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RESEARCH NEWS

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1 3D television without glasses

When the boundaries merge between the action and the viewer, television becomes a special experience. Fraunhofer research scientists are optimizing the technologies that make it possible to watch TV in 3D without technical aids such as 3D glasses. A new four-camera system will even be able to handle live transmissions.

2 Saving electricity while playing

The federal government of Germany has decided to accelerate change in energy policy. But the transition will succeed only with the help of the consumers. They are called upon to use the energy from renewable resources in a more efficient fashion. A new online game shows how energy can be saved.

3 Early detection of plant disease

Each year, plant viruses and fungal attacks lead to crop losses of up to 30 percent. That is why it is important to detect plant disease early on. Yet laboratory tests are expensive and often time-consuming. Researchers are now developing a low-cost quick test for use on site.

4 Crash-safe battery protection for electric cars

Everyone is talking about electric drives, and the scientists from Fraunhofer are also working on them. Engineers have replaced a battery box for lithium-ion batteries with a lightweight component. Not only does the housing save weight and sustain no damage in an accident – for the first time ever, it can also be mass-produced.

5 Components based on nature's example

They are lightweight and yet strong and resilient: straw, bamboo, bones and teeth owe their surprising strength to their cleverly designed internal structures and a judicious combination of materials. The same principles can be applied to produce lighter and more durable plastic products.

6 Wireless window contacts – no maintenance, no batteries

Window contacts tell us which of a house's windows are open or closed. Researchers have now developed a fail-safe system that is particularly easy to use and needs no wiring or batteries. The sensors harvest the energy they need to run from ambient radio signals.

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 60 Fraunhofer Institutes at over 40 different locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of around 18,000, who work with an annual research budget totaling 1,66 billion euros. Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects. Branches in the USA and Asia serve to promote international cooperation.

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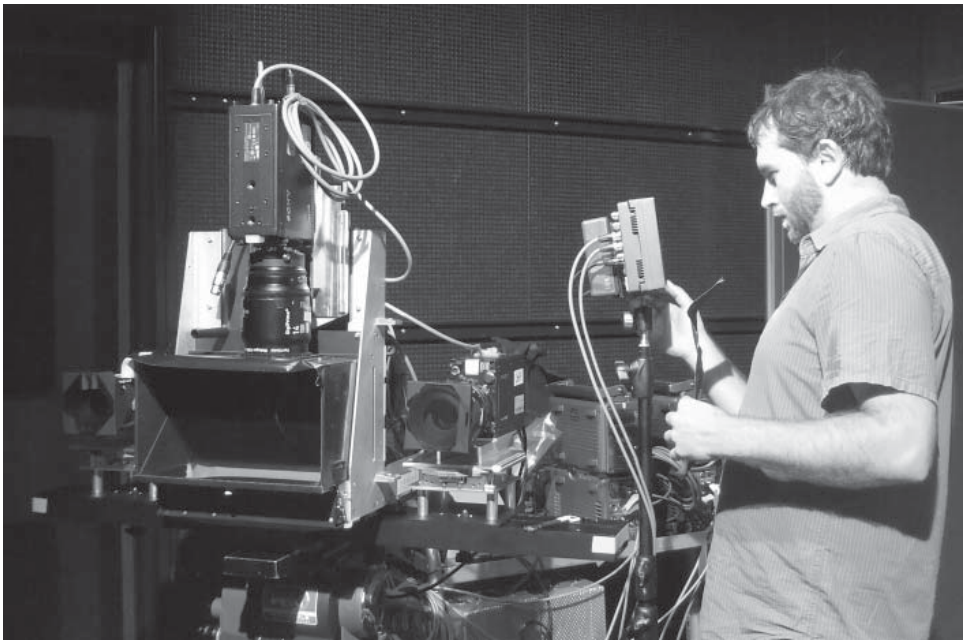
3D television without glasses

Things are looking bad for the hero, the criminals are on his heels. The TV viewers hold their breath: One of the dark figures seems to be coming straight at them... 3D glasses make the viewer feel they are right in the middle of the action. "The breakthrough for 3D television will only come, however, when you don't need glasses. Wearing them is just too uncomfortable and tiresome," states Frederik Zilly from the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute HHI in Berlin. Research scientists at HHI are therefore working with twelve partners in the MUSCADE project on technologies which will make it possible to watch 3D TV without glasses.

For this to happen, autostereoscopic displays are needed, which are coated with special optical foils. They create two different images for the left and the right eye, which is the basic principle of three-dimensional vision. To allow different viewing positions – for instance, when the viewer moves his head – these displays use five to ten different views of an image. In the future this number will be considerably higher. As conventional stereo productions only have two views, however, the captured images have to be converted before transmission, for which purpose depth information is extracted from them. In order to reliably determine the depth information, it is recommendable to use more than the usual two cameras. The MUSCADE project partners use four cameras, but this makes the already complex stereo production extremely intricate and expensive. "It can take days to calibrate four cameras to each other," explains Zilly.

Together with his colleagues the research scientist is therefore working on a four-camera assistance system which will reduce this timeframe to about 30 to 60 minutes. "The development is based on our STAN assistance system, which has already proved its value in conventional stereo productions. But with four cameras calibration is much more complicated," explains Zilly. This is because all positions and angles of the cameras must be set exactly the same so that the optical axes are parallel, all lenses have the same focal length and all focal points are on a common stereo basis. To achieve this, the scientists have developed a feature detector which recognizes identical objects in the image on all cameras. Using their position, the assistance system then calibrates the individual cameras to each other. But even after calibration small inaccuracies remain. These occur if lenses with fixed focal lengths are used, which in most cases are subject to small fluctuations. Such residual faults can only be corrected electronically, e.g. using a digital zoom. This last correction stage is carried out by the

new assistance system in real time – making even live transmissions possible. The HHI research scientists are currently working on an efficient video encoding system for compressing the huge volume of data that arises when four cameras are used so that the content can be transmitted on the existing broadcasting infrastructure. The research scientists are presenting a first prototype of the new system on the Fraunhofer booth at the IBC trade show (Hall 8, Booth B80) from September 9 to 13 in Amsterdam.



A research scientist calibrates the four-camera assistance system. (© KUK Filmproduktion)

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Saving electricity while playing

Do I toast my bread rolls in the oven or over the toaster? Should I heat the water on the stove or in the electric kettle? Do I start the washing machine in the afternoon or after 10 at night? How do I lower CO_2 emissions by the way I use energy? Answers to such and similar questions are provided by the online game "RED" – which is an acronym for "Renewable Energy Drama." Researchers from the Fraunhofer Institute for Digital Media Technology IDMT in Erfurt, Germany, have developed the Web application in the course of the "RESIDENS" project. Together with the Ilmenau University of Technology, the Fraunhofer Application Center System Technology AST, the city utility of the City of Ilmenau as well as the Friedrich Schiller University in Jena, the researchers investigate how consumers of energy can be motivated to use the energy gained from renewable resources more efficiently. The experts see great potential in online games for teaching the subject of "saving electricity at home" in an entertaining manner and to show that one's own behavior can affect how much electricity costs. "Online games are very well suited to demonstrating situations taken from daily life. The interactive character supports learning very well, since the user receives individual feedback at all times. For this reason, we designed RED as an action-oriented, interactive 3D application," explained Ms. Imke Hoppe, research scientist at IDMT.

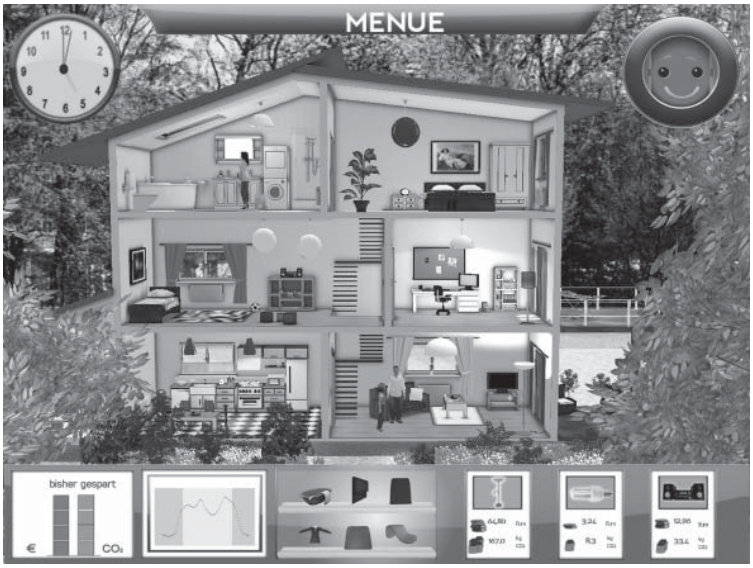
The software is targeted at adults and young people interested in renewable energies who want to know how they can save energy. "How much energy do individual household appliances consume, which ones are the energy robbers and are the high bills the results of price increases or are the uplights that are always on the reason for the high bills – RED supplies the answers. The user does not even have to invest a great deal of time, the game takes only about ten to 15 minutes," says Ms. Hoppe.

RED leads you through the daily life of a fictitious family of three. The screen shows all the rooms in a house. The user goes, via his avatar – one of the three members of the family – into each room and is able, via mouse click, to do the regular household chores such as baking food from the freezer or do laundry. If he, for example, clicks on the washing machine, an information box supplies him with information about CO_2 generation and the electricity costs for a load of laundry when the machine is full, three quarters full or half full, and it calculates how much this would cost per year.

In a second module, the online game informs the user how he can save electricity using "Smart Meters." These electronic electricity meters are currently being tested

by electric utilities in pilot projects throughout Germany. The German Energy Management Act mandates that as of January 2010 they must be installed in new buildings and houses that have been completely renovated. Taking the time of day into account, they measure the exact actual usage of electricity and show the current tariffs. This is how the consumer can identify the potential for savings and start his dishwasher only at night – when electricity is particularly cheap. He also finds out when energy from renewable resources, eco-electricity, is cheap.

The "Saving electricity at home" module will go online on September 29, 2011. The researchers at IDMT will put the second RED module, "Saving electricity with Smart Meters," online at the end of 2011. The online game can be played at www.residens-projekt.de and is free of charge.



The user can go into all the rooms of the house by simply clicking the mouse. At the lower edge of the screen, information boxes provide data on energy costs and the CO2 footprint. (© Fraunhofer IDMT)

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Early detection of plant disease

The farmer casts a worried gaze at his potato field: where only recently a lush green field of plants was growing, much of the foliage has now turned brown – presumably the result of a fungal disease. Usually, by the time the disease becomes visible, it is already too late. The course of the disease is then so advanced that there is little the farmer can do to counteract the damage done. To determine early on whether and how severely his plants are diseased, he would have to submit samples to a laboratory on a regular basis. There, researchers usually employ the ELISA method, a conventional detection method based on an antibody-antigen reaction. "These tests are expensive, though. It also takes up to two weeks before the farmer has the results of the tests. And by then, the disease has usually spread out across the entire field," explains Dr. Florian Schröper of the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in Aachen, Germany.

Researchers at the IME are now working on a new quick test that is to provide the farmer a low-cost analysis right there in the field. At the heart of the test is a magnetic reader devised by scientists at the Peter Grünberg Institute of the Forschungszentrum Jülich. The device has several excitation and detection coils arrayed in pairs. The excitation coils generate a high- and low-frequency magnetic field, while the detection coils measure the resulting mixed field. If magnetic particles penetrate the field, the measuring signal is modified. The result is shown on a display, expressed in millivolts. This permits conclusions about the concentration of magnetic particles in the field.

Researchers are making use of this mechanism to track down pathogens. "What we detect is not the virus itself but the magnetic particles that bond with the virus particles," Schröper notes. These are first equipped with antibodies so that these can specifically target and dock onto the pathogens. This way, essentially there is a virus particle "stuck" to each magnetic particle. To ensure that these are in proportion to one another, researchers use a method that functions similarly to the ELISA principle. They introduce plant extract into a tiny filtration tube filled with a polymer matrix to which specific antibodies were bound. When the plant solution passes through the tube, the virus particles are trapped in the matrix. Following a purification step, the experts add the magnetic particles modified with antibodies. These, in turn, dock onto the antigens in the matrix. A subsequent purification step removes all of the unbound particles. The tube is then placed in an appliance in the magnet reader to measure the concentration of magnetic particles.

The researchers have already achieved promising results in initial tests involving the grapevine virus: the measured values reached a level of sensitivity ten times that of the ELISA method. Currently, Schröper and his team are working to expand their tests to other pathogens such as the mold spore Aspergillus flavus.

The mobile mini-lab needs to be made more user-friendly, however, before it is ready for widespread use in the field. Rather than grapple with measurements in millivolts, farmers should be able to consult the display and determine directly how severe the level of crop disease is. If possible, the scientists also want to reduce the number of analytical steps, and hence the detection time involved.

By detecting magnetic particles, the magnet reader can track down pathogens in plants. Filtration tubes are inserted into the reader for the purpose. (© Fraunhofer IME)

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Crash-safe battery protection for electric cars

If an electric car wants to be environmentally friendly it must weigh as little as possible, because when the light turns green every additional pound/kilogram must be accelerated with considerable energy expenditure. And the lighter the electric vehicle, the longer it can be on the road without having to be plugged back into a power outlet. To advance the symbiosis between electromobility and lightweight construction, engineers from the Fraunhofer Institute for Chemical Technology ICT in Pfinztal, Germany, are developing manufacturing concepts that have one goal – they want to gradually replace individual components in the vehicle with lightweight ones. "However, this cannot affect the stability or the safety of the passenger," said Manfred Reif, project manager in the joint project "Fraunhofer System Research for Electromobility."

The fact that this is possible is proven by the researchers with the Artega GT, a sports car that was modified into a prototype with an electric drive, where the electric motor is located in the rear. The experts, along with colleagues from the Fraunhofer Institutes for Mechanics of Materials IWM, for Structural Durability and System Reliability LBF and for High-Speed Dynamics, Ernst-Mach Institut EMI, have developed a mass-production-ready, crash-safe battery housing that meets strict requirements. The battery housing that surrounds the battery that weighs 340 kilograms (749.57 lbs.) only weighs 35 kilograms (77.16 lbs.). "Traditional solutions made of steel weigh up to 25 percent more," said Reif. "The battery housing can withstand a crash, assuming a ten-fold gravitational acceleration." And even if a sharp object collides with the housing at 60 km/h (45mph), the highly sensitive battery on the inside remains intact. In addition, the 16 lithium-ion modules are protected from humidity, and a semi-permeable membrane to equalize pressure also guarantees that the batteries are able to "breathe."

What make the new battery protection so special are the new fiber-reinforced composite materials. Currently, steel components are welded together to make these boxes. "However, it must be possible to mass-produce the lightweight components," explained Reif. "Up to now, this has not been possible in this form." Fiber composites have been used for a long time in the manufacturing of airplanes; however, only a few hundred are built every year. But as far as cars are concerned, this number could be several thousand daily, and mass production involves completely different requirements as far as materials are concerned. For this reason, the scientists have developed a special process chain with cycle times that make the production of high unit counts

possible. "The process chain is designed so that many steps can be run simultaneously," said Reif. For example, the plastic is heated up parallel to the production step, and elements are prepared that ensure load and tensile strength or the attachment to the storage in the rear of the Artega. This includes, for example, directionally oriented fiberglass structures or custom-made metal inserts. All the individual components are then assembled and pressed together in a "one-shot process."

The scientists will be presenting the housing at the 2011 Composites Europe Fair in Stuttgart (Hall 4, Booth D03). Currently, the battery box must still be secured with transverse attachments in the rear of the Artega; however, the experts working with Prof. Dr.-Ing. Frank Henning are already looking at a lightweight replacement for that.

The battery housing made of lightweight component materials weighs only 35 kilograms (77.16 lbs) – 25 percent less than traditional solutions made of steel. (© Fraunhofer ICT)

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Components based on nature's example

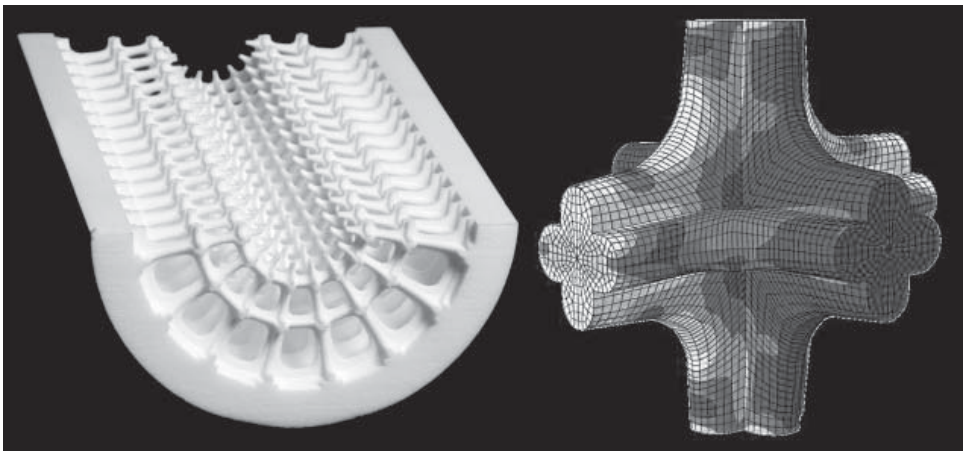
The exceptional strength of certain biological materials is due principally to their complex structure. Long bones, for instance, consist of a compact, solid outer casing filled with spongy tissue, which makes them particularly strong and resilient. Researchers from the Fraunhofer Institutes for Mechanics of Materials IWM and for Environmental, Safety and Energy Technology UMSICHT are collaborating on a project entitled "Bionic Manufacturing", which aims to develop products that are lightweight but strong and economic in their use of materials – imitating the perfected structures found in nature. The IWM scientists in Freiburg have taken on the task of identifying the best internal structures for manufactured components. "We have set ourselves the challenge of working as efficiently as nature: The finished component must not weigh more than necessary and yet still be able to perform its mechanical function reliably," explains Dr. Raimund Jaeger of IWM. This approach can be combined with a high degree of creative freedom: "Such components can be used to produce consumer goods with a high aesthetic value, such as designer chairs," adds Jaeger. And if by chance one of these bionically designed objects should break as the result of excessive loading, it will do so in a benign way – collapsing smoothly in localized areas rather than shattering into sharp splinters.

Whereas natural materials have evolved over numerous generations to reach the level of perfection we see today, engineers and product designers have to work much faster. The Freiburg research team has therefore developed a new design method. They start by constructing a virtual model of the future workpiece on the computer, filling out its contours with almost identical, cube-shaped, elementary cells. If the numerical simulation reveals that the grid structure does not satisfy requirements, the cell walls (trabecular microstructure) are refined accordingly. "We make them thicker if they are too weak and thinner if they need to be more pliable, or align them with the force lines along which the load is distributed," explains Jaeger. This method enables many different shapes to be designed around an inner cell structure that can then be evaluated and optimized using the simulation tool. To complement the simulations, the researchers carry out tests on real-life components to verify the structure's mechanical properties.

Jaeger reports that the method has worked very well every time they have used it to design any type of workpiece based on two-dimensional templates that can be pulled into the desired shape using the computer simulation. The same applies to components with a relatively regular shape. Despite their light weight, all of these

components are very strong and resilient and capable of absorbing even substantial shocks. According to the scientists, they have potential applications wherever there is a need for products that combine a high level of mechanical stability and aesthetic appearance with low weight – for example medical orthopedic devices or anatomically formed body protectors such as lumbar support belts for skiers.

Fraunhofer UMSICHT is responsible for the technical implementation of the bionic design principles. The solution chosen by the project managers in Oberhausen involves the use of additive manufacturing techniques – in this case selective laser sintering of polymer materials. This technique enables workpieces to be fabricated by laying down successive layers of a fine polyamide powder, which are fused together in the desired configuration using a focused laser beam. It is the ideal method for creating complex internal structures and, at a later stage, components with a distributed pattern of material properties, which experts refer to as functionally graded materials. The resulting structures are similar to those observed in nature.



The picture on the left shows a lightweight structure made of polyamide inspired by bionic principles. The picture on the right shows its detailed simulation on the computer. (© Fraunhofer IWM)

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Wireless window contacts – no maintenance, no batteries

It is 7:30 a.m. and high time she left the house; she mustn't be late for her 8 o'clock appointment. But the young lady still feels the need to check that she closed all her windows, because the forecast is for thunderstorms that afternoon. Later, in the car, she realizes that she forgot to check one of the rooms when she went round the house. In situations like this, window contacts can make life easier and give peace of mind. These little electronic helpers are fitted onto window handles, and they can tell from the position of the handle whether the window is wide open, tilted open or closed. They transmit this information to a base station, and the house's occupants can then see at a glance which windows are open.

Research scientists at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS in Duisburg have now developed a version of this sensor arrangement that is particularly reliable and easy to use and which needs no wiring or batteries. "Our wireless window contacts draw all their energy from ambient radio signals," explains Dr. Gerd vom Bögel, a scientist at the IMS. Until now, wireless models have been reliant on either batteries or solar cells, but both of these approaches have drawbacks. Batteries need to be changed regularly to keep window contacts operational. Solar-powered systems avoid this problem, but they too are liable to fail: all it takes is for the sunlight to be blocked by something casting an unintentional shadow over the solar cell. Solar systems are also aesthetically less pleasing because they cannot be tucked away in a dark corner of the window. Which leaves the classic setup: window contacts with cable connections. Such systems have been on the market for years. The main argument against these is the effort it takes to install them – quite apart from the fact that it is often impossible to retrofit them to existing buildings.

The new system, however, can be fitted with little effort – and they can be positioned very discreetly. Aside from window contacts, each room is equipped with a room controller. This transmitter module not only receives the data from individual window contacts, it also actively provides the sensors with energy via its radio signal. The room controller also has the function of passing the sensor data on to a central base station in the building, from which users can query the status of all windows. Alternatively, the system can be configured to permit remote querying, for instance from a user's smartphone. The only prerequisite for this is a DSL connection for the base station.

Energy management was the issue which caused the most headaches during development. "Room controllers, too, have to comply with certain limits on the strength

of their radio output. This makes it particularly tricky to get enough energy to all the window contacts in bigger rooms," vom Bögel points out. "But we have made sure all the sensor modules, antennas and components are so finely tuned to each other that the system works reliably even over considerable distances."

The IMS research scientists have already constructed an initial prototype, and they know which way they want to head next: They are hoping to integrate other types of sensor into the system along the same lines – to regulate room temperature, for example. At the moment, thermostats are generally fitted somewhere just inside the room. If a door is open, the temperature by the door will be lower than in the middle of the room. As a result, the thermostat will then unnecessarily regulate the temperature upwards. The new system would allow a temperature sensor to be placed unobtrusively precisely where a particular temperature is desired – for instance on the display cabinet by the dining room table.

Wireless contacts make it possible to monitor all the windows in a house. They can tell whether a window is wide open, tilted open, or closed. (© Fraunhofer IMS)

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