How DLR uses high tech to fight forest fires

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Forest fires endanger humans and nature, pollute the atmosphere and wreak economic havoc. If detected at an early stage, the damage they leave behind may be limited. Using cameras and satellite-enhanced early detection systems, DLR has declared war on the flames.

The figures are alarming: more than 200,000 square kilometres of forest go up in flames each year. In Germany alone, some 1,400 fires destroy an average of 1,000 hectares of forest area. Forest and bush fires endanger human beings, while also affecting the biosphere and the atmosphere. Moreover, they cause nearly 30 percent of all CO2 emissions. Plus: Forest fires cause enormous losses to national economies.

Forest fire with fire fighters at work.

Credit: picture-alliance/dpa

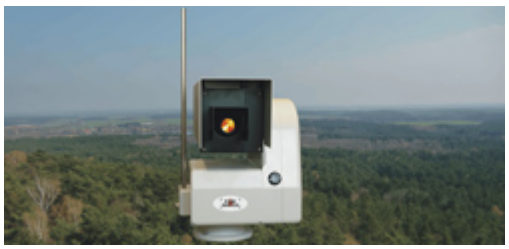
Next to fire prevention, early detection is essential to keep the consequences as small as possible. In Germany a fire is required to be reliably reported within ten minutes of its detection, for only then is it possible to fight it efficiently. For many decades, this task was carried out by trained personnel on duty on fire lookouts – a demanding and tiring job. Other countries have taken recourse to surveillance aircraft – a complex and expensive method. And up to now, systematic satellite-borne fire surveillance has not materialised yet.

DLR researchers have come out to join the fight against forest fires. As part of a number of technology transfer projects, scientists at the DLR Institute for Planetary Research and at the Optical Information Systems department of the Institute for Robotics and Mechatronics have been engaged for more than 15 years developing both camera-assisted and satellite-borne methods of early forest-fire detection. In both cases, the sensor technology used was originally developed for planetary missions to Mars and some comets.

Take FireWatch: The system is modular. It uses a configuration of high-resolution optical sensors installed on towers or masts to monitor forest areas of up to 700 square kilometres. Using its special software, FireWatch automatically and in real time scans its digital images for signs of fire, analysing smoke plumes with regard to motion patterns, structure and brightness. A special red filter attached to the lens enhances the contrast ratio between the forest and the smoke. And yet: various local conditions sometimes make smoke detection difficult. Forest structure, topography, land formation and weather situation vary widely and can thus corrupt measurement data. This may trigger false alarms, a contingency that needs to be kept as infrequent as possible.

Keener than the human eye

The technology was developed by and patented for DLR and the IQ Wireless company. In case of a suspected fire, it transmits both images and the coordinates of the fire source automatically to an alarm centre. Staff at the forestry authorities evaluate the data and report them to the fire service. FireWatch has been successfully tried and tested and offers a demonstrable benefit over land-based surveillance of forest areas, guaranteeing a quick response and gapless coverage. The system of optical sensors used for early detection of smoke is more reliable than the human eye and clearly more sensitive, particularly during night times. It will detect a smoke plume measuring only ten metres in diameter. For a full 360-degree scan including its evaluation the system requires no more than about eight minutes.



FireWatch in operation in Brandenburg.

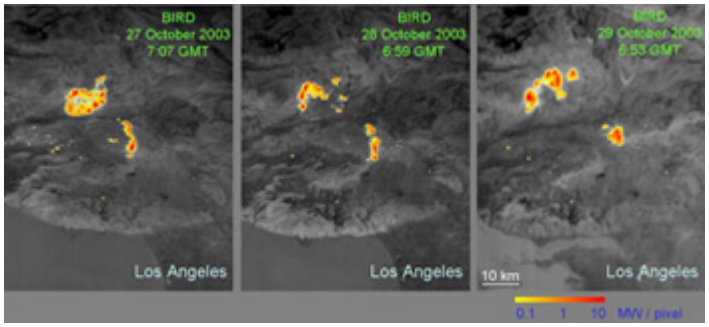
Credit: IQ wireless

FireWatch is already in use or undergoing tests at about 280 locations in Germany, the EU America and Australia. The system is thus monitoring c. 5 million hectares of forest. In Germany, nearly eighty percent of all areas with a forest fire hazard are monitored using this technology. Unquestionably, thanks to FireWatch there has been a significant reduction in the damage done by forest fires, and thus a reduction in costs. Moreover, the health and safety situation of employees working in forest fire surveillance has seen significant improvement. This has made jobs with the forestry authorities very attractive. Given that the system is modular, it can also be used for other surveillance functions once the necessary modifications have been made.

Satellite BIRD detects fires from four square metres upwards

And yet: where forest areas are very large, satellite monitoring may have its advantages, too - weather permitting. For demonstration purposes, DLR developed a small-scale satellite of the 100-kilogramm range: BIRD was brought into a 570 kilometre high polar orbit in the year 2001. Its payload consists of two infrared channels for measuring heat variation, and three optical channels for scene description and smoke detection. BIRD was able to detect a fire of no more than four square metres – making it a satellite of unprecedented sensitivity.

The power of this DLR technology, innovative instruments aside, lies in two patented innovations. For one, DLR scientists were able to develop a specific way in which the two infrared channels are connected. This is how a quantitative evaluation becomes feasible even for very small fires. Following a successful test phase with BIRD, the method made its way as an internationally recognised data product in remote sensing. And: ESA's ECOFIRE study, which was based on BIRD data, was able to indicate methods whereby quantitative measurements of fire parameters permit conclusions concerning the quantity of greenhouse gases emitted. The data thus found has the potential for substantial simplifications in emission trading.



BIRD data of the development of a fire near Los Angeles: The colour code indicates the amount of thermal energy released by the fire.

Credit: DLR.

Obviously, unlike FireWatch, satellite assisted fire surveillance deals with global problems. While, in theory, satellites could also be used to detect individual local forest fires, the data from local observation systems would usually become available to the personnel faster since satellite systems do not continuously monitor the same area. On the other hand, major, long lasting forest fires, especially in difficult, unfamiliar terrain, require a multitude of information. And this is what satellites from orbit can deliver more fully. In that respect, the two systems complement each other.

BIRD successors will improve early fire detection further

Two BIRD follow-up satellite projects with similar on-board instruments are in preparation. These projects, which involve tetrahedral explorer technologies (TET), will be ready for launch before the end of this year. BIROS will follow in 2013. The tandem of satellites will provide a significant improvement in the space-based detection of forest fires and the monitoring of their propagation. Furthermore, DLR is currently discussing with international partners concerning further components of a multi-satellite system. Putting in place such a constellation would be a further improvement of space-based fire monitoring. A welcome side effect would be the important contribution that the instruments could make to climate research, too – such as the mapping of urban microclimates.

Scientists from one of DLR's main research areas, astronautics, is involved in this project, which at the same time forms part of DLR's security research, a cross departmental programme under which defence- and security-related research and development activities are being planned and controlled.

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