Bird's-eye view

THE GERMAN AEROSPACE CENTER (DLR) HAS DEVELOPED A CAMERA THAT CAN TAKE 3D PICTURES OF EARTH. AND IT CAN DO IT FROM A JET AIRPLANE TRAVELING AT VERY HIGH SPEED

BY BERND MÜLLER

Three-dimensional images can be created from two-dimensional pictures by shooting various overlapping shots and deriving information about the elevation from various perspectives. In the field of geo-informatics, this procedure is widespread. It helps scientists measure the elevation profile of a certain area.

More recently, however, this technique has also been used to create realistic views of towns and cities, similar to what we know from Google Earth. The images are taken partly from satellite photographs, but more frequently from photographs shot from airplanes, because these reveal a lot more detail.

But pictures taken from an airplane have one problem: only if the airplane is traveling slowly enough will the images overlap sufficiently afterward. An overlap of at least 50% is needed; even better is a ratio of 60-80%. Every point on Earth is captured in two or more pictures, and therefore from various perspectives. Until now, however, aerial survey cameras could not be used in airplanes that were faster than a propeller-driven airplane.

Images from a jet airplane

But things are changing, as the German Aerospace Center (DLR) has demonstrated. The Department of Optical Information Systems, an institute within the DLR, has developed a camera called MACS (Modular Airborne Camera System), which overcomes this speed limitation. Instead of having to travel slowly enough, the camera takes more images per second at a high resolution. As a consequence of the faster image sequence, a sufficiently large number of overlaps can be created, making it easier to derive information about elevation and enabling the synthesis of extremely precise three-dimensional photographs with ground resolutions accurate in the centimeter range.

The camera developed by the DLR team has already been used successfully on jet planes traveling at speeds of up to 750km/h. This has not been achieved anywhere else in the world.

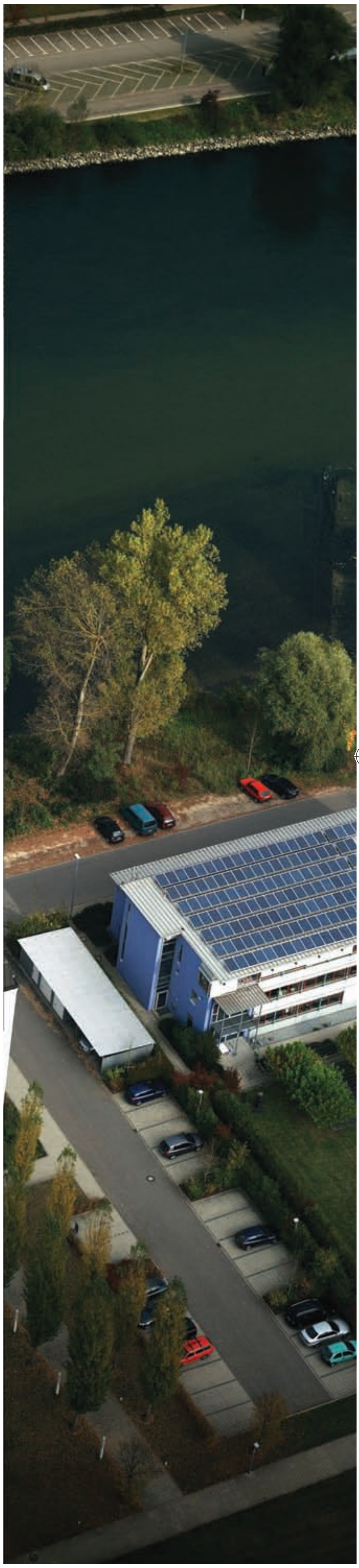
The camera system utilizes built-in camera modules from PCO AG in Kelheim, Germany. The camera body contains three modules of the type pco.4000. In total it weighs 8kg. Each module has a resolution of 4,008 x 2,672 pixels and is capable of taking up to five frames per second at this resolution. Two of the cameras with a telephoto lens take high-resolution pictures of Earth's surface. From the pictures shot with the third camera, which has a wide-angle lens, the orientation of the camera system can be calculated with an angle accuracy of 0.004°, so that the software can later align the individual images to overlap exactly. The deviation of individual pixels, which can be found on several photographs, should not exceed half a pixel.

The DLR decided to use a PCO camera because it combines several favorable technical characteristics. "There are many similar cameras on the market, some of them even with the same sensor chip, but none of them combines all of our requirements within one model," explains Sebastian Pless, head of the sensor technology team in the Department for Sensor Concepts and Applications.

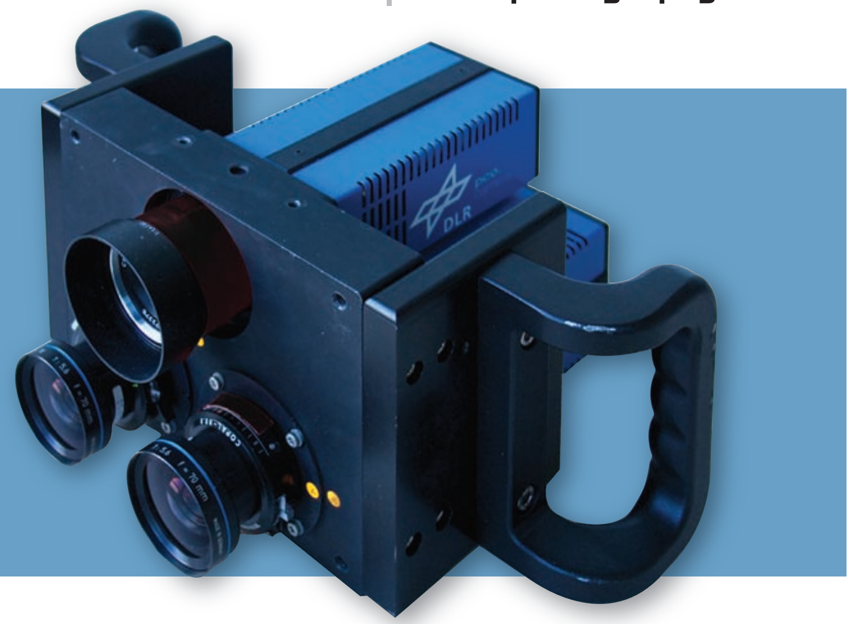
Two characteristics in particular distinguish the pco.4000 from the models of other manufacturers. The first is how the sensor is cooled. A Peltier element reduces the temperature of the sensor by 45°C below the surrounding temperature. This greatly improves the signal-to-noise ratio and keeps the 'offset' constant, therefore enabling images to be taken even when lighting is poor or when there are strong contrasts between shadows and reflecting surfaces (for example in densely populated areas).

The second key characteristic is that the pco.4000 has an electronic shutter, whereby only the read-out time determines the amount of light that is collected in the chip. This is more precise than mechanical shutters and, more importantly, makes it completely free of wear and tear. When using MACS, the DLR scientists use shutter speeds of 1/500 to 1/2000 seconds. Even at high speeds, these shutter speeds create pictures that can later be evaluated and assessed extremely well.

BELOW: This digital surface model was created from data from the MACS camera system. Pictured is the Wista technology park in Berlin



pictures courtesy DLR



> **"The photographs taken by the special camera capture the Earth's surface from up to 16 different perspectives"**

Earth from 16 perspectives

The camera can take five images per second with full resolution. As a result, overlaps of up to 98% can be achieved, depending on the airplane's speed and its distance from the ground. These photographs capture Earth's surface from up to 16 different perspectives.

MACS is not meant to replace commercial aerial photography. "It's a tool for scientific research, which enables us to further develop our software," says Pless. It has already been helpful in planning mobile phone networks, because the elevation profiles have helped determine where to place radio masts so that they optimally cover the required area.

In future, Pless's team wants to produce more three-dimensional pictures, because in reality the photographs are so far only 2½-dimensional. On pictures of a skyscraper or a bridge, for example, only those points that are closest to the camera are visible – for example the roof or the street. The vertical walls of the building or even the pillars under the bridge cannot be seen, even though this information is already embedded in the images due to the use of different perspectives. The DLR plans to create genuine 3D pictures that can even look under objects. This would be extremely useful during natural disasters, for instance. The aerial images could help monitor the erosion of dykes during a flood or judge the feasibility of various rescue options, for example from collapsed buildings after an earthquake. Tourists are also likely to be interested in the possibility of viewing three-dimensional pictures of popular attractions on the internet.∎

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ABOVE: The camera developed by the DLR team has already been used successfully on jet airplanes traveling at speeds of up to 750km/h. The camera is so fast due to built-in camera modules from PCO AG in Kelheim, Germany

CENTER: Photographs of Earth's surface can be captured from up to 16 different perspectives. The camera can take five pictures per second with full resolution. In the picture you can see the buildings of PCO AG in Kelheim, Germany