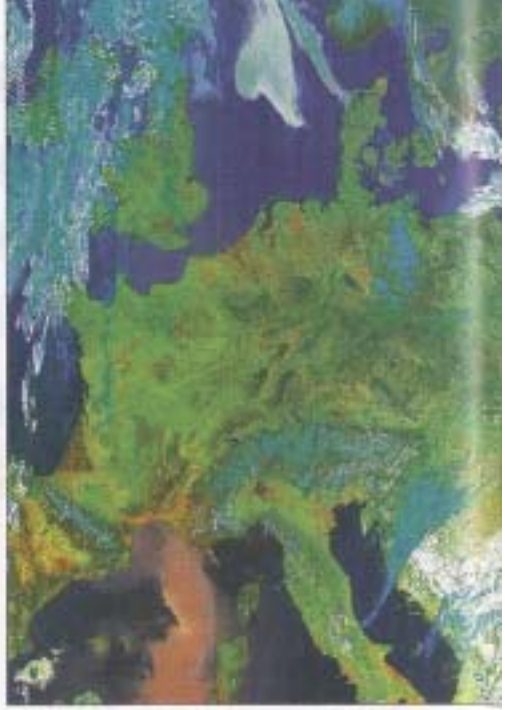
PRESENSE – Monitoring from space

Ruhrgas AG and European Partners frames a concept for an automatic remote surveillance system in space



"Essen, we see a problem!" It's quite possible that this message from space will be received in the not too distant future, and it will be most useful. Ruhrgas AG in Essen is part of a consortium of 17 European partners and operators who are working on the PRESENSE (Pipeline Remote Sensing for Safety and the Environment) development project that is 50 % financed by the EU as part of its fifth framework programme for research and technological development. The project concerns the development of a concept for an automated remote surveillance system in space, which within ten years at the most will ensure the safety of European oil and gas pipeline systems by means of a radar satellite photographic eye. In addition to planning the implementation of results, Ruhrgas AG as technology leader is coordinating the areas of the project concerning gas system operation as part of a consortium of European oil and gas network operators, technological experts and software developers.

Harmonised basic concept of remote sensing

Ruhrgas AG's gas pipeline network alone comprises about 11000 km, and in Europe as a whole there is about 200000 km of gas transmission pipeline. The EU PRESENSE project involving nearly € 4 million has been running since 1. January 2002 and will continue until mid-2004.

At the beginning of this project, which is particularly concerned with environmental safety, the emphasis was on harmonising the requirements of the many European network operators with the state of the art in remote sensing. Definition of the basic concept for the development of this satellite-based automated pipeline monitoring system has now almost been completed. Now the particular attention of research activities is focused on the solution of problems related to the analysis of the enormous quantities of image data that the computer will have to handle.

At the start of the project, feasibility studies were carried out by image analysis experts into the development of new types of image processing software. The currently available resolution of radar satellite image data is not adequate and effective enough for pipeline monitoring.

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International consortium drives development forward

Under the overall leadership of the British gas research centre, Advantica Technologies, the PRESENSE consortium consists of 17 partners from five European countries. As future users, seven gas pipeline operators are determining the basic requirements for the new surveillance system and are making their pipeline network infrastructure available for practical tests. Three flight measurement and sensor experts are preparing graphical material with simulated threats to the pipeline, on the basis of which the five specialist institutes for image processing and analysis will determine the most suitable image analysis tools, and finally two firms specialising in system integration and data handling will determine the ultimate overall system architecture.

Satellite-optimised pipeline surveillance

How are the images transmitted? The image data recorded in digital form by the satellite are stored until visual contact is established with a ground station and the data can be downloaded by radio transmission. The speciality of the pipeline monitoring system is that, from a great height and with high frequency, it provides a picture of a large area of Europe. Gas pipeline operators such as Ruhrgas AG are required by law to ensure that their pipeline systems do not affect the environment. Experience shows that this can be caused by excavators as well as flooding, erosion or subsidence, which can occur in the Ruhr area in particular. The radar satellite of the future will differentiate between all objects in the vicinity of the pipeline route, especially changes located by the coordination system, and direct the operator to the problem area. The replacement of the walking, mobile and aerial surveys of high-pressure gas pipelines by satellite sensor surveillance is but one aspect of the booming satellite sensing sector.

Current satellites for optical surveillance of the earth guarantee a resolution of 0,5 m. In three to four years time a satellite radar image resolution of 1 m ought to be possible (currently about 6 m), which will ensure that the smallest object on gas or oil pipeline routes is recognisable. The pipeline axes that lie below are usually at a depth of about 1 m in the soil.

Changed requirements of the current satellites standard

Current commercial satellites with the necessary image resolution are quite simply too expensive and are packed with multifunctional equipment that is not necessary for the specialised satellite surveillance of pipeline routes, but which must be paid for. In addition, the necessary image resolution software for a pipeline surveillance corridor about 200 m wide is still being developed. The current commercially available satellite image standard provides an image section of 11 x 11 km, which is barely effective for pipeline monitoring. The PRESENSE project is therefore striving to achieve an image with a narrow corridor using an analysis capability that is able to distinguish an excavator at work from a combine harvester or a

moving car by means of a correspondingly higher resolution.

More importantly, however, the expensive, but theoretically useable commercial satellite technology does not have the optical ability to cope with a commonplace phenomenon of the German and north European climate zone: extreme weather conditions and especially cloud, which permanently covers 40 % of the earth's surface. The proposed one-metre radar satellite, which will not be available until 2005 at the earliest, would have no trouble with this sort of visibility problem, even with variable ground conditions, buildings or vegetation. Due to the orbiting frequency, several satellites will probably need to be used in order to clearly depict a specific point at short intervals.

PRESENSE combines various requirements

The PRESENSE project designed on a European scale anticipates the fundamental technical possibilities of the near future. It tries to combine the requirements of the various pipeline operators with the possibilities of satellite sensing and to motivate satellite operators. The various European partners had to be brought together, starting with their topographical and meteorological specifications and including various types of data evaluation and software systems. As Werner Zirnig, departmental head at the Dorsten Development Centre of Ruhrgas AG, says, "it is also in our interest to find out how we can combine the high potential of currently available technology into an appropriate and efficient system".

The next step in the development of PRESENSE, before the planned satellites can be built, consists not only of mounting the cloud-compatible radar sensor technology (SAR - Synthetic Aperture Radar Systems) in an aircraft. Other equipment must also be tested for possible evaluation suitability at heights nearly simulating space, including laser location procedures, thermographic detectors with infrared recognition and image conversion capability of bodies, as well as high-resolution digital cameras or hyperspectral sensors that can determine the character and features of the earth's surface. In general, recordings from a height of 3000 m simulate images taken from space. Naturally, holes will be dug in the ground and excavators will move to and fro so that the satellite image equipment can be set to track the foremost foe of high-pressure gas pipelines.

Finally, development of the technology is governed by cost-benefit considerations. Progress in high-resolution remote sensing is naturally intended to "undercut" the current high costs of frequent walking, mobile and aerial surveys. There is only one financial aspect that cannot be currently calculated: How many satellites will be required in space for daily operation? The life of a satellite is five to seven years, but this is surely a profitable investment in the improvement of protection for industrial installations on our planet.

The constantly updated image data of pipeline monitoring systems could also be used for the special requirements of cartography and land usage classification, or perhaps for evaluating the consequences of natural disasters.

17 partners from five countries

Belgium

- Fluxys

Germany

- Definiens Imaging
- Deutsches Zentrum für Luft- und Raumfahrt
- Intermap Technologies
- Ruhrgas AG
- Verbundnetz Gas AG

England

- Advantica Technologies
- BP Exploration Operating Company
- Integrated Systems Solutions
- Natural Environment Research Council BGS
- Nigel Price Associates
- University of Nottingham

France

- CS Systèmes d'Informations
- Gaz de France

Netherlands

- Nederlandse Gasunie
- National Aerospace Laboratory NLR
- Netherlands Organisation for Applied

Finally a rather curious but true, and more light-hearted sideways glance at another of the possibly many applications of satellite sensing. The Californian wine-growing legend Robert Mondavi and his technical director Daniel Bosch are clearly delighted with satellite recordings and the evaluation of aerial images. Space images supply targeted information about the optimum plots of land and locations on which Mondavi should plant his vines. After all, spatial analysis of images from the colleague in space 700 km away provides decisive insights into the finest variations of topography and microclimate. With the help of satellite surveillance Mondavi has even analysed the number of leaves and quality of vine growth and even the best possible time for wine-pressing. So, cheers! and long live satellite interpretation.