Glaciers and mountains in 3D – DLR special camera flies over Himalayas for first time

24 January 2014

Time and again, Himalayan landslides and flash floods cost the lives of dozens of people in Nepal, sweeping away entire villages and infrastructure like bridges and roads. Until now, the images of this remote region have been acquired by satellites. But now, as part of a measurement campaign by the Mountain Wave Project (MWP) set to last several weeks, scientists from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), with a special focus on security research, will test an innovative camera system that takes detailed aerial images from a motorised glider. The flights at high altitude are used for validation of the developed optical sensor system. The researchers intend to use these pictures to create precise 3D models of various Nepalese regions, among other things to improve forecasts of hazards to the population. This involves close cooperation with the Nepalese authorities and an international team comprising scientists from the states bordering on the Himalayas (ICIMOD). There are flights scheduled for the Annapurna and the southern Everest region. The scientists are maintaining a blog to provide continuous reports on the events of their audacious research travels.

"We completed the first Himalaya flight with our camera on 23 January 2014," says project leader Jörg Brauchle from the DLR Institute of Optical Sensor Systems in Berlin. He is in Nepal to lead the DLR contribution to the expedition. "We shot first-class, multi-spectral images with a resolution of 20 centimetres at an altitude of 6400 metres above Khali Gandhaki Valley. The optical data provided by the camera could not be better for 3D modelling of mountainous regions." This is the first time that an airborne camera system has been used in flights over this challenging region. The expedition has moved into its basecamp in Pokhara on the outer reaches of the Annapurna region. The team has two motorised gliders of the type Stemme S10, which over the previous two weeks had flown across Europe, Egypt, the Arabian Peninsula, Pakistan and India, before touching down in Nepal. By taking part in the Nepal expedition and contributing to its results, DLR demonstrates further applications in the filed of civil protection.

A Himalayan camera that withstands extreme conditions

The Modular Airborne Camera System (MACS), a specialised apparatus developed and built by DLR, is fitted in an unpressurised instrument container mounted beneath the wing of a Stemme S10-VTX motorised glider owned by the Aachen University of Applied Sciences. The camera was already put to the test in a flight over the Stubai glacier in the Austrian Alps during August 2013. But even before this, the innovative system had to endure a very severe set of tests in a vacuum chamber and under extraordinary lighting conditions. After all, the camera is needed in particular to photograph Himalayan glaciers and rock faces from heights above 8000 metres and temperatures below minus 40 degrees Celsius. "To do this, we drew on the expertise the Institute has in building space cameras," says Brauchle. "The conditions in outer space are even more extreme." The imaging technology in the camera system is tailored to the specific aspects of high mountainous regions. Three camera heads, arranged facing toward each other at a lateral slant, provide a vision field of 120 degrees and permit acquisition of high-resolution images of precipitous cliff faces.

Identifying the weak points on a slope

The pictures are used to create detailed computer images of the mountains regions the glider passes over in 3D and colour. DLR has its own software to do this, which it also uses to evaluate data acquired with Earth observation satellites. It is crucial that the steep sections of the slopes are rendered with particular precision. After all, the researchers around departmental

head Frank Lehmann are seeking to identify where precipitous mountainsides are at their most fragile: "Imminent landslides and rock avalanches are barely visible to the naked eye," explains Lehmann. "The 3D model allows us to integrate the images within a Geographic Information System (GIS), which permits analyses and assessments relating to possible hazards based on geological, hydrological and meteorological data."

The scientists also have their eyes on the glaciers and glacial lakes sparkling further down the valley. They are often key to making better predictions of floods occurring in lower reaches of the sweeping landscape. Seti Valley, a recent flight destination, is of particular interest to geologists and glaciologists in this respect. The river Seti is a repeat offender in bursting its banks without warning, causing flash floods. This is due to a natural dam blocking a glacial lake.

Partners in the Mountain Wave Project

"The basic idea behind the project is to exploit atmospheric mountain waves or lee waves as updrafts in a variety of mountainous regions around the world. They can lift the gliders to huge altitudes and carry them long distances," says René Heise, passionate glider pilot, meteorologist and founder of the Mountain Wave Project. On 23 November 2003, MWP set a highly publicised long-distance world record with a 'wave flight' of this kind, travelling 2138 kilometres across the Andes in a straight line. And in 2006, scientists successfully embarked on the first turbulence measurement flights over the Andes, reaching the lower stratosphere at an altitude of 12,500 metres. The insight gained during this campaign is hugely beneficial in completing MACS missions, which are highly demanding for the people and systems involved. The strong upper-level winds and downdrafts are phenomenally challenging for pilots. "Originally, the Mountain Wave Project was founded to research the wave systems in high mountainous regions and their dreaded vortex with horizontal axis of rotation, known as rotors," explains Heise. "But now we are also researching what goes on in transport from the troposphere to the stratosphere, and are analysing atmospheric turbulence, ultimately aiming to improve weather forecast systems and climate modelling." Partnering up with DLR has helped the Mountain Wave Project substantially enlarge its operations in environmental monitoring.

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On Annapurna: First test flight with camera

On the first test flight with the 3D special camera, the scientists flew in the vicinity of the 8,091-metre-high Annapurna (visible in the background).

Credit: DLR (CC-BY 3.0).

The Stemme S10 research aircraft in Pokhara, Nepal

Two motor gliders type Stemme S10 are available to the research team on site. The pod containing the DLR special camera system is fitted on a Stemme S10-VTX, which is provided by the FH Aachen.

Credit: DLR (CC-BY 3.0).

Over the Khali Gandaki valley

This is the first time that an airborne camera system has been used in flights over this challenging region.

Credit: DLR (CC-BY 3.0).

Camera pod beneath the wing

The Modular Aerial Camera System (MACS), a specialised apparatus developed and built by DLR, is fitted in an unpressurised instrument container mounted beneath the wing.

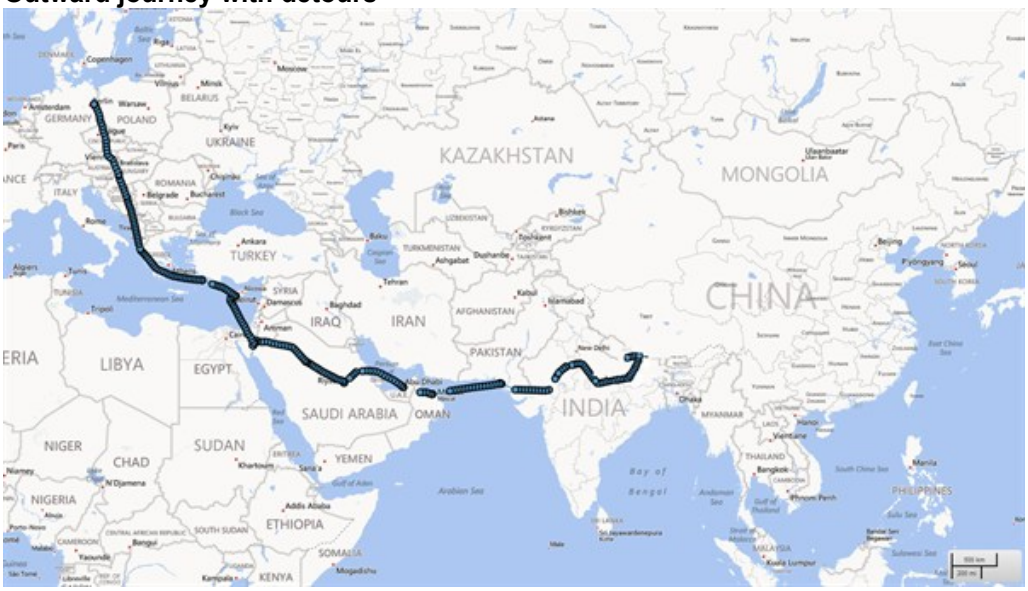
Credit: DLR (CC-BY 3.0).

3D model of the Stubai glacier in the Alps

The pictures from MACS are used to create detailed computer images of the mountains regions the glider passes over in 3D and colour. The camera was already put to the test in a flight over the Stubai glacier in the Austrian Alps during August 2013.

Credit: DLR (CC-BY 3.0).

Outward journey with detours



The ferry flight lasted two weeks: from Europe to Egypt, the Arabian Peninsula, Pakistan and India, ending in Nepal.

Credit: Tracking and mapping powered by: DeLorme inReach Satellite Communicator, www.inreachdelorme.com.

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