Uwe Freiherr von Lukas and his Maritime Graphics department had been working on this subject, which suits the Institute’s research focus perfectly. For about three years, Rostock-based researchers have been concentrating on the entire underwater subject area with visual computing.

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Walking unknown paths requires a lot of courage – paths for which it is difficult to predict where they will lead – requires a lot of courage. Such paths involve both risks and opportunities. Fraunhofer IGD mustered up this kind of courage when it signed a memorandum of understanding with Nanyang Technical University (NTU) in Singapore in 1997. People were very skeptical: What on earth is an utterly German research institution like Fraunhofer doing on the other side of the globe?

Now, 20 years later, the situation has changed. Internationalization is in vogue among research institutions. What is more, the story of Fraunhofer Singapore has turned out to be one of success. You can see how proud Professor Dr. Wolfgang Müller-Wittig, Director of Fraunhofer Singapore, is when he talks about his “baby.” In fact, the history of the outpost, which has developed into a project center for interactive digital media, is the story of a pioneer. “We had already been present in Singapore before billions were spent on research – we were far ahead of the internationalization trend,” reminisces Müller-Wittig with pride. “This gives us an enormous competitive edge. If we had waited until now to enter Singapore, things would be much more difficult, due to the substantial inrush from all sides. Over the years, we have demonstrated our reliability as a partner, and we have established a strong network.”

A Success Story

Let us take a look at the story of the Singapore branch from the beginning. A small project group was quickly set up following the memorandum of understanding: the Center for Advanced Media Technology, a joint venture at the university. Singapore showed interest in the Fraunhofer model, as it serves both the industry and society and does not depend fully on government funding. The local decision-makers wanted to see whether this model would work in Singapore.

The long-standing presence was an important precondition for taking the next step. In 2010, Fraunhofer Singapore became the Fraunhofer Project Center for Interactive Digital Media. Müller-Wittig draws attention to the fact that the center does not receive any funds from Germany, but that the financing is generated entirely on site. But what kind of work does a project center actually do? Unlike Fraunhofer representation offices like the one in Jakarta, which serve as intermediaries and forward regional inquiries to Germany, a project center operates on a different plane: it has its own research group, enabling the team in Singapore to process inquiries from the industry directly on site. The researchers of the project center also come from the network of Fraunhofer IGD, i.e. the scientific staff members come from the locations in Darmstadt, Graz and Rostock. Additionally, an international doctoral program has been introduced.
to enable students of partner universities to study and research in Singapore.

Excellent Partner for the German Economy – Win-Win Situation for Fraunhofer and Singapore

The project center is an excellent partner for German businesses that operate in Singapore and, as such, it is in line with the core objective of the Fraunhofer-Gesellschaft: to support the German economy. Its scientific excellence is at a high level. Alliances are a useful means wherever complimentary expertise is available – expertise that effectively supplements the one’s own know-how. "Nanyang Technological University (NTU) has proven to be an outstanding choice. In recent years, the university has developed speedily from a pure teaching institution into a research-oriented university," explains Müller-Wittig. The university ranked 13th in the QS World University Ranking for 2015/2016, and 7th in the field of engineering. Another advantage of the location is that Singapore is considered the gateway to Asia.

The Fraunhofer Project Center also provides Singapore with numerous benefits. For a long time, the local research landscape had concentrated almost exclusively on scientific publications. Now, however, the primary focus is on applied research. In other words, the decision-makers in Singapore are increasingly eager to see the return on investment; they want to transform the results of the fundamental research into money. "With the Fraunhofer model, we fit in very well," says Müller-Wittig. This is also evident from the new subsidy notice that the Fraunhofer project center recently received from Singapore. Over the past five years, the Fraunhofer Project Center in Singapore received subsidies of approximately SGD 8 million. For 2016 to 2021, subsidies will total SGD 23 million.

Locked on to Growth

Fraunhofer and the decision-makers in Singapore agree that the Fraunhofer presence in Singapore should be stepped up. Specifically, this means that apart from Fraunhofer IGD, other Fraunhofer institutes are to be represented, as well. Initially, Fraunhofer IKTS and Fraunhofer SIT are to in the process of joining the team. The first employee of Fraunhofer SIT and a colleague of Fraunhofer IKTS Singapore will commence their work in February 2017. The research base of Fraunhofer Singapore will expand as: Fraunhofer IKTS adds the field of material sciences, and Fraunhofer SIT boosts the field of cybersecurity. Both institutes can launch their activities in Singapore without any risk, in collaboration with their colleagues on site. Müller-Wittig feels that the selected topics are appropriate. "Cybersecurity is a hot topic, and the subject of ceramics-based additive manufacturing is in a good position to get started. Thus, everything is locked on to growth." Here too, a win-win situation arises for both sides: the "newcomers" will access the existing network. Colleagues on site will supplement the subject areas that are being worked on, e.g. with respect to Industry 4.0. In this way, the collaboration between the institutes reaches a new level in Singapore, where they are combined under one roof. "To promote and demonstrate close cooperation by operating across institutes and disciplines is also in line with the intentions of the Fraunhofer Executive Board," adds Müller-Wittig.

The internationalization strategy of the Federal Ministry of Education and Research (BMBF) also brings a fresh breeze. Together with the Software Cluster South, Singapore and Fraunhofer IGD have successfully positioned an internationalization concept with the BMBF in the first round of the selection process. The application for the rollout is currently being evaluated. The functional coordination on the German side is performed by Fraunhofer IGD.

The success story continues. Müller-Wittig believes that, in the not too distant future, the Fraunhofer project group could even become an autonomous legal entity. It is very likely that this goal will be reached in 2017.
Broad Lineup

Industry 4.0, assistance systems for BMW, training via virtual reality: Professor Dr. Wolfgang Müller-Wittig, Director of the Fraunhofer project group in Singapore, in an interview with business journalist Janine van Ackeren on the research topics that he and his team are working on.

Mr. Müller-Wittig, the Fraunhofer Project Center in Singapore has a new research plan. So what has changed?

Initially, the focus was mainly on interactive new media and the creative industry. Now, the focus has shifted to “smart nation.” The subject area is deliberately defined in very broad terms and includes the key topics of Fraunhofer IGD: Digitized Work, Individual Health, Smart City, Visual Computing as a Service. Since the hot topics are similar the world over, we fit in well.

Have any new themes been added?

Industry 4.0 is one such subject. As Industry 4.0 is a German brand, our Fraunhofer label provides us with significant advantages. Last year, for example, several delegations from Singapore, including Singapore’s Minister for Trade, visited Germany in order to learn more about Industry 4.0. Although most mass production has been transferred to China, production remains an important pillar in Singapore. Like other countries where labor is expensive, Singapore also wants to remain a location for high-quality products by offering easily configurable products. This means small quantities, highly flexible manufacturing systems – in other words, Industry 4.0. This is where Singapore has an opportunity. Singapore wants to learn from Germany and further develop and strengthen the link between research and industry. For this reason, government agencies as well as small and medium-sized enterprises are keenly interested in collaborating with us.

Could you state an example of how you collaborate with Singapore-based companies?

Together with Singapore-based companies, we work on new technologies: augmented reality, virtual reality, and brain-computer interfaces. With the help of brain-computer interfaces, the computer learns how its human counterpart feels, e.g. how much the use of certain technologies challenges people. This can help air traffic controllers as well as car drivers or end consumers. Currently, we use light headsets to record an electroencephalogram (EEG) to analyze the brain activity. On this basis, we develop adaptive assistant systems, e.g. for BMW Singapore, or even next-generation jobs, such as for Singapore’s Civil Aviation Authority. The objective is to understand drivers or air traffic controllers better. What are the stress situations? How can support be provided as effectively as possible?

You also work in the field of virtual reality.

What are some of the things you do?

Among other things, we offer immersive training, e.g. when it comes to operating special machines. Workers need to be able to understand the increasingly complex systems. This can be achieved brilliantly with VR. The importance of custom-tailored training in the industrial context is on the rise. Apart from VR, there is an increasing trend toward the use of augmented reality in the real industry setting.
“Which steps are you going to handle? I’ll do the rest.” Such coordination is nothing unusual among human colleagues. In the future, however, production machines will clarify such questions among each other within the context of a concept referred to as Industry 4.0. Instead of off-the-rack products, the vision of an individual product will become reality. Thus, each customer will be supplied with a custom product.

**Robots Autonomously Copy Products**

But how can such small series be manufactured cost-efficiently? How can robots be of assistance? This is what the DUPLOcator of Fraunhofer IGD focuses on. With the help of cameras, the software scans the “product” – a construction of Duplo blocks in the above figure – analyzes its structure by means of detection algorithms and copies it autonomously with the robot arm. Thus, the researchers have combined detection algorithms with precise self-learning robot control. The only requirement is that the DUPLOcator can see the structure clearly with its camera eye and has the same blocks at its disposal. The software can be used for various applications. The concept can support staff especially in the production of highly complex small series.

**Robots Assist Assembly Staff in Error-Prone Steps**

For assembly staff, customization is not an easy job. Information density is on the rise, and the demands on cognitive skills are increasing. It is no wonder that errors creep in time and again. Therefore, the researchers of Fraunhofer IGD want to support the assembly staff. Henceforth, robots can take over the steps that are particularly prone to errors. In the EU project “AUTOWARE,” the scientists of Fraunhofer IGD, their colleagues from SMC Pneumatic GmbH, and other partners work on solutions for human-robot interaction.

The robot captures its work environment via cameras and identifies objects around it, e.g. work material such as bolts and tools. Smart algorithms connect the loose ends: What needs to be done next? What is to be done by the robot, and what by people? It is important for the robot not to slow down the people in their work; the workflow must not be interrupted by the cooperation. Therefore, the speed of the human and automatic work steps must be tuned to each other. Communication is another key aspect for the cooperation. In other words, the people should know what their tin colleagues will do next. The robot communicates this visually, enabling the human counterpart to be prepared. The project is still in the fledgling state, but the researchers hope to deliver the first prototype as early as spring or summer 2018.

**SELF-LEARNING ROBOTS FOR INDUSTRY 4.0**

Times are changing, and so are production processes. Henceforth, for example, Industry 4.0 technologies will enable the custom-tailoring of products to individual customers. For assembly staff, this flexibility represents a formidable challenge. Robots can support them and help avoid errors.

BY JANINE VAN ACKEREN
FROM NICHE APPLICATION TO HYPE – VIRTUAL REALITY GOES NEW WAYS

Pokémon Go, affordable VR glasses – in recent years, virtual worlds have taken the field of entertainment by storm. In the public perception, VR is often identified with VR glasses. However, virtual reality has much more to offer, e.g. for product tests.
By Janine Van Ackeren

Hordes of Pokémon hunters scavenge through forests and cities, looking behind trees and bushes, cars and building corners. However, they often perceive very little of what is going on around them – their eyes are fixed on their smartphone screens, on which the fantasy monsters to be caught hide in the real or abstract landscape. Some will be surprised to learn that the underlying virtual reality and augmented reality are by no means new inventions. In fact, this technology has been around since the 1970s. The flight simulators used by airlines and the military are a prominent example. But it has only been recently that virtual reality has evolved from a niche application into a widely used technology, even a hype. The reason is quite simple: VR has reached the entertainment industry – and thus our living rooms.

**Virtual Reality beyond VR Glasses**

Affordable VR glasses – head-mounted displays such as the Oculus Rift – have doubtlessly served as a major door opener for the entertainment industry. Thus, most people associate VR exclusively with the worlds in which they are fully immersed by means of the glasses. The way to the modern glasses was long. "First, the limited field of vision of the glasses had to be resolved with lenses," explains Dr. Volker Settgast, Senior Researcher in the Visual Computing division of Fraunhofer Austria in Graz. "For the user, this used to be like having blinders on." Meanwhile, this obstacle has been overcome: modern glasses achieve a viewing angle of about 100 degrees. In comparison, human vision has an angle of up to 180 degrees. Another challenge is that with the glasses, the pixels are located very close to the eyes. Thus, even slight head movement of the user used to necessitate adjustments of the image, which in turn resulted in an annoying afterglow of light pixels. This issue belongs to the past: current VR delivers 90 to 120 images a second; thus, the image remains clear despite fast movements.

Due to these challenges (limited field of vision, low image refresh rate), CAVEs provide much more pleasant access to virtual worlds than VR glasses. In these projection rooms, the artificial reality is projected against the walls, and the user stands at the center of the action. Thus, he has a natural viewing angle, and the image remains clear even when he moves his head rapidly. The researchers of Fraunhofer Austria in Graz have also developed such a CAVE in collaboration with the colleagues from the Graz University of Technology. They call it "DAVE." Four cameras record the user in the projection room and determine the position of his head. "Unlike 3D movies, the technology enables the user
to look under objects in the virtual worlds by kneeling down or to look around corners by moving the head,” explains Dr. Eva Eggeling, who supervises the Graz location. Electronic shutter glasses make sure that each eye gets a separate image, resulting in the 3D effect. This year, the researchers also integrated a new tracking system that works at 240 Hz and uses standard PC hardware and graphics adapters.

Meanwhile, most of the challenges in connection with VR glasses have been resolved. Especially in the private sphere, the glasses provide effective access to artificial worlds. For other applications, however, CAVEs are clearly more suitable, especially if several persons are to interact concurrently in the virtual world.

From What Is Technically Feasible to What Is Meaningful

But what can VR actually be used for? “For a long time, the VR research at universities was driven by the question of what is technically feasible. Now, the search for industrial VR applications is gaining in significance,” says Settgast. In this area, the researchers of Fraunhofer Austria delivered numerous answers. After all, they have long-standing expertise in this area: in 2016, they celebrated their 10th anniversary of applied VR research together with their colleagues from the Graz University of Technology, and DAVE has already been around for 10 years, too.

The field of architecture offers a wide spectrum of application for the artificial worlds. Building plans are available as CAD data that can be visualized on the computer in 3D with relatively little effort. “This is especially interesting for major construction projects such as luxury residences, railway stations, or airport terminals. In the virtual presentation, builders and architects can walk through the building and get a realistic impression of the planning,” says Eggeling. This enables changes to be implemented easily during the planning stage. Any errors that are detected can be corrected at little cost.

For example, consider the Graz lighthouse project, “Moving.” In this project, the researchers examined whether a CAVE would also be suitable for testing guiding systems for pedestrians. ÖBB kindly provided the Vienna central railway station as a scenario for this evaluation,” says Settgast. Hundreds of subjects performed various tasks in the virtual railway station in the DAVE before the actual railway station was built. In this way, the scientists checked whether signs and information screens were put up in the right places and whether travelers were able to find their way around in the railway station. “In such tests, we record a lot of data that we evaluate automatically with digital eye tracking,” says Eggeling. “Where does the person walk? Where does the person look? What distracts the person?”

The redesign of business facilities can also be planned more effectively with VR. Where are products, racks, and exhibits to be set up? Test persons can evaluate the rooms without any distractions, such as other people or different lighting. In this way, the statements can be compared efficiently. The virtual worlds also offer a lot of potential for complex machines, both for their construction and as a learning environment. If something went wrong on the actual machine, this could be expensive and possibly even dangerous for the employee. By contrast, the mistakes that candidates make on simulated machines do not have any critical consequences.
MILESTONES OF VIRTUAL AND AUGMENTED REALITY

The work on hardware for virtual and augmented reality (VR/AR) started more than 20 years ago. We had already used headmounted displays (HMD) at Fraunhofer IGD in the early 1990s, and Sony Glasstron, the first optical-see-through HMD, was introduced to the market in 1996. These first glasses were quite heavy, and users had to carry along a rucksack full of computing power for mobile applications.

Despite the long history, however, it has only been recently that HTC Vive and especially Microsoft HoloLens have set new milestones in the field of VR/AR. Apart from the compelling hardware quality (e.g. image resolution and ergonomics) the systems are equipped with tracking functions that support fluid and intuitive user interaction:

- The VIVE system makes use of outside-in tracking: two cameras that capture the interaction space are set up in order to capture the HMD and the interaction devices.
- The HoloLens integrates a stereo camera, a depth camera, and inertia sensors in order to reconstruct the environment and firmly position 3D objects in the environment of the AR user.

From a superficial perspective, this could be understood to mean that the tracking issues of AR applications have been resolved, and the tracking technologies that Fraunhofer IGD developed over the last 15 years are no longer needed. However, what the HoloLens lacks is exactly the “model-based tracking” that is being developed at Fraunhofer IGD, which establishes a tie between the CAD data and the tracked environment. The new VR/AR platforms can offer an outstanding basis for diverse AR applications. Now the technologies are becoming highly relevant to applications in the context of Industry 4.0, as digital and real environments are transformed into common coordinate systems that consolidate the real world and the virtual world. With the glasses that are now available, we can introduce applications that offer an entirely new range of possibilities.

For example, consider the systems that are designed to support assembly or maintenance staff. In the face of constantly changing tasks, AR solutions based on the CAD data of an object offer great potential for achieving better results in less time.

In this way, a mechanic can be guided systematically through complex maintenance operations. Moreover, the cameras that are required for capturing the scene can also be used for teleconsultation purposes, i.e. the video footage can be transmitted to a remote expert over the Internet. The remote expert can then provide situation-specific assistance by associating images, drawings, explosion drawings, and audio/video information or web links with the CAD data. The information is shown to the mechanic in the camera picture and is linked to the CAD data; thus, it can be accessed in the next AR-supported maintenance run without asking the remote expert for assistance. In this way, the teleconsultation system becomes an authoring tool for the AR system. This approach represents another milestone for VR and AR technologies.
PEOPLE AT THE CENTER OF DIGITIZATION
GUIDING THEMES

The solutions of Fraunhofer IGD are based on the principles of visual computing – image and model-based information technology. We are proficient at transforming information into images and extracting information from images. In regular strategy processes, we examine and decide which topics determine the direction that our research should take. Based on our long-standing experience and intensive market analyses, we have identified four new key topics that will dominate our research work in the coming years.

Digitized Work – Man and Industry 4.0

Nowadays, digitization is a buzzword. The idea of Industry 4.0 appears like a nightmare, especially to the labor market. It is as if nobody can be sure that his job will not be taken over by computers and robots. Professor Bodo Urban, in charge of the “Digitized Work” topic and Head of the Interactive Document Engineering department at the Rostock location of Fraunhofer IGD, also recognizes such dangers, but says, “As a company, it is in our hands to make this digitization a win-win development.” According to Urban and his colleagues, it is especially important to offer solutions to help people keep track of the advancing digitization of the working environment. A good example of the research of Fraunhofer IGD on this subject area is the interactive control center solution Plant@Hand3D.

Previously, a separate analysis was required for each production planning and control system. “Our Plant@Hand3D consolidates all relevant information of the production in one application,” explains Urban. “Special attention is paid to ensuring intuitive access to the production data.” A realistic 3D model of the production environment serves as the basis. All data are managed on an interactive multitouch table. With simple finger gestures, it is possible to zoom in on individual machines from an overview of the entire hall and transparently present brief information on the production data. The congruence with the real environment makes it easier for the user to understand the information and see where it comes from.

Smart City – Innovative, Digital, and Sustainable

BY KONRAD BAIER AND ANNA BARTH

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Smart City – Innovative, Digital, and Sustainable
Digitization has also started conquering our daily life, and we wouldn’t want to miss the many advantages it provides. This can easily be seen from how rarely we still use printed maps or book hotels by phone. Most people prefer to do such things with the smartphone. On the way to the smart city, citizens who have effective networks have special requirements for their city. For example, it is extremely difficult to obtain public approval if the people are simply confronted with the result of an urban planning measure. What is more, no matter how thoroughly the authorities work, they might forget a critical option. Therefore, the disclosure of communal development plans is a beneficial tradition. "Often, only experts are able to clearly understand the wide range of planning documents that are prepared in connection with the design of a new neighborhood," says Dr. Eva Klien, who is in charge of the “Smart City” topic and Head of the Geoinformation Management department of Fraunhofer IGD. "Of course, this is very disappointing for the many citizens who are affected by the measure." Klien and her fellow researchers want to tackle this issue within the scope of the EU research project “smarticipate.”

In "smarticipate," the 10 partners from six European countries are developing a holistic software platform for citizen participation under the supervision of Fraunhofer IGD. Interactive 3D city models form the basis of this solution. In such models, development projects are offered in visualized and thus readily comprehensible form. This also works online, enabling all who are interested to submit proposals for the planning process from their computers at home.

Individual Health – Digital Healthcare Solutions

In the healthcare sector, digitization enables therapies and procedures to be custom-tailored to the needs of an individual patient. To make this possible, the visual computing technologies of Fraunhofer IGD offer a number of constructive approaches that assist physicians in selecting the most suitable treatment. Among other things, they are advancing on oral cancer, a very dangerous type of cancer. Every year, more than 10,000 patients in Germany are diagnosed with this disease. Following successful therapy, about 55 percent of the patients in Germany survive for more than five years. However, the disease is often recurrent, even after removing the main tumor.

Within the framework of the EU project "Oramod," a software system has been developed to help physicians to predict the probability of recurrence of oral cancer faster and more accurately on the basis of patient data. Fraunhofer IGD provided part of the software solution for the system. "By means of semi-automated procedures, our solution helps the physicians to clearly highlight and analyze the tumor on the examination images," explains Dr. Stefan Wesarg, Head of the Visual Healthcare Technologies department, who is in charge of the “Individual Health” topic. In this way, the physician can quickly and objectively identify any changes in the oral cavity that are visible in the image data. This enables comparisons to be drawn with known courses of the disease, allowing individual and more reliable patient prognoses. The Oramod software is presently being tested in the clinical setting in the university hospitals of Amsterdam, Düsseldorf, and Parma.

Visual Computing as a Service – the Platform for Applied Visual Computing

For comprehensive digitization, there is still a need for suitable IT platforms that are able to handle the growing requirements. "The further development of the software components of Fraunhofer IGD takes place in the context of the strategic service platform ‘Visual Computing as a service, which forms the integrated visual computing basis for meeting customer requirements,” says Dr. Joachim Rix, who is in charge of the platform strategy.

The handling of very large and complex 3D models is a good...
example of this subject area. With its instant3DHub software, Fraunhofer IGD presents an ideal solution with which engineers and other technical staff can easily use spatial design and scan data on any device, from smartphones to VR glasses. "For example, the software enables the user to walk and experience industrial plants or digital buildings in real time," explains Dr. Johannes Behr, Head of the Visual Computing System Technologies department at Fraunhofer IGD. With the web-based Fraunhofer solution, it is actually possible for any enterprise to customize the visualization tool according to its own needs. The software autonomously decides which data are to be transferred, e.g. by computing that only views of visible sections are to be sent to the user’s device. For interactive walk-through the approximately 3.5 million components of a power plant, typically only 3,000-odd visible parts are thus computed on the server and transmitted to the device. In this way, extremely large 3D data can be displayed smoothly even on low-performance devices.

**Committed to Its Own Claim**

Back in 1992, Fraunhofer IGD was one of Europe's first institutions that had a website. The institute has promoted developments such as CAD (since its establishment in 1987), AR (since the mid-1990s), and 3D visualization (also since its establishment). Significant contributions to digitization have been and continue to be made in Darmstadt, Rostock, Graz, and Singapore. Our customers, and society as a whole, benefit from the possibilities that our research results present. We have set a high standard for ourselves. We want to find solutions that benefit people, putting them at the center of digitization.
The guests in the museum rotunda are filled with wonder as the Nike and Zeus sculptures set up in the circle gaze intently at the huge projector at the center of the round hall. The first images become visible on the projection screen: a mixture of intertwined reliefs, dramatic mythological scenes, and graphics full of data. The purpose of the press event on May 24, 2016, was to present a unique project of the Fraunhofer Institute for Computer Graphics Research (IGD) and the National Museums in Berlin (SMB): the virtual immortalization of the Pergamon altar, the 3D digitization of one of the world’s most significant cultural objects.

While various speakers of Fraunhofer IGD and SMB present the results of their work, it becomes clear what the team led by Pedro Santos has achieved. Though the colleagues had already digitized numerous cultural objects within the scope of the renowned Cultlab3D project, this project amplifies digitization to an entirely new magnitude.

The result is remarkable: The 3D model obtained from scans and photogrammetry comprises about 90 GB of high-resolution data and consists of about 580 million triangles. For the precise acquisition, the team used 3D laser scanners that captured the hall around the Pergamon altar, including the huge fresco and colonnades, from 51 positions, producing 176 million 3D dots per measurement. The fresco details were captured with a DSLR camera in 8,065 individual 2D color photographs at a resolution of 24.2 megapixels.

However, the photographers who circle around the crowd in the rotunda and try to capture all visual impressions can only imagine what kind of difficulties the researchers had been faced with. Due to an outage of the freight elevator of the Pergamon Museum, an alternative to the planned lifting ramp of 1.3 tons had to be found at short notice. To photograph the friezes, a collapsible 12-m camera crane was equipped with a programmable motorized camera head on which a DSLR camera with diffuse lighting was mounted. Additionally, several trips had to be made to local hardware stores, and the assistance of a number of companies in Berlin was required to procure the hardware needed for the entire digitization process.

Step by step, the speakers uncover the project details. While relaxing in their seats, the attending guests gradually understand what kind of pressure the digitization innovators had been exposed to. Due to the upcoming closure of the museum section housing the altar, which is currently being renovated, the work had to be finished within as little as one week. Thus, the friezes were captured during normal opening hours. At night, the entire hall was scanned with laser scanners. The empty museum at night doubtlessly had a special appeal.

Thus, the team of researchers enjoyed strolling through the abandoned Ishtar gate of Babylon to the market gate of Milet and from there to the Pergamon altar.

The processing of the acquired data to create the model took about six months. This gives an approximate idea of the overall project scope. The computing power required to render the model was also enormous. The calculation of the northern frieze
IN A NUTSHELL

JUNIOR RESEARCHER RECEIVES HUGO GEIGER AWARD

The flood of data is rising exponentially. But how can these proliferating data be analyzed meaningfully? And how can they be used to support decision-makers? In his dissertation, Dr.-Ing. Jürgen Bernard of Fraunhofer IGD examined this issue, more precisely the analysis of time series data. Bernard showed how developers of search systems can create powerful application-oriented data analysis solutions. In recognition of his doctoral thesis, the scientist received the Hugo Geiger Award. The award ceremony took place on November 14, 2016, at the Munich Science Days.

FRAUNHOFER ICT DISSERTATION AWARD 2016 FOR FRAUNHOFER IGD

The German Informatics Society (Gesellschaft für Informatik e.V. (GI)) is the largest professional non-profit organization of and for IT specialists in German-speaking countries. At its annual conference, the “Fraunhofer ICT Dissertation Award” was bestowed. Dr.-Ing. Tobias Große-Puppendahl was one of the award winners of 2016. In his doctoral thesis that he prepared at Fraunhofer IGD, Große-Puppendahl examined the perception of a user with the help of device control sensors. The perception of the environment is essential in order to facilitate the interaction with technology. With the help of capacitive sensors, it is possible to develop user interfaces that are able to detect gestures, body movements, and manipulations of the environment from a distance of up to 50 cm. In his dissertation, Große-Puppendahl concentrated on the expansion of capacitive perception methods, the detection of limbs of a user on the basis of capacitive sensors, and the explicit and implicit interaction design of such systems.

took eight days on a Dual-Xeon computer with 32 cores and 512 GB RAM and delivered a 3D model with more than 100 million triangles and a resolution of less than 500 μm.

While the event approaches its end and the invited guests get ready to ask their questions, the speakers present one more innovation: as the resolution of the original 3D model would have been far too high for an online presentation, a modified interactive browser version is now available to the public. This is truly necessary, as museum visitors will most likely have to wait until 2019 to see the Pergamon altar again in person, like the Fraunhofer IGD researchers last saw it. For Pedro Santos and his team from the Digitization of Cultural Assets department, this is another reason why the project represents a unique experience. The museum, on the other hand, is pleased to have gained an exquisite 3D model of the historical masterpiece.
Every patient history is unique. However, the patients also have some things in common. Physicians are especially eager to understand why different patients react differently to a certain therapy. Physicians consolidate similar cases in cohorts in order to draw conclusions for subsequent therapy decisions. Fraunhofer IGD has developed an application that quickly filters commonalities from digital patient data, presenting them in a well-structured form.

The decision on how to treat cancer clearly shows how necessary personalized medicine is. Individual patient history makes it difficult to apply existing knowledge of other cases to the specific patient. The information of the patient and the evaluation of therapy options by the physician generate more questions than answers.

Evidence-based medicine would not work if every patient was an exception to the rule. However, the question that arises at the crossroads of clinical research and practice is how the rules for substantiated prognoses can be found in the first place. Every physician considers which cases from the past he could use for a prognosis. The development and description of cohorts of comparable patients is one of the central tasks in medical research, and rightly so.

Fraunhofer IGD develops analysis methods for the Martini Clinic at the University Medical Center Hamburg-Eppendorf. The physicians of this special clinic for the treatment of prostate cancer use a repository of data from about 20,000 patients. These analysis methods include technologies to display the patient data. The portrayal that was developed in collaboration with the physicians enables details such as the course of the disease and the therapy to be correlated. Hereinafter, all these data are referred to as "markers." Bar charts show the distribution of individual markers within the patient group. For example, this might be the age distribution, the surgical method, or the time until the relapse. The physician can either choose an overview of all patients or a detailed display of one or several patients. The design adapts accordingly.

However, the screening of patient data is only the first step prior to the hypothesis. This step is followed by the composition of the data for the statistical test and finally the actual test and its analysis. The problem is that this complex process is impaired by a number of media disruptions (e.g. between the patient files, spreadsheet software, and statistics software) and can take several hours, or even days. Ultimately, only the analysis by means of the statistical test reveals whether the work has been successful.

Our solution facilitates this process by means of a preliminary "one-click" evaluation. For this purpose, the cohort can be modified interactively within the portrayal. For example, patients with certain markers can be added to the cohort. Every time the cohort is modified, all views and statistics are...
automatically recalculated. For the researcher, statistics that compare the selected cohort with the reference group are especially relevant. All markers for which the selected cohort differs significantly from the reference are highlighted prominently in the presentation. From hundreds of markers, it is thus possible to select those that characterize the commonalities of the selected patients.

In particular, this means that it is not necessary to "manually" test every single marker for peculiarities. Rather, all markers available in the data repository are tested. The medical researcher can concentrate on interpreting the peculiarities. A typical approach is to compile a cohort from patients that reach the same endpoint. The prognosis can now be made on the basis of previously known patient markers, which are also incidental to the particular cohort. If the examination is to be limited to a subgroup, this can be achieved by combining multiple filters.

A reverse approach would be to select patients who have undergone a particular therapy. Here, it can be examined which endpoints this patient group has reached with an above- or below-average frequency. It also becomes obvious whether markers need to be taken into consideration as cofactors or as confounders in the subsequent statistical test. The search always delivers the definition of a cohort and a selection of relevant markers that must not belong to this definition. In this case, a non-trivial correlation exists, which can be formulated as a hypothesis to be tested statistically. At this point, the test methods for the statistical tests come in again.

Last but not least, this method can also be used for the evaluation of existing cohorts or stratifications. For example, this becomes necessary when the data are supplemented with new markers. Here too, the screening delivers information on the relevance of the cohort with respect to the other markers or information on potential perturbations that might not have been taken into consideration as yet.

The automation expands the focus of the analysis, enabling the utilization of the growing volume of unused data. Through the visual analysis, it is possible to find connections not directly searched for, but without abandoning the accuracy of statistical test procedures. The medical expertise is not replaced by the automation of technical operations, but upgraded. The visual analysis is based on the idea that innovative results must be developed both on the basis of data and on the basis of experience. This knowledge is introduced to the analysis during the screening, search, and evaluation.
IN A NUTSHELL

MINISTER PRESIDENT BOUFFIER VISITS FRAUNHOFER AUSTRIA

On October 5, Steiermark welcomed Volker Bouffier, Hessen’s Minister President. He had been invited by Governor Hermann Schützenhofer. The agenda included a visit to the Visual Computing division of Fraunhofer Austria in Graz, where he took a look at the virtual 3D presentation room, DAVE. In this versatile, walkable projection room, the user can get fully immersed in a virtual 3D reality. Bouffier observed, “It is fascinating to see how, for example, researchers from Hessen and Steiermark can jointly visualize plans, enabling rooms to be entered before they are even built. This enables the smart avoidance of building errors right at the planning stage. This saves time and money and helps the users later on.”

GUESTS FROM THE FAR EAST IN DARMSTADT

In September 2016, Fraunhofer IGD in Darmstadt welcomed some prominent visitors from the Far East. The institute’s work on technologies such as 3D digitization, virtual and augmented reality, and 3D visualization has aroused international attention. For this reason, Nicholas W. Yang, Secretary for Innovation and Technology from Hongkong, visited Darmstadt on September 27. Yang was greatly impressed by the institute’s high level of research innovation. Cooperation options were also discussed.

DELEGATION FROM SINGAPORE EXAMINES RESEARCH ON INDUSTRY 4.0

The fourth industrial revolution is referred to as “Industry 4.0”. This movement involves the use of Internet communication technologies in factories. In the future, machines will be able to see and react to employees. Thus, the human-machine interaction will be more direct. To learn more about Fraunhofer’s research on Industry 4.0, Mr. S. Iswaran, Singapore’s Minister for Trade and Industry, visited Fraunhofer IGD in Darmstadt in July with a delegation of government officials.
Doubtlessly, computers, smartphones, and the like need to be protected from hacker attacks, but this is usually more easily said than done. The task is too daunting for most private individuals, and even experts are increasingly reaching their limits. How can visual computing help in this area? Fraunhofer IGD is one of the partners of the Center for Research in Security and Privacy (CRISP) in Darmstadt, Germany. Read the interview with Professor Dr.-Ing. Jörn Kohlhammer, Head of the Information Visualization and Visual Analytics department at Fraunhofer IGD, Dr.-Ing. Andreas Braun, head of the Smart Living & Biometric Technologies department at Fraunhofer IGD, and Dr.-Ing. Reiner Wichert, Managing Director of CRISP.

There are still many gaps with respect to cybersecurity. Which is the first one that should be closed?

**Braun:** To increase the security of data and to protect them from external access, we need to step up the access protection, i.e. we need to shield the data in such a way that only authorized individuals can access them. In my department at Fraunhofer IGD, we are working on biometric protection mechanisms. In many applications, these mechanisms are more difficult to breach than conventional methods. Additionally, we are developing a system to protect biometric data, as well. For example, this will enable us to protect smart homes from attacks and abuse. We are also doing research on soft biometrics, a field that is relevant to many applications. Soft biometric properties include physical features such as eye color and size, as well as behavioral patterns such as a person’s gait. Mood detection, for example, can contribute to the improvement of social contacts. Using the couch or chairs, we can measure the breathing frequency and heartbeat of a person and draw conclusions concerning the person’s stress level.

**Kohlhammer:** To elevate the access threshold surely makes sense. At the same time, however, the intrusion detection should be improved. Time and again, we have seen that whenever experts want to penetrate a system, they manage to do so. Therefore, we need to find out how we can notice as quickly as possible when and where somebody gained access to the system. Until now, most attacks have remained undetected. For example, the fact that hackers had penetrated the IT network of the German parliament and had constant access to the system from the outside remained undetected for months.

**Braun:** I feel that the two areas supplement each other. To be honest, many people use computers, smartphones, and the like although they are not particularly skilled at using them. The same is true of most users of smart living systems, which we actually develop especially for this target group. This means that the systems should be secure without requiring the user to do anything, and this can best be achieved by means of improved access protection. By contrast, the visual systems that you and your group develop are designed primarily for businesses that need assistance in the analysis of the security and attacks.

Enterprises collect more and more data about the users. Often, it is impossible to know what these data are used for. What about the security of these big data?

**Wichert:** I’m quite worried about the privacy of these huge amounts of data that are being collected. Bad things happen all the time, such as the voice detection box on the TV that records and analyzes everything that is said in the room. Therefore, we
at CRISP specifically examine questions like how can the secure transmission, storage, and analysis of user data can be ensured. How can the users be informed about the risks? As a former department head of Fraunhofer IGD and former spokesman of the Fraunhofer AAL alliance, I'm still concerned with the complex infrastructure of the living environment. I consider personal security to be extremely important for this area.

Kohlhammer: For Fraunhofer and all CRISP partners, the issue of data security and privacy is the top priority. This cannot be overemphasized. The objective is to achieve the maximum benefit for society, for enterprises, and for users, while ensuring maximum protection of privacy. For example, a key issue in cybersecurity that can be addressed without impairing privacy is the review of lengthy IT network logs. Most companies have a security officer who examines these logs day by day, lists that grow at a rate of 100 or more messages a minute.

We are working on visually condensing these data and extracting relevant information in order to discover attacks more speedily. For example, this can be done by means of a similarity-based approach: attacks always cause little changes in the system. Therefore, we examine whether the current data are similar to those that we have in the pool. This works especially efficiently if a large amount of data is available for comparisons. If used correctly, big data can thus be a boon, not only a bane.

Wichert: You are right, Jörn, in that a compromise needs to be found for big data. Big data can be positive, but this does not mean that all data are needed. In a smart home, for example, the user should be able to systematically decide which data he wants to release to whom, and for what.

Braun: I think this needs to be evaluated carefully. Of course, we also need big data. In our smart living project in Weiterstadt, for example, more than one thousand sensors collect data. Therefore, effective and, most importantly, secure methods are required in order to analyze the data. For this reason, one of the things that we and our partners will develop in one of our next CRISP projects is a secure big data platform.

What is more, the Internet of things has a major impact on cybersecurity. Instead of a conventional gateway system that centrally collects all data, every individual device now accesses the network. So we have an entirely new, much more difficult situation, as we need to protect every individual device. In other words, instead of a single entryway that could be attacked, we now have several. In a large EU project spanning thousands of users throughout Europe, we therefore want to integrate and test Internet-of-things systems on a wide scale in smart living environments. We collaborate in the development of the platform via which the systems communicate and take care of the technical supervision of a pilot installation.

Kohlhammer: Still, it would not be wise to rely solely on "security by design." This goes for the Internet as well. The Border Gateway Protocol (BGP) connects the individual subnets of the Internet to an integrated whole. However, it is highly insecure and is repeatedly used for redirecting traffic flows in the network. While the user might think that his data are sent directly to the requested server, they might be redirected via other countries without him being aware of this. In a CRISP project, we thus work on making such traffic flows visible. To ensure cybersecurity, I feel that it is always necessary to use both approaches: prevention and detection. Happily, Fraunhofer IGD and CRISP effectively cover both areas.
Smart living has not yet been adopted on a wide scale. Usually, the solutions are simply too complex. However, it is actually quite easy to wire up the home with CapFloor 2.0, a solution developed by researchers of the Smart Living & Biometric Technologies department of Fraunhofer IGD. CapFloor 2.0 basically consists of a mesh of wires spread under the floor. The system had originally been designed to detecting falls of the elderly and call for assistance. Now, the system is able to do much more. For example, it can control the lighting and help save energy. The floor becomes a secret household helper that makes life safer and more comfortable. But how?

"The system captures its environment using thin wires under the flooring and compact sensors that are positioned in the skirting, where they can easily be serviced. Through electric field measurement, it passively notices the movement of the persons living there," explains project manager Florian Kirchbuchner. Basically, the floor is turned into a constantly watchful observer without using motion detectors or cameras as in other systems. "A clean solution in terms of data protection," says Kirchbuchner. The sensors installed on two sides of a room notice changes in the natural electric field of a person. Then little controllers transmit the information on the field strength to a central analysis unit, where the data are compared with the stored floor plans. "In this way, we can determine the position of a person with an accuracy of 20 cm," explains Kirchbuchner. The system also notices when somebody falls, in which case CapFloor automatically makes an emergency call. In this way, the elderly can live safely in their own homes without putting on a bracelet with an emergency button, which is often forgotten or considered to be a nuisance.

The technology is easy to install in new buildings or when renovating and can be used in various ways, as it allows a wide range of assistant systems to be controlled. The Fraunhofer researchers have already prepared the smart floor for numerous application possibilities. Individual functions can be configured depending on individual needs, such as a function that alerts parents or care staff when toddlers or dementia patients leave the home. Forgetful people can be reminded to switch off the stove or close the windows. For this, a smart meter should be installed at home, and the windows should be armed with contact switches, which is not too difficult. Similarly, the technology serves as an alarm system. Finally, by detecting the motion of the people at home, the floor identifies the rooms in which the light needs to be switched on – this makes life more comfortable and saves energy, as the lamps are only kept on where there is activity. Heating can also be controlled in this way.

**Applied Research Soon Market-Ready**

But that is not all. "We are also working on other possible applications," reports Kirchbuchner. For example, visitor flows could be measured in public spaces, or advertising panels could be illuminated only when somebody stands in front of them. Kirchbuchner and his team also want to make the system, which is already simple, even simpler so that it needs fewer sensors and any craftsman can easily lay the wire mesh from a roll. CapFloor 2.0 is already being tested in a residential complex for the elderly and dementia patients in Weiterstadt. The market launch could take place within a few years.

**Little Effort, Great Effect**
FRAUNHOFER GOES HOLLYWOOD – 3D PRINTING FOR THE MOTION PICTURE INDUSTRY
Stop-motion animation has a unique appeal. When employing the technique, each frame must be set up with puppets and props incrementally altered in small movements. An entire movie is compiled from the individual motionless scenes, captured by a digital camera. 24 frames equal one second of animation. LAIKA, the US based animation studio, has produced three Oscar®-nominated animated films: The Boxtrolls (2014), ParaNorman (2012) and Coraline (2009). Their use of 3D printing in animation garnered them a Scientific and Engineering award from the Academy of Motion Picture Arts and Science. The studio’s fourth feature, Kubo and the Two Strings, opened in theaters in 2016.

In order to produce the puppets’ facial expressions, LAIKA designs, models, animates, and paints the faces on the computer, then uses color 3D printers to produce tens of thousands of slightly different facial expressions. LAIKA pioneered this technique on its inaugural film, Coraline, and has continued to push the limits of 3D printing technology on each subsequent film. On LAIKA’s fifth film, they will be utilizing the most cutting edge 3D color plastic printing hardware from Stratasys, combined with the powerful universal print driver Cuttlefish from Fraunhofer IGD, to help achieve accurate and repeatable color from face to face. Cuttlefish makes it possible to work with many printing materials at the same time, to accurately replicate the geometry, colors, and smooth color transitions of the original, and to simulate the printout on screen in advance. “Our first tests were fantastic,” says Academy Award winner and director of LAIKA’s rapid prototyping department, Brian McLean. “We have never seen such accurate and detailed color before in a plastic 3D print.”

Three questions for Dr. Philipp Urban, Head of the 3D Print Technology department of Fraunhofer IGD:

What is “Cuttlefish”?

Cuttlefish is a universal 3D color printer driver that enables the creation of truly realistic 3D color prints. Printer manufacturers agree that Cuttlefish delivers the best results in terms of color and texture reproduction.

What is the reason for the high quality?

Our printer software makes it possible to work with many printing materials at the same time, to accurately replicate the geometry, colors, and smooth color transitions of the original, and to simulate the printout on screen in advance.

You have already achieved a lot. What are the next challenges that you would like to tackle?

Translucency, i.e. partial transparency and light dispersion of an object, represent the next challenge. In this way, many objects change their color or reveal structures under their surface depending on the light incidence. To emulate this with 3D printing is our next goal.
FROM ASSISTANT RESEARCHER TO DEPARTMENT HEAD – SMART LIVING ALWAYS IN FOCUS
As a department head, he is now responsible for 10 employees and more than 20 student assistants – a major achievement at Fraunhofer, as scientific careers usually provide for the transfer of employees to the business world in line with Fraunhofer’s principle of ensuring technology transfer through highly qualified staff.

The professional world appreciates the running enthusiast’s expertise. For more than five years, he has actively participated in numerous European cooperative research projects. Since January 2016, he has served as the deputy spokesman of the Fraunhofer Ambient Assisted Living (AAL) Alliance, a subject-specific network of 11 Fraunhofer institutes in the fields of Personal Health and Ambient Assisted Living, as well as Principal Investigator in the Center for Research in Security and Privacy (CRISP).

A smart couch that knows who sits on it and switches on their favorite show on the TV or a floor that calls for help when somebody falls – such future scenarios are commonplace for Dr. Andreas Braun. His research takes place at the crossroads of sensors and the measurement of human activities in smart environments. Numerous technologies and methods are employed to create an environment that supports its inhabitants in taking care of daily chores.

**Researcher out of Passion**

In early 2016, smart living and biometrics, two of the most fascinating research subjects of Fraunhofer IGD, were consolidated into one department. Andreas Braun serves as Head of the new Smart Living & Biometric Technologies department. "The field of biometrics is a key element of smart living," says the researcher. "In our opinion, the technology does not merely enhance safety, it also increases comfort. By interlocking all elements, the daily life of the inhabitants is streamlined to provide maximum comfort."

Fraunhofer offers motivated, talented people outstanding development opportunities and a lot of personal responsibility from the outset. For example, consider Andreas Braun. Even while studying computational engineering at TU Darmstadt, Braun worked at Fraunhofer IGD as an assistant researcher. After graduating, he continued working on the subject of smart living as an employee in the Interactive Multimedia Appliances department. He was awarded his doctoral degree "summa cum laude."

Smart environments and biometric procedures can support us in our daily life. Dr. Andreas Braun of Fraunhofer IGD is familiar with the needed sensor technology, especially if it is supposed to be invisible and unobtrusive.

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Professor Uwe Freiherr von Lukas and his Maritime Graphics department had been looking forward to this subject, which suits their research focus perfectly. The seas are essential for human life. We develop technologies that help use them in a positive way. What can visual computing do in this area? For example, consider abbreviation number one: FlexMoT, for "Flexible Monitoring Tool". This monitoring system is to be used primarily for environmental monitoring in the waters surrounding offshore oil and gas production platforms. We have no choice but to use maritime resources, so we need to endeavor to make the process as gentle and secure as possible. Good monitoring provides the basis for being able to react speedily to environmental pollution. FlexMoT enables the exact measurement of the concentration of gases like methane and other environmental parameters in sea water as an indication of leaks. Additionally, FlexMoT can operate autonomously for several months and, in peak times, up to a year, continually recording measurement data and submitting them to a central data reception station at predefined time intervals.

"Aerating" the Baltic Sea: on Tour with VisAnox

Another system, VisAnox, focuses on oxygen instead of methane. VisAnox visualizes the oxygen content of the Baltic Sea at our doorstep. On the exhibition ship "MS Wissenschaft," the ScienceStation at selected railway stations, and at the Science Days in Munich, visitors were able to get a visual impression of and interactively explore the Baltic Sea on a multitouch table. VisAnox is a joint project with the Leibniz Institute for Baltic Sea Research, Warnemünde (IOW), that simulates the inflow of water with high
One Network Is Not Enough

Apart from showcasing purely technical exhibits, von Lukas’ team also tours trade shows and events, where they assume the role of network coordinators. Networks such as Mini-ROV, Munitec, and Subsea Monitoring Network (SMN) bring together enterprises large and small, research institutions, and government agencies. The most important part of networking is to convince people. Be it with Mini-ROV at the Oceanology International or with SMN at the SMM in Hamburg, – von Lukas shows how even small businesses can introduce innovative ideas and contribute to the solution of complex challenges. The Mini-ROV partners drive the development of remotely operated submarine vehicles and their equipment. The objective is to use such remotely operated vehicles (ROV) to replace dangerous inspection dives by professional divers, making them safer and more efficient. SMN promotes the development of mobile deep sea observation systems and underwater monitoring. Fraunhofer IGD is involved with the flexible monitoring tool FlexMoT. And here the circle closes. Within the scope of the Science Year 2016/2017, von Lukas and his team have one more year to make a difference and draw attention to the significance of Fraunhofer IGD’s work on the subject of seas and oceans and how it can contribute to their sustainable use.

Clear Images at the Oceanology International in London

“Interactive” was also a keyword at the Oceanology International exhibition, a forum for maritime technologies in London, UK. At the exhibition, Fraunhofer IGD presented the OceanView framework, which processes data acquired by sensors in the sea, generating interactive 3D maritime models. The framework uses Web3D standards like X3D and X3DOM in order to process the supplied data automatically. But for what do we need 3D models of the sea? Using such interactive 3D models, the sea levels can be modified, and their effects and consequences can be visualized. These models display the normally invisible underwater landscape and can be used for potential construction projects. Additionally, pictures and videos provide even more precise data. However, underwater shots are often noisy due to poor lighting, air bubbles, or suspended matter. Another factor is the loss of color due to the reduced light at greater depths. It is well known that the image quality can be improved manually using suitable software. The tools of the Rostock experts, however, are specifically designed for underwater use and can correct even high-resolution videos in real time. Meanwhile, impressive achievements have been made: apart from improved image post-processing, the researchers have developed new recording procedures that additionally facilitate the post-processing. As was also evident at the Oceanology International, there is a great demand for such technology. Potential customers ranges from inspectors of underwater structures such as pipelines and offshore plants to amateur divers.
What does the Science Year of Seas and Oceans mean to you, your department, and the subjects you work on?

von Lukas: Actually, the subject suited us well. We have been working on underwater image processing for quite some time. But for about three years, we have been concentrating more intensively on the entire underwater subject area, i.e. not just on image processing, but also on visualization tools for monitoring purposes or 3D modeling. So it’s just perfect.

How would more public awareness of the subject of seas and oceans benefit your research?

von Lukas: Due to our location on the coast of the Baltic Sea, the sea is very important to us. However, the public is not necessarily aware of the enormous economic and social significance of the seas. Solutions for global transport, food for the world population, and energy reform are all closely related to the seas. Our research also benefits from this justified attention.

What else have you planned for the rest of the year?

von Lukas: Well, it’s quite simple. We will continue to use the subject as a basis for connecting the visualization technologies and the sustainable use of the seas and oceans even more closely. For example, consider the Munitect network. The two great wars of the last century left a lot of ammunition in the North and Baltic Seas. This poses a constant threat. We started our work in 2016 in order to increase the detection rate and ward off any residual danger of detonations or chemical weapons. For this purpose, we bring the partners together and introduce our technologies.
Trade Shows and Events 2016
Excerpt from the list of trade shows and events in which Fraunhofer IGD participated in 2016:

*Jugend forscht 2016* – regional contest Hessen South, Darmstadt, Germany, February 25, 2016

*CeBIT 2016*, Hannover, Germany, March 14-18, 2016


*Hannover Messe 2016*, Hannover, Germany, April 25-29, 2016

*Zukunft Lebensräume Kongress 2016*, Frankfurt/Main, Germany, April 20-21, 2016

*ehealth week 2016*, Amsterdam, Netherlands, June 8-10, 2016

*RapidTec 2016*, Erfurt, Germany, June 14-16, 2016

*iWOAR 2016*, Rostock, Germany, June 23-24, 2016


*SIGGRAPH 2016*, Anaheim, USA, July 24-28, 2016

*SMM 2016*, Hamburg, Germany, September 5-9, 2016

*INTERGEO*, Hamburg, Germany, October 11-13, 2016

*Fraunhofer Cybersecurity Day 2016*, Berlin, Germany, October 20, 2016

*Go-Visual 2016*, Berlin, Germany, October 21, 2016

*MUTEC 2016*, Leipzig, Germany, November 10-12, 2016


*MEDICA 2016*, Düsseldorf, Germany, November 14-17, 2016

*formnext 2016*, Frankfurt/Main, Germany November 15-18, 2016

*RSNA, Chicago*, USA, November 27-December 2, 2016

*18th Darmstadt Computer Graphics Evening*, December 1, 2016

INDUSTRY 4.0: AS MUCH ASSISTANCE AS NEEDED

Andrea Nahles, Federal Minister of Labor and Social Affairs, looked into the latest research on the fourth industrial revolution. Among other things, Nahles examined an application from the social augmented reality project. Here, texts, images, and videos for the next work steps of the technical staff are superimposed on the camera picture on tablets, showing existing machines in the correct position. Nahles comments: "Digitization raises many questions for enterprises, social partners, and politicians. To benefit from the opportunities of the digital change and to keep the competencies of the team up to date, learning at the workplace and work environments that are conducive to learning will play a vital role. This, in turn, can be done with the help of new digital technologies and instruments."

HESSEN’S MINISTER OF THE ECONOMY TAKES A DIGITIZATION TOUR

During a "digitization tour" through the Rhine-Main region, Ta-rek Al-Wazir, Hessen’s Minister of the Economy, examined innovative projects, research plans, and digital business ideas. In the residential center of Weiterstadt, which is technically supported by Fraunhofer IGD, Al-Wazir learned more about smart homes that support inhabitants in their daily life. At Fraunhofer IGD in Darmstadt, the researchers demonstrated other possibilities of their applications for 3D digitization of cultural artifacts and 3D color printing.
TRADE SHOWS AND EVENTS AS A REAL PLATFORM FOR SOCIAL NETWORKS

COMMENT BY DETLEF WEHNER

Social networks are in vogue: I can tell everybody where I am, whom I am meeting, and what I am doing. So far, so good. However, I need an occasion in order to send a report. I need a real person to meet and report about. And where are all the people who I can meet in the real world? Where do real people see, hear, or say interesting things that are worthwhile to report about? At trade shows, conventions, and other events, of course. So we at Fraunhofer IGD make it a point to be there.

What if the DUPLOcator had not been set up at the Hannover Messe? If would not have been possible to use it at the press preview, to have stimulating conversations with real people, and to then successfully introduce it to social media. Of course some pictures of the DUPLOcator with its new bright green base and a reference to our YouTube channel would have been sufficient to announce it, but this is merely the first step: A product becoming known through distribution in trade show media is merely the first step. Potential customers want to see it, talk about it, and, most importantly, get answers to specific questions.

The situation of Health@Hand at MEDICA was similar. Here, the lead time for the communication was even shorter. The date of the trade show had been determined long in advance. However, the exhibit was only finished just shortly before the trade show – an issue that research institutions often encounter. After all, they mainly sell development services, not products. Anyway, nothing to worry about, the people know how to finish their work on time. How can an idea be promulgated even before a trade show? One way is to invite known customers. Moreover, to spread the subject even further, we can address new customers. Social media channels are very useful in this regard, especially if this needs to be done on short notice, e.g. during the trade show.

To disseminate a subject, it often helps to post pictures featuring prominent people in social networks. When and where can such people be found? How do we get them into the frame? We need an occasion. For example, this could be a campaign where people meet, such as the Fraunhofer Day of Cybersecurity in Berlin or the inauguration of the Fraunhofer High Performance Center for Cybersecurity in Darmstadt. Pictures of Hessen’s Minister President and follow-up reports on TV (HR and SAT.1) drive home the importance of the subject. The experts now continue to follow up on the subject in bilateral or multilateral discussions.

Since we already have Industry 4.0, would it not be fitting to call this link between the real world and the digital world “Event 4.0” or “Trade Show 4.0”? Of course this would be an option. However, the most important conclusion is as follows: to achieve results, digital and real aspects need to be linked to real life as well. That is exactly what Fraunhofer IGD endeavors to do at trade shows and events.
2016
FRAUNHOFER IGD IN NUMBERS

179
FULL-TIME EMPLOYEE*

54
PART-TIME EMPLOYEE*

THE ETAT
21 mil Euros

*FULL TIME EQUIVALENT

DARMSTADT ROSTOCK SINGAPORE GRAZ
PROFILE: FRAUNHOFER IGD

Fraunhofer IGD is the internationally leading institution for applied research in the field of visual computing. The term “visual computing” refers to image and model-based IT and combines computer graphics and computer vision. In simple terms, it describes the capability of transforming information into images and extracting information from images. All technology solutions of Fraunhofer IGD and its partners are based on visual computing.

For some 30 years, Fraunhofer IGD has developed visual computing technologies and applications. While doing so, Fraunhofer IGD focuses on the users, providing them with technical solutions to facilitate their work with the computer and make it more efficient. Through its numerous innovations, Fraunhofer IGD elevates the human-machine interaction to a new plane.

The history of Fraunhofer IGD began with a workgroup set up by Fraunhofer-Gesellschaft at the TU Darmstadt back in 1987. The Rostock location was added in 1992. The Visual Computing division of Fraunhofer Austria in Graz (2008) and Fraunhofer IDM@NTU in Singapore (2010) are direct affiliates.

Since October 2006, Professor Dr. techn. Dieter W. Fellner has been Professor of Computer Science at TU Darmstadt and Director of Fraunhofer IGD. Previously, he had held academic positions at the Graz University of Technology, Austria, the University of Technology in Braunschweig, Germany, the University of Bonn, Germany, the Memorial University of Newfoundland, Canada, and the University of Denver, Colorado, USA. He is still affiliated with the Graz University of Technology, where he chairs the Institute of Computer Graphics and Knowledge Visualization that he had founded in 2005.

Since January 2016, Dieter W. Fellner has also served as Chairman of the Fraunhofer Information and Communication Technology Group and member of the Presidential Council of Fraunhofer-Gesellschaft.

Head Office Darmstadt

Since the end of 2006, Professor Dr. techn. Dieter W. Fellner has headed Fraunhofer IGD, as well as the GRIS (Interactive Graphics Systems) Group of the TU Darmstadt. On his initiative, visual computing research and other areas have been greatly expanded. Thematically and organizationally, Fraunhofer IGD in Darmstadt consists of nine research departments and a service center. The close, tradition-rich collaboration with the visual computing subject areas of the IT department of TU Darmstadt guarantees the excellence of the institute’s scientific work.

Rostock Location

In Rostock, systematic research is conducted in two core areas. In the Interactive Document Engineering competence center, the researchers address issues from the field of visualization of existential data, especially for the engineering and healthcare sectors. The competence area Maritime Graphics supports shipbuilding, ship operation, and maritime technology research customers digitally, virtually, and visually. For this, the researchers make use of their experience in the fields of virtual training environments, mixed reality, image processing, context-related work with interactive documents, and systematic handling of knowledge and computer vision. The Visual Computing Research and Innovation Center (VCRIC), which is also based at Fraunhofer IGD in Rostock, Germany, is a joint institution of the Fraunhofer-Gesellschaft and the University of Rostock. Here, preliminary fundamental research and Fraunhofer-style application research and development are conducted in close cooperation. Additionally, the Rostock location has extensive modern lab equipment. A wide spectrum of training seminars supplements the offer for the institute’s customers.

Graz Location

In 2008, the Austrian affiliate of Fraunhofer IGD started operating under the umbrella of Fraunhofer Austria. The project office of Fraunhofer IGD, which had already existed at the Graz University of Technology since 2007, was transformed into the Visual Computing division of Fraunhofer Austria Research GmbH. For the Fraunhofer-Gesellschaft, Austria is an important cooperation partner for international contract research in Europe. The researchers of Fraunhofer Austria closely collaborate with the “Visual Computing” excellence cluster established at the Graz University of Technology.
Singapore Location

In 1998, Fraunhofer IGD and Nanyang Technological University (NTU) established the Center for Advanced Media Technology (CAMTech), which became the Project Center Fraunhofer IDM@NTU in 2010. The center engages in direct research for interactive digital media (IDM). This includes the development of software solutions for modern mobile phones with Internet access, for example. The research spectrum also comprises other key areas of visual computing.

Lines of Research

The research at Fraunhofer IGD concentrates on five strategic lines of research:

Computer Graphics
Computer graphics – "image synthesis" – is a key discipline of visual computing. This area develops technologies and procedures to generate images from information. The objective is to use highly standardized data models as the basis for diverse application scenarios. Fraunhofer IGD conducts research on efficient and flexible procedures and methods in order to accommodate current trends, such as the shared use of resources, real time, and mobility.

Computer Vision
The ability to understand and interpret camera images ("computer vision") is increasingly relevant to automation and engineering processes. For this, computer vision technologies are combined with numerous sensors and thus guarantee high process stability. In this context, Fraunhofer IGD develops new and enhanced technologies for augmented reality, material acquisition, and 3D reconstruction that can capture, track, and faithfully reproduce objects as well as their position and texture at a higher speed.

Human-Machine Interaction
The interaction between humans and machines is gradually becoming more similar to natural human behavior. On the other hand, growing amounts of data are posing new challenges both for visualization and for interaction. In order to support this process, the researchers of Fraunhofer IGD develop technologies that enable humans and machines to collaborate more efficiently. In this context, they conduct research on new ways of interaction, intelligent environments, and visualization methods. They also improve the human-machine interaction in complex, security-critical, and data-intensive applications.

(Interactive) Simulation
One of the core challenges of computer graphics involves the support and acceleration of simulation processes. The term "simulation" refers to the virtual reproduction of the behavior of physical objects and physical phenomena, such as the escape behavior of passengers on ships. Fraunhofer IGD uses modern methods with integrated modeling, simulation, and visualization in order to speed up the design process and enable users to directly influence the simulation.

Modeling
Models are an important element of visual computing. They provide an abstract view of selected aspects of reality, thereby laying the basis for projection in an information processing system. Besides traditional 2D and 3D model types, Fraunhofer IGD also conducts research on more complex models with more dimensions for practical use. Supplementary information is often made used of in order to create innovative applications and networked solutions.
Key Topics

Based on its long-standing experience and intensive market analyses, Fraunhofer IGD’s work in the coming years will focus on the following key topics:

Visual Computing as a Service
The shift of value chains toward the digital world is associated with a growing need for suitable IT platforms to enable this change. The researchers of Fraunhofer IGD provide the industry with technologies on the basis of which countless other solutions can be implemented. In this context, they develop efficient and flexible basic technologies and platforms for the institute’s customers.

Individual Health
Every patient has a different medical history and reacts differently to administered drugs. This is where “personalized medicine” comes in. The way to personalized medicine is associated with a complete redesign of the healthcare sector. Visual computing delivers the technical basis for this.

Smart City
Holistic development concepts are to make the cities of tomorrow more efficient, more progressive in terms of technology, greener, and more socially inclusive. These concepts are summarized under the term “Smart City.” The solution approaches address all forms of living together.

Digitized Work
In Industry 4.0, modern Internet technologies are combined with conventional industrial manufacturing technologies across companies. Using visual computing methods, real environments, such as products and manufacturing workflows, can be captured and combined with virtual worlds such as 3D models and production plans.

Technology Labs
Fraunhofer IGD uses its labs to demonstrate the results of the departments. Moreover, experiments and studies for project work are conducted in these labs.

The following (technology) labs and demonstration centers are available to Fraunhofer IGD:
- Acti-lab
- Ambient assisted living lab
- CultLab3D pipeline
- DAVE
- Demonstration center for geoinformation management
- Evaluation lab for biometric systems
- Interactive engineering lab
- Interactive showroom & innovation lounge
- Lab for high-quality image acquisition and output
- Lab 4.0
- Maritime graphics lab
- Visual analytics lab
- Visual computing for Industry 4.0 lab
- VRAR lab

Advisory Board
The Advisory Board of a Fraunhofer institute serves advisory and control purposes. It comprises a number of renowned representatives from the fields of science and business.

Chairman
Dr. Kai Beckmann, Merck KGaA, Darmstadt

Deputy Chairman
Professor Dr. Reiner Anderl, TU Darmstadt

Members
Professor Dr. techn. Horst Bischof, TU Graz, Austria
Ekkehart Gerlach, Deutsche Medienakademie GmbH, Cologne, Germany
Professor Alfred Katzenbach, Katzenbach Executive Consulting, Gaienhofen, Germany
Professor Dr. rer. nat. Reinhard Klein, University of Bonn, Germany
Dr. Ulrike Mattig, Hessen State Ministry for Higher Education, Research and the Arts, Wiesbaden, Germany
Dr. Torsten Niederdränk, Siemens AG, Munich
Dr. Albert Remke, 52° North GmbH, Münster, Germany
Professor Dr. Bernt Schiele, Max Planck Institute for Informatics, Saarbrücken, Germany
Professor Dr. Heidrun Schumann, University of Rostock, Germany
Fraunhofer Alliances

Institutes or departments of institutes with a variety of competencies cooperate in Fraunhofer alliances in order to jointly process and market a business area. Departments of Fraunhofer IGD cooperate closely with departments of other Fraunhofer institutes in alliances such as "Ambient Assisted Living," "Big Data," "Embedded Systems," "Additive Manufacturing," and "Numerical Simulation of Products, Processes."


Fraunhofer ICT Group

The groups comprise functionally related institutes that jointly operate on the research and development market. Fraunhofer IGD is a member in the ICT Group, which focuses on information and communication technologies. The group bundles the competencies of the Fraunhofer institutes that develop and implement IT solutions for diverse industries and application scenarios. The group enables division-specific, holistic, and customer-tailored approaches, as well as competent technology advice for the industry, government agencies, and media from one source. It assists businesses and users with vendor and system-independent market knowledge, know-how, experts, and state-of-the-art technologies.

The Fraunhofer ICT Group represents 20 institutes with about 4,600 employees. The office in central Berlin is a service provider and contact for businesses, politics, media, and users for questions related to IT innovation.

The main areas that the institutes work on comprehensively cover the value chains in the IT and telecommunications industry. The member institutes boast a high innovation potential in the field of technology development.

Since January 1, 2016, Professor Dieter W. Fellner (Director of Fraunhofer IGD) has been Chairman of the Fraunhofer ICT Group. Alexander Nouak, previously department head and biometrics expert at Fraunhofer IGD, is the Managing Director.

www.iuk.fraunhofer.de/en/profile/
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2016
FRAUNHOFER IN NUMBERS

69
INSTITUTES AND RESEARCH FACILITIES

24,500
EMPLOYEES

> 2,1 billion euros
RESEARCH VOLUME
Fraunhofer-Gesellschaft concentrates on research for practical application. Founded in 1949, the research organization undertakes application-oriented research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contracting partners in the industry, the service sector, and public administration.

Fraunhofer-Gesellschaft currently runs 69 institutes and research institutions in Germany. 24,500 employees — most of whom have a scientific or engineering background — work with an annual research budget of EUR 2.1 billion. Contract research accounts for EUR 1.9 billion of this amount. Fraunhofer-Gesellschaft generates more than 70 percent of this service area with contracts from the industry and publicly funded research projects. The federal and state governments contribute almost 30 percent of the funding to enable the institutes to develop solutions that will be relevant to the industry and society in 5-10 years.

International partnerships with excellent research partners and innovative enterprises around the globe ensure direct access to the most important current and future science and business avenues.

With its clear focus on applied research and trend-setting key technologies, Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. The effect of applied research extends beyond the direct benefits for customers: with their research and development work, the Fraunhofer institutes contribute to the competitiveness of Germany and Europe. They promote innovation, strengthen technological performance, improve the acceptance of modern technology, and help to train urgently needed junior scientists and engineers.

Fraunhofer-Gesellschaft enables its employees to develop professional and personal skills that will allow them to take up positions of responsibility in its institutes, at universities, in the industry, and in society. Thanks to the practical training and experience gained at Fraunhofer institutes, students have excellent prospects of starting and developing a career in the industry.

Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), a successful researcher, inventor, and entrepreneur from Munich.

www.fraunhofer.de/en
Fraunhofer IGD collaborates with research institutions and leading enterprises around the globe. Our customers appreciate us as a cooperation partner. Here you can find a selection of companies and institutions that make use of our visual computing technologies.

- 2b AHEAD ThinkTank GmbH, Leipzig
- Airbus, Toulouse, Frankreich
- Airbus Operations GmbH, Hamburg
- Align Technology B. V., Amstterdam, Niederlande
- All-in-Image Ltd., Hertzlia, Israel
- ARCTUR d.o.o., NovaGorica, Slowenien
- ATHENA Research & Innovation Center, Athen, Griechenland
- Athens Technology Center SA, Athen, Griechenland
- ATOS, Madrid, Spanien
- Audi AG, Ingolstadt
- AVL List GmbH, Graz, Österreich
- Baltic Metalltechnik GmbH, Grevesmühlen
- BASIS Computer- & Systemintegration GmbH, Wismar
- Bergische Universität Wuppertal
- BioArtProduct GmbH, Rostock
- BioCurve S.L., Zaragoza, Spanien
- Bundesministerium für Bildung und Forschung, Berlin
- BOC Asset Management GmbH, Wien
- BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG, Bielefeld
- Bond NV, Geel, Belgien
- British Telecom, London, Vereinigtes Königreich
- BTechC, Martorell(Barcelona), Spanien
- Building Construction Authority Singapore, Singapur
- Capvidia GmbH, Neuss
- CARSA, Getxo, Spanien
- Certis Cisco, Singapur
- CIMNE, Barcelona, Spanien
- cirp GmbH, Heimsheim
- Clausohm Software GmbH, Neverin
- clesgo UG (haftungsbeschränkt), Stuttgart
- Cottés Group, Barcelona, Spanien
- Coventry University, Coventry, Vereinigtes Königreich
- CPU 247 GmbH, Potsdam
- CST AG, Darmstadt
- CSUC - Consorci de Serveis Universitaris de Catalunya, Barcelona, Spanien
- CYPE Ingenieros, S.A., Alicante, Spanien
- Dassault Aviation, StCloud, Frankreich
- Delta Electronics, Taiwan, Taiwan
- Deutsches Herzzentrum Berlin
- DFKI GmbH, Kaiserslautern
- DHCAE Tools GmbH, Krefeld
- Die Johanniter, Berlin
- DITG GmbH, Düsseldorf
- DocMorris N.V., Herleen, Niederlande
- Donerter Amortisseur, Montech, Frankreich
- EMO Extrusion Molding GmbH, Micheldorf, Österreich
- E-PATROL north GmbH, Rostock
- Europäische Union, Brüssel, Belgien
- EurActiv.com PLC, Brüssel, Belgien
- Europäische Kommission, Brüssel, Belgien
- European Sensor Systems S.A., Athen, Griechenland
- FCC, Stiftelsen Rh-Chalmers Centrum for Industrimatematik, Göteborg, Schweden
- FICEP s.p.a., GazzadaSchianno, Italien
- Fondazione IRCCS Istituto Nazionale dei tumori, Mailand, Italien
- FORCAM GmbH, Ravensburg
- FORTech GmbH, Rostock
- Fotofinder GmbH, Passau
- FutureTV GmbH & Co. KG, Rostock
- German Computer Company GmbH, Hameln
- Gnübila France, Argonay, Frankreich
- GPB Arke Ing.-Büro für Umwelttechnik..., Hemerungen
- Hahn-Schickard-Gesellschaft, Villingen-Schwenningen
- Hamburg Applications MES UG, Hamburg
- Heidelberger Druckmaschinen AG, Heidelberg
- Heinrich-Heine-Universität Düsseldorf – HNO-Klinik, Düsseldorf
- Helic S.A., Maroussi, Griechenland
- Hochschule Darmstadt
- IFQ GmbH Wismar
- IGN Institut National de l’Information Géographique et Forestière, Saint-Mandé, Frankreich
- IMATI CNR, Italien
- Infokom GmbH, Neubrandenburg
- Innovagency - Consultoria, Tecnologia e Comunicacao S.A., Lissabon, Portugal
- Innovaial Association, Bilba, Spanien
- INO-Ingenieurbüro für Numerische Optimierungsmethoden, Aachen
- INRIA – Institut National de Recherche en Informatique et en Automatique, Frankreich
- Institut für Prävention und betriebliche Gesundheitsförderung, Rostock
- Institute of Adult Learning, Singapur, Singapur
- Institute of Geodesy, Cartography and Remote Sensing, Hungary (FOMI), Budapest, Ungarn
- Intrsys, SA, Moitra, Portugal
- IQGen, Köln
- Istituto Giannina Gaslini, Genua, Italien
- ITAINNOVA Instituto Tecnológico de Aragón, Zaragoza, Spanien
- ITECAM - Centro Tecnológico del Metal de Castilla-La Mancha, Tomelloso, Spanien
- iuem - Institut Universitaire Européen de la Mer, Plouzane, Frankreich
- John Deere GmbH & Co. KG, Mannheim
- Jotne EPM Technology AS, Oslo, Norwegen
KIT, Karlsruhe
Klinikum Karlsruhe
KOMSA Business Process Services Europe GmbH, Hartmannsdorf
LDR Pte Ltd, Singapur, Singapur
Leada AG, Fildersadt
Leonardo Aircraft, Pomigliano, Italien
Liebau Orthopadiotechnik, Rostock
Liebherr-MCCtec Rostock GmbH, Rostock
Lloyd’s Register Marine & Offshore EMEA, Hamburg
Lufthansa Systems, Raumheim
Lykeus Srl, Roma, Italien
M.O.S.S. Computer Systeme GmbH, Taufkirchen
Mankiewicz Gebr. & Co., Hamburg
Martini-Klinik am UKE GmbH, Hamburg
MEYER WERFT GmbH & Co. KG, Papenburg
MIU S.A., Zaragoza, Spanien
Ministry of Defense Singapore, Singapur, Singapur
Mongabay GmbH, Leipzig
MPM Design, Dublin, Irland
Mondon Design, Berlin
Multimed Engineers SRL, Parma, Italien
nablaDot, Zaragoza, Spanien
Nanyang Technological University, Singapur, Singapur
National Institute of Education, Singapur, Singapur
Next Step Dynamics, Malmö, Schweden
NOESIS Solutions N.V., Leuven, Belgien
NOVATRA SAS, VarennesStSaiveur, Frankreich
NUMECA Ingenieurbüro, Altdorf. Nürnberg
NUMECA International, Brüssel, Belgien
OneToNet Srl, Mailand, Italien
Ospedale Pediatrico Bambino Gesù, Rom, Italien
Phacon GmbH, Leipzig
Pironex GmbH, Rostock
Politecnico di Milano, Mailand, Italien
PowerKut Ltd., Coventry, Vereinigtes Königreich
Progether SA, Oslo, Norwegen
ProSes BDE GmbH, Pforzheim
PSPENTA Automotive & Industry GmbH, Berlin
Robert Bosch GmbH, Blaichach
S. K. M. Informatik GmbH, Schwerin
Sanalytica AG, Zürich, Schweiz
scapos AG, SanktAugustin
SEAR GmbH, Rostock/Weißfels
Seazone Solutions Limited, Wallingford, Oxfordshire, Vereinigtes Königreich
SenSpec GmbH, Rostock
SES-Tec OG, Graz, Österreich
SGM Solutions Global Media GmbH, Berlin
ShareDat, Rostock
Sharedat Deutschland, Rostock
Siemens AG
SimPlan AG, Maintal
Singapore Maritime Institute, Singapur, Singapur
Singapore Sports Institute, Singapur, Singapur
SINTEF ICT, Oslo, Norwegen
SIV Software-Architektur und Technologie GmbH, Rostock
SMC Pneumatik GmbH, Egelsbach
Sonormed GmbH, Hamburg
STAM S.r.l., Genua, Italien
Standard Profil, Logrono, Spanien
Stellba Hydro GmbH & Co KG, Herbrechtingen
Stichting Maastricht Radiation Oncology MAASTRO Clinic, Maastricht, Niederlande
Stichting VU-VUmc, Amsterdam, Niederlande
Steblich Hallenbau GmbH, Güstrow
STMicroelectronics Srl, Mailand, Italien
STOLLE Sanitätshaus, Schwerin
STT Systems, SanSebastian, Spanien
SUPSI - Scuola Universitaria Professionale della Svizzera Italiana, Manno, Schweiz
symmedia GmbH, Bielefeld
Technische Universität Berlin
Technologie- und Anwendungszentrum Vorpommern mbH, Greifswald
Thünen-Institut, Rostock
Trebing & Hirnstedt Prozeßautomation GmbH & Co. KG, Schwerin
TRIMEK, Altube-Zuia, Spanien
TRIVISO Prototyping GmbH, Trier
Tronrud Engineering AS, Honefoss, Norwegen
TRV Airbag Systems GmbH, Laage
TTS - Technology Transfer System S.r.l., Mailand, Italien
TU Wien, Österreich
UCL - University College London, Vereinigtes Königreich
Universidad de Zaragoza, Spanien
Universität Politecnica de Madrid, Spanien
Universität degli Studi di Parma, Italien
Universität Kassel
Universität Konstanz
Universität Rostock
Universität Stuttgart
Universitätsklinikum Essen
Universitätsmedizin Rostock
University of Edinburgh, Vereinigtes Königreich
University of Nottingham, Vereinigtes Königreich
University of Patras, Griechenland
University of Sheffield, Vereinigtes Königreich
Universitätsmedizin Utrecht, Niederlande
VCI, Athen, Griechenland
Verband Druck und Medien NordOst e. V., Hannover
vital & phsyio GmbH, Rostock
VIVAS GmbH, Hamburg
VTT, Tampere, Finnland
VU University Medical Center, Amsterdam, Niederlande
Werner Otto GmbH, Hameln
Worldbank Energy & Extractives, WashingtonDC, USA
Wulf Gaertner Autoparts AG, Hamburg
Zentral-Fachausschuss Berufsbildung Druck und Medien (ZFA), Hannover
Scientific publications are part of the research work and are vital to increase awareness. The scientific excellence of Fraunhofer IGD is evident from the institute’s numerous publications. We engage in intensive dialogue with visual computing professionals. Here you can find an excerpt of the scientific publications of 2016.

Braun, Andreas; Wichert, Reiner; Kuijper, Arjan; Fellner, Dieter W.: Benchmarking sensors in smart environments - Method and use cases. Journal of Ambient Intelligence and Smart Environments 8 (2016), 6, pp. 645-664


Altenhofen, Christian; Dietrich, Andreas; Stork, André; Fellner, Dieter W.: Rixels: Towards Secure Interactive 3D Graphics in Engineering Clouds. The IPSI BgD Transactions on Internet Research 12 (2016), 1, pp. 31-38


Ruppert, Tobias; Bannach, Andreas; Bernard, Jürgen; Lücke-Tieke, Hendrik; Ulmer, Alex; Kohlhammer, Jörn: Supporting Collaborative Political Decision Making - An Interactive Policy Process Visualization System. INCI 2016, 2016, 8 p.


Gierlinger, Thomas; Krämer, Michel; Michel, Frank; Böhmg, J.; Bredif, Mathieu; Lindenbergh, R.; Liu, K.; Sirmacek, B.: The IQmulus Urban Showcase: Automatic Tree Classification and Identification in Huge Mobile Mapping Point Clouds. ISPRS Congress 2016, pp. 301-307

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At 18, people in Germany are regarded as having come of age. As such, the Darmstadt Computer Graphics Evening has "come of age." Every year, high-quality scientific papers are honored. The evening thus makes sure that visual computing will not suffer any shortage of excellent junior staff. This is exactly what the awards of 2016 draw attention to. To put it as the jury did, though there are winners, each individual paper that reached the final nominations was of such a quality that it would have deserved to win.

»Best Paper Award« 2016


»Best Thesis Award« 2016


Thu Huong Luu: «Adaptives und hybrides SLAM für handgeführte RGBD-Kameras» (Master Thesis)

Marcel Wunderlich: «Visual Analysis of Train Schedules Regarding Expected Delays and User Preferences» (Master Thesis)
With our applied visual computing competencies, we support industry, business, and government customers. Visual computing offers visualization and simulation technologies for a wide range of applications.

Wherever you deploy modern computer technologies, you will find application areas for visual computing and thus supporting solutions to facilitate the work of humans, who are highly vision-oriented. Especially when it comes to making engineering or aesthetic decisions speedily, you can improve the quality and quantity of your work with adapted visual computing solutions.

Fraunhofer IGD and its partners offer their customers numerous services in the field of contract research and implement these for you and with you at a high quality level.

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- Contract research for industry, business, and government agencies
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- Creation of concepts, models, and practical solutions
- Support services at the customer site
- Evaluation of software and hardware
- Visualization of information
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- Simulation of models
- Studies and consulting
- Licensing
- Training
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Our competencies are borne by technologies and applications. In our research work, we utilize a wide spectrum of methods that are subject to ongoing further development. Thanks to our comprehensive, interdisciplinary perspective, we are able to present a versatile service offer that we bundle in 14 research departments and a service center.

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VIRTUAL AND AUGMENTED REALITY

“Virtual and Augmented Reality” – this is the name of the competence center headed by Ulrich Bockholt and active in the fields of virtual reality and augmented reality. The competence center researches technologies for object recognition and tracking by means of video camera images. The technologies are used on smartphone and tablet systems in industrial maintenance, 3D interaction, and driver assistance.

VISUAL COMPUTING SYSTEM TECHNOLOGIES

Visual computing refers to image- and model-based computer science. This includes virtual and augmented reality, graphic data processing, and computer vision. The “Visual Computing System Technologies” Competence Center, headed by Johannes Behr, is on a mission to make these basic technologies of Fraunhofer IGD more available to other research groups and to German industry.

SMART LIVING & BIOMETRIC TECHNOLOGIES

The “Smart Living & Biometric Technologies” Competence Center, under the direction of Andreas Braun, develops future-oriented solutions for smart environments. Dynamic sensor systems, intelligent platforms, and innovative interaction options, as well as biometric systems, are discreetly integrated in living and working environments, intelligently assisting us in our daily routines.

VISUAL COMPUTING

To make high-end visualizations possible, modeling and simulation must interlock. The team around Eva Eggeling combines these two demanding disciplines with each other and brings immersive environments to life in this way. In the various application fields, Fraunhofer Austria in Graz thus creates visualizations for practice in order to continuously improve the interaction between man and machine.
SPATIAL INFORMATION MANAGEMENT
Eva Klien heads the “Spatial Information Management” Competence Center. Successful communication and efficient cooperation are made possible by the researchers by means of new digital spatial information technologies. In the process, the competence center explores new paths for the comprehensive integration, administration, and visualization by means of 3D spatial information systems.

INTERACTIVE DIGITAL MEDIA
Headed by Wolfgang Müller-Wittig, the research center Fraunhofer IDM@NTU, with its expertise in real-time rendering, virtual and augmented reality, and man-machine interaction, not only strengthens the “Interactive Digital Media” market, but also provides solutions for other sectors, such as transportation, marketing, and education. Due to its presence in Singapore, valuable knowledge on the regional particularities of the Asian market is gained.

INFORMATION VISUALIZATION AND VISUAL ANALYTICS
Visual analytics, semantic visualization, and real time – these are the topics of the “Information Visualization and Visual Analytics” Competence Center. The team headed by Jörn Kohlhammer creates solutions for the interactive visualization of large amounts of data, so-called visual-analytics technologies.

CULTURAL HERITAGE DIGITIZATION
With his “Cultural Heritage Digitization” Competence Center, Pedro Santos develops fast, economic digitization procedures for the true-to-the-original, virtual reproduction of real objects. In the process, geometry and texture, as well as the physical-optical material properties, are to be measured and captured automatically. In the reconstruction procedures used, the objects are scanned with various optical sensors and light sources under constant environmental conditions as much as possible for a comparably high quality.

MARITIME GRAPHICS
The “Maritime Graphics” Competence Center develops solutions for the maritime industry: shipbuilding, ship operation, and maritime technology / marine research benefit from the Center’s future-oriented developments. Under the direction of Uwe Freiherr von Lukas, researchers are combining the technical competence in (submarine) image processing and visualization with the knowledge of the special needs and basic conditions of the maritime industry.

INTERACTIVE ENGINEERING TECHNOLOGIES
Under the direction of André Stork, the “Interactive Engineering Technologies” Competence Center creates solutions to simplify decision-making processes for engineers. This is done by means of computer graphics technologies – interactive graphics and simulations, as well as modeling reality. Demanding simulation methods provide assistance through interactive presentation formats and allow for insights to be gained in complex issues.
INTERACTIVE DOCUMENT ENGINEERING
The “Interactive Document Engineering” Competence Center develops solutions for the visualization of existential data, in particular for the mechanical, plant engineering, and healthcare industries. Under the direction of Bodo Urban, researchers are working on technologies to support man in many areas of working, learning, and living, and to provide information and documents in line with needs and context and to offer intuitive interaction options.

3D PRINTING TECHNOLOGY
Headed by Philipp Urban, the “3D Printing Technology” Competence Center develops models, algorithms, and software to make printed 3D objects confusingly similar to the original. The goal is a 3D copying machine that will render original and reproduction virtually indistinguishable. The developments are headed towards 3D printing with multiple materials.

VISUAL HEALTHCARE TECHNOLOGIES
New software solutions are changing medicine and medical engineering. Imaging techniques support the daily work of doctors and have become firmly established in the hospital routine. They help the hospital staff in planning, simulating, and navigating surgical procedures. The “Visual Healthcare Technologies” Competence Center, headed by Stefan Wesarg, develops solutions so that doctors can effectively use image data when it comes to diagnostics, therapy planning, and intra-operative navigation.

For more information visit our website:

www.igd.fraunhofer.de/angebot
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