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Small radio transmitters on skis provide information on whether the skis were parallel during a run for instance.

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Signal opportunities on the slopes – with RFID

A skier gives her all, closely races past the gates in the giant slalom to the final stretch. Yet, upon reaching the bottom, the disappointment is great: Too slow once again. How come? Until now, coaches and athletes have analyzed videos to identify weaknesses in technique. "An analysis was based more on instinct than concrete measured values," explains Dr. Klaus Richter, Expert Group Manager at the Fraunhofer Institute for Factory Operation and Automation IFF in Magdeburg.

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In the future, transponders – radio transmitters and receivers – will support coaches in their work. They can be attached to an athlete's skis and transmit radio waves in every direction through small antennas one thousand times per second. The antennas are located to the front and the back of the skis. Receiving stations placed alongside a slope in regular intervals pick up the signals and analyze the time a signal needs to travel from the antenna to a station, thus accurately determining an antenna's position within three centimeters. The underlying technology is radio frequency identification or RFID. A computer calculates the position of the skis every millisecond and displays their exact path on a monitor. "A coach recognizes whether both skis were parallel," explains Richter, "whether the skier has drifted from her path in a curve and whether she is able to carve properly." Carving involves taking the turns entirely on the edge of one's skis.

The Austrian firm Abatec developed the system. Together with colleagues from the university in Magdeburg, the researchers at the Fraunhofer IFF are testing its systematic implementation in sports: What adhesive bonds the antennas to the skis so they do not loosen during a downhill run but can be detached when no longer needed? How can the radio signals be evaluated so a coach is able to draw conclusions about technique? Another challenge: Many skis contain metal layers of varying thicknesses, which shift a transmitter's frequency. Depending on the skis' design, the antennas transmit on another frequency and the base station no longer detects the signal. The solution: An additional metal plate under the antennas alters the signal so intensely and predictably that the slight differences between different skis are of no consequence: The antennas always transmit with the same controlled frequency. The technology performed well in initial tests in Bottrop ski hall and the system is now ready for use.

A researcher examines the guide wire.
Small picture: Rolled-up guide wire.

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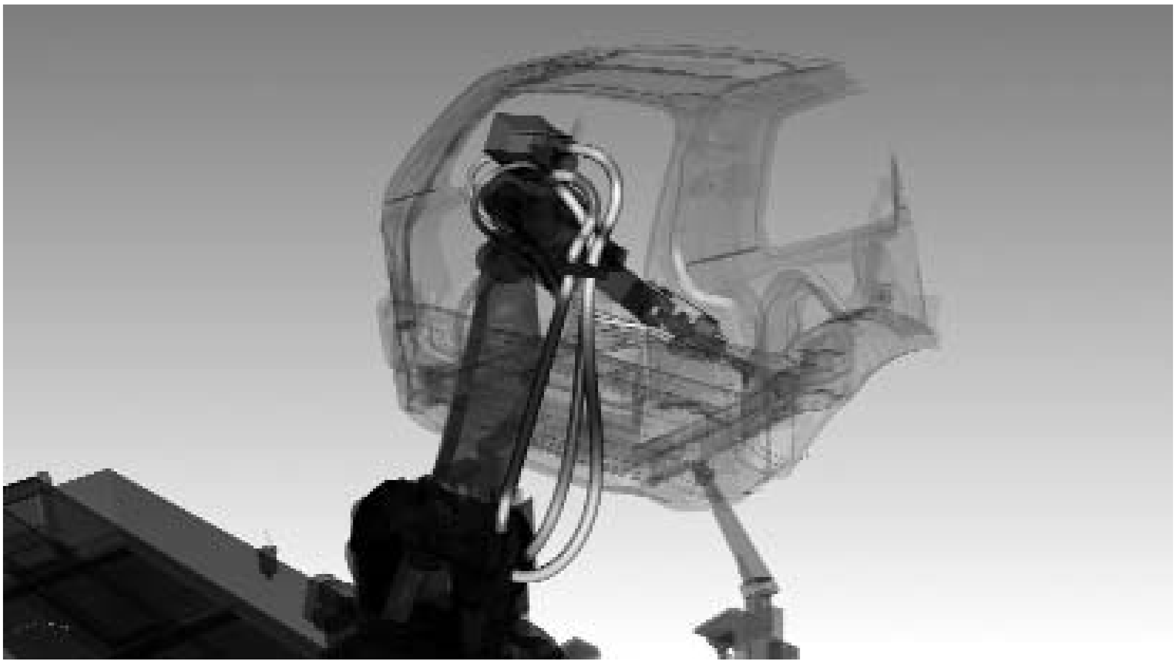
Inserting catheters without X-rays

Have the patient's coronary vessels, heart valves or myocardial muscle changed abnormally? Doctors can verify this and administer the necessary therapy with the help of a catheter, which is inserted into the body through a small incision in the groin area and pushed to the heart through the vascular system. A metal guide wire inside the catheter serves as a navigational aid. It is pulled and turned by the physician to steer and guide the catheter. At the same time the catheter's position in the vascular system has to be monitored. This task is performed by X-rays, which penetrate the patient and show exactly where the catheter is. The problem with this computer tomography method is that it exposes the patient to quite a high dose of radiation. In addition, a contrast medium has to be injected into the patient's body in order to make the vascular system and the soft tissue visible on the X-ray images.

Researchers at the Fraunhofer Institute for Production Technology IPT in Aachen have now found a way of avoiding both the radiation and the contrast medium. In collaboration with colleagues at Philips and University Hospital Aachen, they have developed a guide wire made of glass-fiber-reinforced plastic. "Because the guide wire is made of plastic the imaging can be performed by magnetic resonance tomography instead of computer tomography," says IPT scientist Adrian Schütte. "This is not possible with metal guide wires as the metal wire acts as an antenna and heats up too much – this would damage the vessels, and could cause proteins to clot." Magnetic resonance tomography has many advantages for doctors and patients. It does not produce ionizing radiation like computer tomography, and soft tissue is clearly visible, so there is no need for a contrast medium.

For the manufacture of the two-meter guide wires the researchers use the pultrusion method, which is the standard procedure for making continuous profiles from glass-fiber-reinforced plastic. "Diameters of half a millimeter or less are required for the guide wires – that's the absolute minimum," explains Schütte. The new guide wires will be presented at the JEC trade fair in Paris (Hall 1, Stand T18) from March 24 to 26 and will be used in hospitals for the first time in the next few months.



A software program simulates assembly processes: virtual robots weld a virtual car body.

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Topic 3

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Software fits flexible components

Car component designers not only have to ensure that their designs are visually appealing, they also have to think about the assembly process: Can the designed dashboard be easily installed in the new car model? What assembly paths need to be taken so that the component does not hit and scratch the car body? Thanks to a new software program, components that only exist in the form of CAD data can be virtually installed in the new car model by the assembly planners. If a component is too large to be maneuvered into place, the program gives concrete advice on where to change its shape.

The software was developed and has now been further improved by researchers at the Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC in Gothenburg, Sweden, and the Fraunhofer Institute for Industrial Mathematics ITWM in Kaiserslautern. "We can also include the pliability of components in the assembly simulation," says ITWM group manager Dr.-Ing. Joachim Linn. "In the CAD data, flexible components such as plastic parts for the passenger compartment appear rigid, but during assembly they have to be slightly bent and pressed." How much force needs to be applied to bend the dashboard far enough to install it in the car? Can the job be done by just one employee and are special tools required? How can flexible brake hoses be installed most efficiently? The researchers also simulate the use of assembly robots, whose flexible supply lines often scrape against the car body, leaving small scratches. The program computes how the robot should move and fit the parts so that the cables do not hit the bodywork.

These computations are fast – like the CAD programs the designers are used to. "You can work interactively with the program, for example to make a component longer or shorter in just a few seconds. For this purpose we slimmed down the highly accurate structure-mechanical computation processes. The results are still accurate enough but are delivered in real time," says Linn. Assembly paths, too, are computed within minutes. The researchers will give a live demonstration of the program at the Hannover-Messe (Hall 17, Stand D60) from April 20 to 24. The software is due to be launched on the market before the end of the year; support services and training material are already available.

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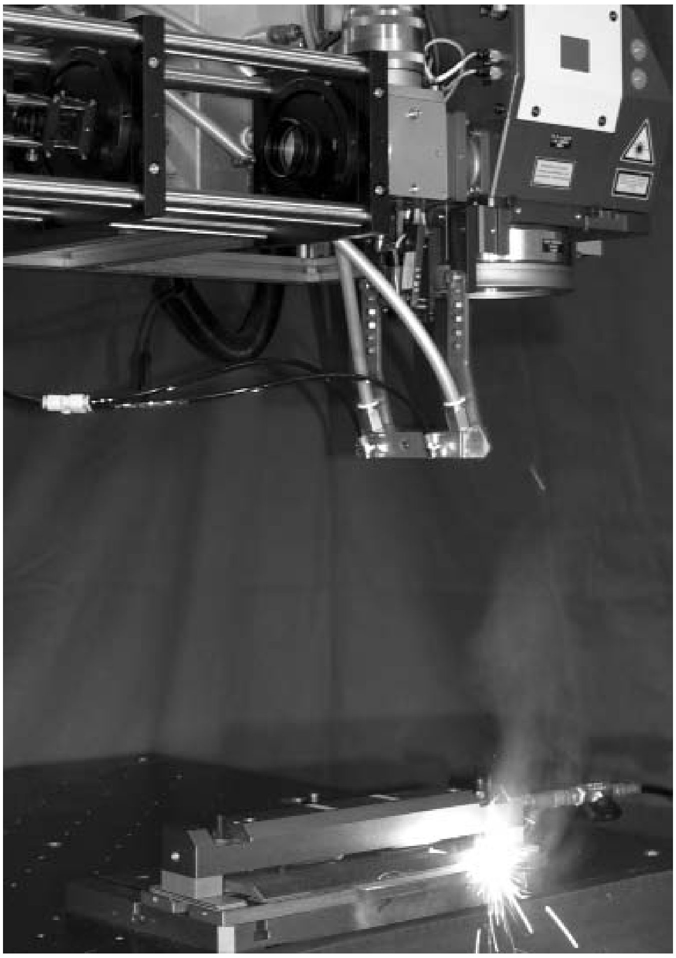

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An innovative control system adapts the laser output instantly to the welding situation.

Picture in color and printing quality: www.fraunhofer.de/press

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Research News
Topic 4

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Instant control for laser welding

Car doors are usually assembled from several sections of sheet metal which are welded together by laser. The laser beam moves over the slightly overlapping sheets and melts them in a spot measuring several tenths of a millimeter, producing a so called full penetration hole that closes again when the laser beam moves on. It is most important for the laser output power to be set correctly – if it is too low the strength of the welding connection is reduced because it does not extend over the full cross section of the metal sheets, if it is too high the laser cuts right through them. Until now welders have gauged the right laser output by trial and error and then kept it constant. A complicating factor exists, however, in that the protective glass gets dirty after a while and lets less laser light through onto the metal. If this happens earlier than usual, hours can pass before it is noticed and the metal sheets may not be properly welded. Today, welding processes are only monitored without adjustment of the laser power because the achievalble frame rate of about thousand evaluated images per second is not sufficient. For a closed loop control, frame rates of more than 10 kilohertz – equivalent to 10,000 images per second – are needed for a robust surveillance of the rapidly moving full penetration hole.

Researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg have now developed a control system for laser welding processes which adapts the output to the given situation. "Our system analyzes 14,000 images per second and uses the acquired data to adjust the laser output," explains IPM project manager Andreas Blug. So how does the system manage to analyze the images more than ten times faster than conventional software? "We use special cameras in which a tiny processor is integrated in each pixel. All these processors – 25,000 in total – work simultaneously. In conventional image processing systems the data are handled consecutively by just a small number of computer processors," says Blug. The new systems are referred to as "Cellular Neural Networks" (CNN). Just a few microseconds after the image is taken the camera delivers an analyzed picture of the contours of the full penetration hole. For small holes the system increases the output, for large ones it reduces it. "In developing this adjustment system we have achieved the first industrial application of CNN technology," says Blug. A prototype already exists, and the researchers now intend to test the system in production.

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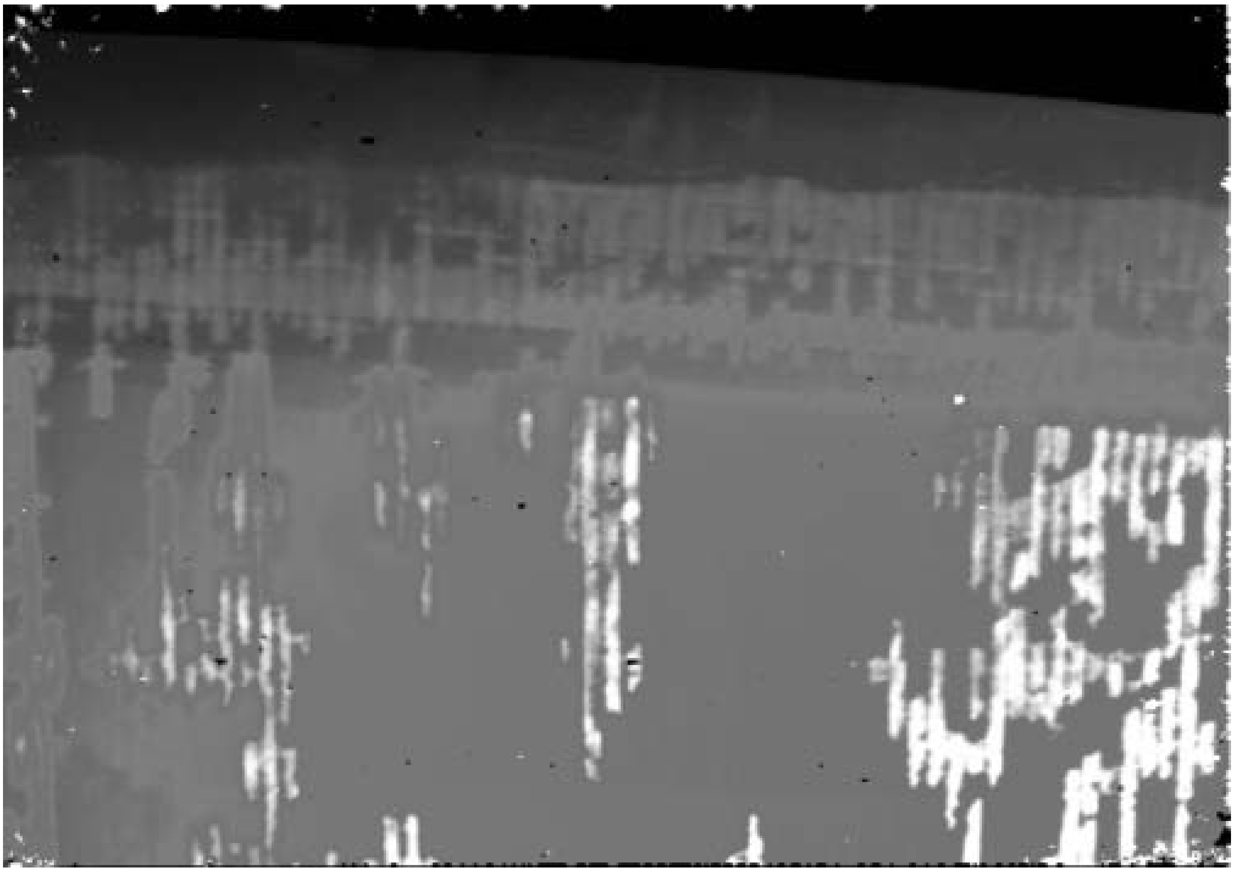

Thermographic image of air inclusions (light-colored) in a rotor blade.

Picture in color and printing quality: www.fraunhofer.de/press

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Topic 5

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Telltale heat

At first glance, the rotor blade appears to be flawless, but the expert knows that outward appearances cannot be trusted. He taps the surface and listens. A full, deep sound tells him that the laminate is homogeneous, while a more flat, hollow tone indicates irregularities in the material. Delaminated and hollow sections of a certain size near the surface can also be detected by running an expert hand over the surface material. But even an experienced inspector cannot find all hidden faults in this way.

Rotor blades consist mainly of glass fibers which are processed to form mats or meshes. In order to make a 60-meter rotor blade, hundreds of these mats have to be laid flat inside a mold and impregnated with special resins in a vacuum. Even minor irregularities can cause air bubbles or other faults to form, and these often lead to mechanical stresses in the material when the blade is subjected to everyday loads. As a consequence, the laminate can rip and cause the rotor blades to fail prematurely.

Researchers at the Fraunhofer Wilhelm-Klauditz-Institut WKI in Braunschweig are able to make such faults visible. “Infrared thermography is well suited to this task, as it is fast, relatively cheap and doesn’t cause any damage,” explains WKI project manager Dr. Hiltrud Brocke. “The surface is briefly heated with an infrared radiator. A special camera shows how the heat front spreads inside the material. If the front hits on any air inclusions or delaminated areas, it accumulates because heat spreads less in air than in solid laminate.” In this way, the researchers can peer several centimeters into the material. “Because the equipment – the infrared radiator, a camera and a computer – is mobile, we can carry out measurements during production, at the end of the transport route, and also on fully assembled wind energy plants,” says Brocke. The researchers will be demonstrating their technology on a rotor blade section incorporating several typical faults at the Hannover-Messe from April 20 to 24 (Hall 27, Stand G20).

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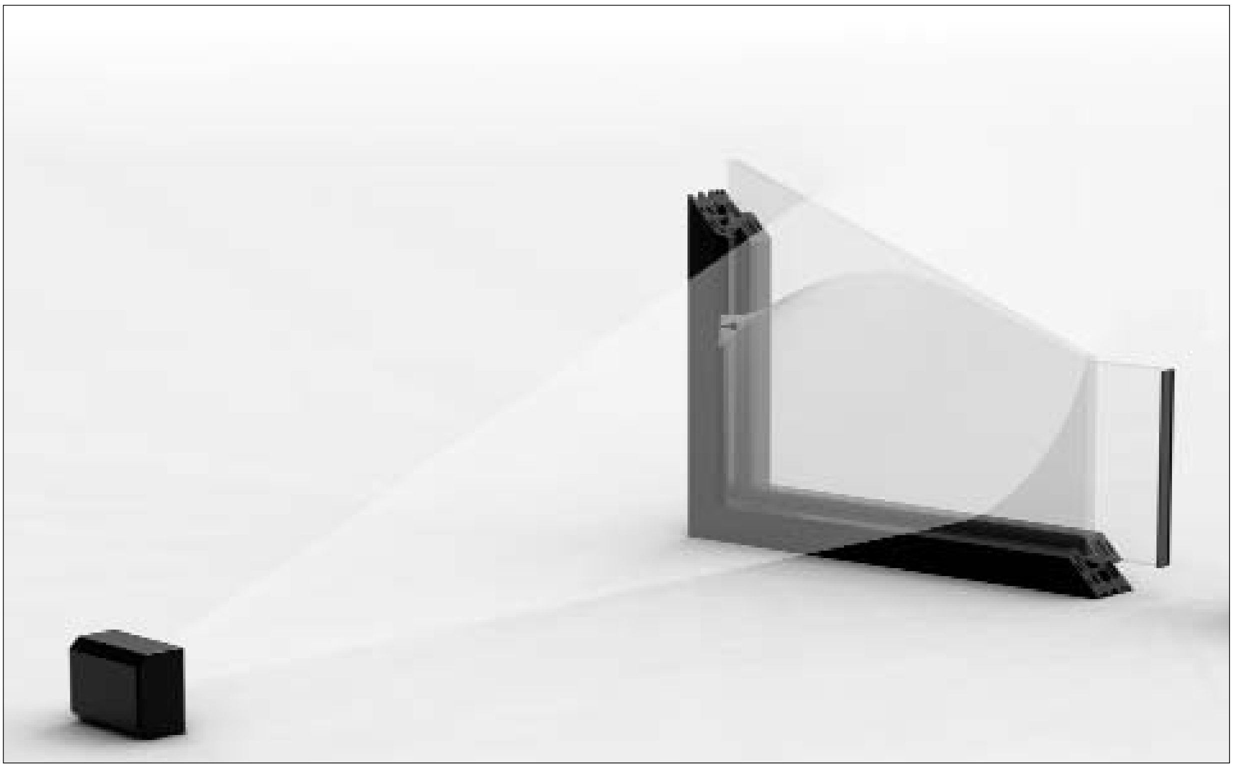

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The invisible light of a UV lamp "illuminates" the window panes and generates fluorescent radiation in the coating. This radiation is detected by sensors in the edges of the window.

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Research News
Topic 6

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Vigilant windows

It is 6 p.m. and the museum is closing down for the night. The building's alarm system is switched on and the security guard does his rounds. A novel motion sensor developed by the Fraunhofer Institutes for Applied Polymer Research IAP in Potsdam-Golm and for Computer Architecture and Software Technology FIRST in Berlin could provide even more security in future, enabling window panes and glass doors to detect movements thanks to a special coating. If anything changes in front of the pane, or someone sneaks up to it, an alarm signal is sent to the security guard.

"The glass is coated with a fluorescent material," explains IAP group manager Dr. Burkhard Elling. "The coating contains nanoparticles that convert light into fluorescent radiation." The principle is as follows: The invisible light of a UV lamp "illuminates" the window panes and generates fluorescent radiation in the coating. This radiation is channeled to the edges of the window, where it is detected by sensors. Simple applications require only one sensor. Similarly to a light barrier, if someone steps into the light of the lamp less light reaches the coating and less fluorescent radiation is produced. If several sensors are installed on all four sides of the window frame, conclusions can be drawn from the data as to how fast and in what direction an object is moving. Its size, too, can be estimated by the sensors. Is it a small creature such as a bird or is it a person? The threshold for the alarm can be set, so that moving objects the size of birds for instance do not trigger an alarm.

Likewise, the sensors do not react to light from passing cars, as the researchers at FIRST have developed a software application that can interpret different light signals. This enables the system to easily distinguish between the frequency of the UV lamp and the slowly changing light from a passing headlight. The system has further advantages: it does not infringe on anybody's personal rights, as it only detects the change in radiation, and not who triggered it. It is also cost-efficient, because the coating can be sprayed onto the windows by airbrush or glued on as a film. A demonstrator system already exists, and the researchers now plan to optimize the dyes and their concentration in the coating.

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Topic 7

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Mood player creates the right atmosphere

MP3 players and digital cameras fill home computers with a data flood of images and music. The sector association BITKOM estimated that the number of music downloads in 2008 would exceed 38 million in Germany. Until now, anyone wishing to maintain an overview of their favorite music and photos had to laboriously assign keywords to everything using cumbersome administration software.

A new approach is to sort the data according to moods. The mood player developed by the Fraunhofer Institute for Digital Media Technology IDMT in Ilmenau compiles musical slide shows to match how the user feels at the time. From euphoric, relaxed and melancholic to vigorous. The software, which is based on the GenreID music analysis tool, trains the PC to recognize different musical characteristics. Images that suit the mood are automatically added to the play list and shown at a speed that matches the tempo of the music.

For this purpose, the mood player classifies the media in real time and makes the acquired information available in a database. The mood of the images is analyzed on the basis of several distinguishing parameters, including brightness, contrast, edges, colors, textures, layout and shape. Warm colors, for instance, represent friendliness and strong emotions, whereas cold colors have a more calming, distanced and melancholic effect. Factors such as saturation, brightness, structures and the combination and arrangement of different colors are decisive in the image analysis. The pieces of music too are sorted according to mood parameters, such as volume, tone, melody, rhythm, instruments and vocals – automatically, without the need for tedious cataloging.

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