Automatic remote surveillance system for the prevention of forest fires

“FIRE-WATCH”

Short description

The technical development in the areas of sensor technology, digital camera technology, image processing and industrial computers resulted in the development of a system for the optical, automated early recognition and warning of forest fires. A test phase of several years in Brandenburg (Germany) justified the required parameters for reliable smoke identification up to 10 km, in good visibility up to 40 km.

The Research and Development team of IQ wireless GmbH initiated the development of prototypes of the system in Brandenburg in 1992.

The FIRE-Watch system is ready for mass production, and can be adapted to different technical specifications.

Currently FIRE-Watch is in already in full operation in 18 sites in Brandenburg, as well as successfully installed in Mecklenburg-Western Pomerania at 4 sites and one in Saxonia.

Introduction

Forest fires, wildfires and bushfires worldwide annually cause damage to the amount of billions of Euros - with costs rising. The environmental impact is also detrimental, human lives are lost, and irreparable damages occur to art treasures and historical buildings.

Most of these can be prevented, or considerably reduced, if there is a timely and automated alert. Of less importance so far was the implementation of such systems in large open areas, which, with conventional signalling systems are detected too late or not at all.

These include:

- Forest fires, wildfires and bushfires,
- Waste dump fires,
- Fires in industrial plants (chemistry, depots),
- Fires in military training areas.

The federal state of Brandenburg, with its forest surface of 1,1 millions of hectare is country wide the province with the highest forest fire hazard (forest fire risk class A1 and European Union classification).
About 30% of all forest fires in the Federal Republic of Germany occur here. There were up to 1,000 forest fires per year with a total damage of several million Euros.

In order to be able to fight the forest fires effectively, they must be identified and located as early as possible.
In many countries, the present conditions for the detection and prevention of said fires are not reliable and efficient.

As situations worsened, the deployment of modern electronic detection methods is inevitable and economically viable.

The idea to enhance the AWFS system with a high-tech video-supported image processing system was already conceived before 1990 and suggested to the forestry authorities.

During 1992-1994 the first field tests were completed with digital video cameras (testing of the recognition range under normal visibility), still without smoke identification software, in the district of Halbe with support of the forestry authorities of Königs Wusterhausen.

Afterwards, a consortium of three German companies, together with the German Council for Air and Space Travel (DLR) developed a completely updated version of AWFS. The design engineer of IQ wireless was solely responsible for the planning and the project management of this system.

The AWFS is based on remote identification of smoke in the designated areas. In laboratory and field tests the proof was furnished that smoke identification and an early alarm is possible over large distances up to 40 km in good visibility.

The optical, land-based smoke identification procedure was selected out of various possible detection methods for forest fires, as the most effective, reliable and accurate procedure.

FIRE-WATCH

FIRE-WATCH resulted as a consistent improvement of the AWFS with the goal to achieve mass production for a system with increased reliability. Additional to this is the independent development of the recognition software by the DLR e.V.
IQ wireless GmbH was responsible for the redesigning and prototyping of all relevant hardware, including the CCD camera. This was done in conjunction with the development by the DLR. Thus the quality of the system as well as the operative logistics was further improved.

Purpose

FIRE WATCH is a tower-sustained, automatic, early smoke detection system for the prevention of forest fires, over large distances with automatic transfer of the alarm-related photos to a pre-designated control centre, where then evaluated and acted upon by relevant staff members.

Capability characteristics

- Automatic detection of smoke with an expansion of up to 10x10 m in a range of up to 40 km distances in daylight. Included is automatic messaging and alerting within 8 min to a monitoring or control centre,
- High image quality from the picture recording to the control centre,
- Computer for the visualization of the alarm pictures,
- Online data processing and picture storage locally over a short period,
- High reliability under all operating conditions (accurate recognition security, few false alarms by influences such as sun, wind, artificial smoke and sources of dust, tower fluctuations),
- Archiving of all events locally and in the control centre
- Highly economical.

Advantages of FIRE-WATCH

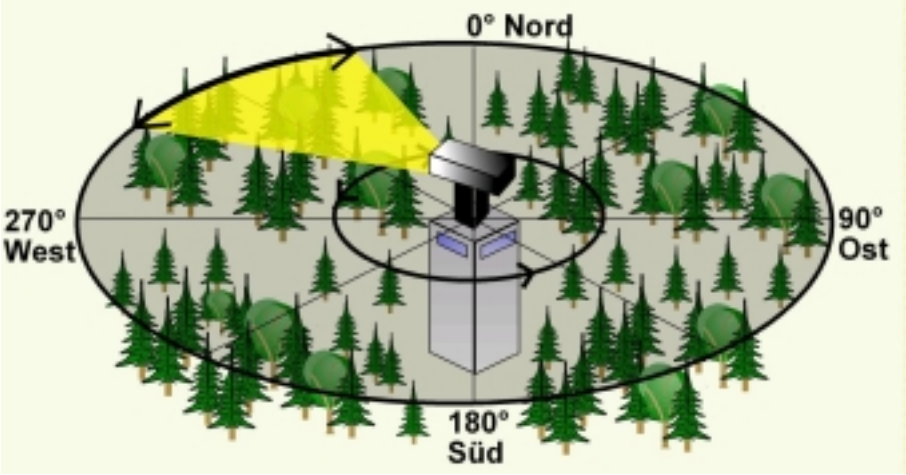

Illustration 1
Illustrated surveillance
Range of the camera

- Quick and comprehensive monitoring of large areas with a rotating, high resolution camera system and automatic recognition of smoke clouds by computer-aided image processing locally,
- More rapid smoke discovery than AWFS and thus decrease of the fire damage,
- High quality of recognition,
- Increased aim accuracy by use of a modern pan/tilt head,
- Lowering of the entire cost of surveillance,

- In addition to ISDN, the cost of data transmission can be lowered by the implementation of the WLL radio system IAP, developed by IQ wireless GmbH,
- Improved service and maintenance conditions,
- Control of the alarm pictures in the control centre
- Graphic data storage locally and in the control centre
- Improvement of working conditions
- Avoidance of human errors
- When smoke is detected, an alarm is sound parallel to the transfer of high-resolution images to the control centre (over radio or ISDN)
- Automatic smoke detection (recognition and alerting the control centre) takes less than 8 min.

Components of the system

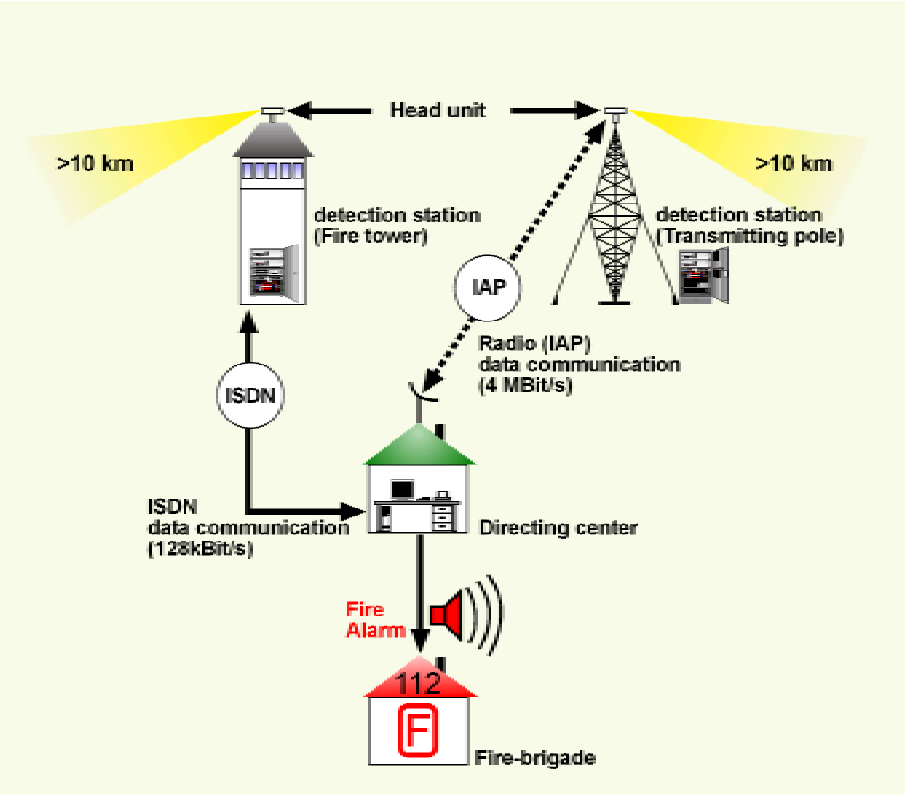

Illustration 2
System components off FIRE-WATCH

Camera unit

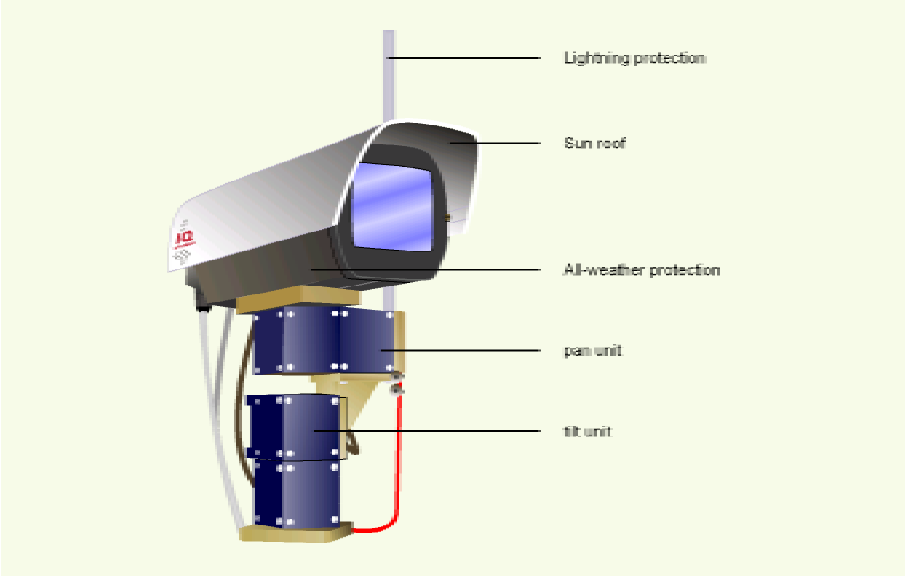

Illustration 3
FIRE-WATCH camera

- Weather-protected head unit with small dimensions
- Digital s/w CCD camera with high resolution (> 1,024 x of 1,024 pixels) and 14 bits grey tone dynamics,
- Use of a highly soluble special lens with optical filter
- Enclosure housing with special windowpane and sun protection housing

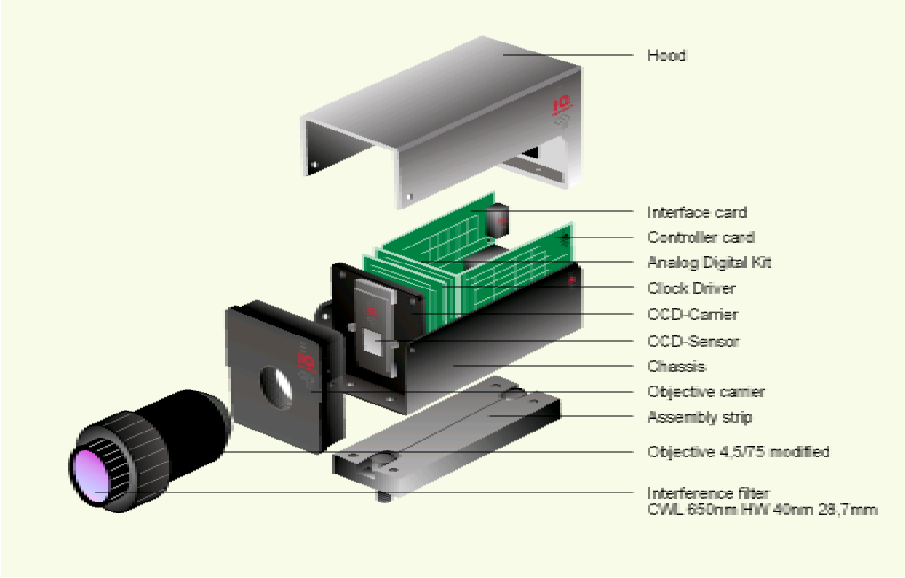

Illustration 4
Detail of the FIRE-WATCH camera

- Image and data communication over LWL into the computers at the bottom of the mast / tower,
- Excellent EMV parameters
- Automatic control of image recording, line of sight and data transfer

- Optional mast extension of the head unit, if and when obstruction of vision occurs by other antennas etc.
- Lightning and high voltage protection
- Operating in temperatures ranging from -20° C to +60° C
- Durability
- Modular installation

Illustration 5
FIRE-WATCH camera unit mounted on a radio antenna

Computers

- State of the art modern computer technology for use of image capturing, storing options for longer periods, graphic data compression for rapid transfer of the graphics to the control centre, telemetric control of the camera and the pan/tilt head, bi-directional telemetry data communication for control problems and status reports
- Password-protected remote access of the entire computer functions at the main control centre, also for service and maintenance purposes (software updates and remote maintenance inclusive)
- Transfer protocols (automatic picture transmission and communication to the control centre) according to the local specifications (POTS, ISDN, radio)
- Uninterrupted power supply (UPS)
- Cabinet as per environmental conditions (indoor cabinet and/or outdoor climatic cabinet)

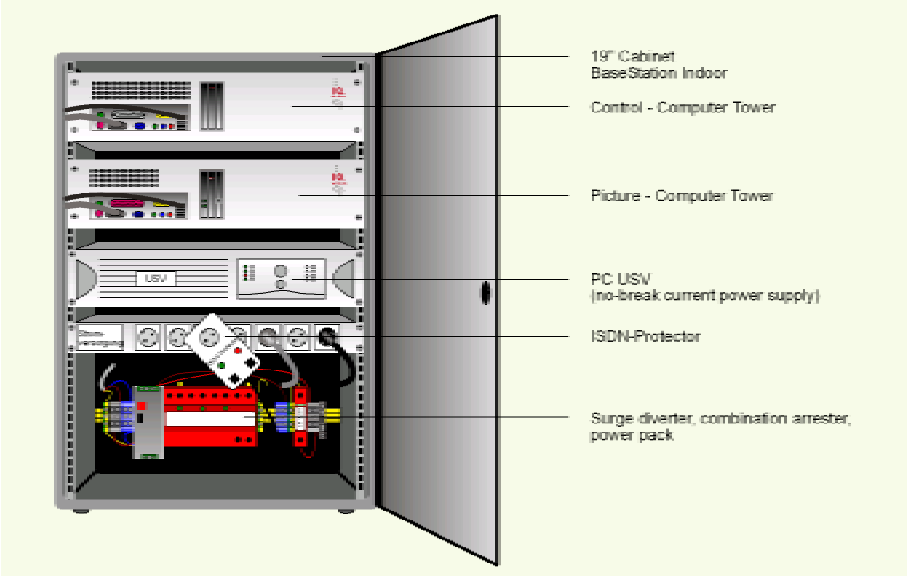

Illustration 6
Indoor-cabinet

Software

The software consists of 3 units:

- ***fire detection software***, recognizes smoke on the basis its typical characteristics in a screen sequence (multi-level decision-making process) and releases alarm,
- ***Control software*** for controlling the system, telemetry, and graphic data storage over a short period, data compression and the transfer of the data via ISDN, satellite, radio (i.e. IAP) to the control centre,
- ***Control centre software*** for visualization, maintenance, position indication of the fire source on electronic maps, data archiving and evaluation
- Software update possible according to agreement
- Remote configuration and system updates are possible

Data transfer possibilities

- ISDN (128 kBit/s)
  compressed picture and data communication to the control centre. Interruptions may be caused by lightning, but can usually be overcome by repositioning of the cables. Relatively high operating cost

- IAP-radio (128 kBit/s to 4 Mbit/s)
  digital radio cell with a range of 50 km radius; further cells are possible in the group; can be used in addition to the image and data transfer for receiving of general local weather condition updates, etc.

Note:

The graphic and telemetric data is compressed to facilitate faster and more economical transfer to the control centre; the FIRE WATCH system uses the most modern certified procedure available.

Control centre

- Ergonomic equipment at the centre to process the necessary tasks Additional computers possible if required, dependant on the number of controlled head units (max 5 per monitoring computer)
- The control centre software decompresses the transferred data automatically, and indicates the source of the fire on the digital maps available,

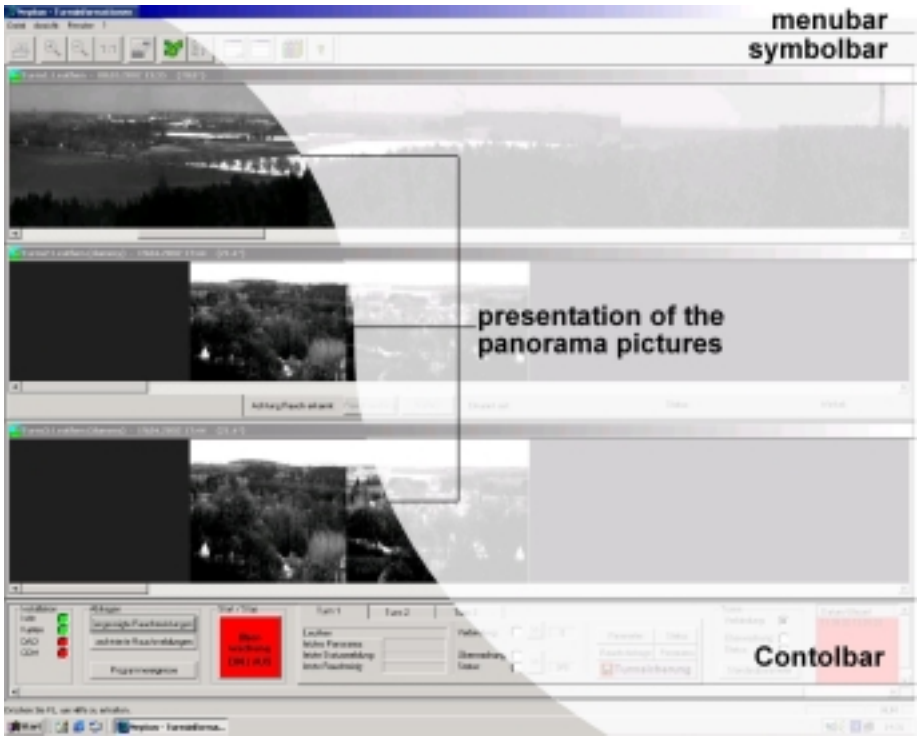

Illustration 7
Structure of the control centre software NEPTUN

Panorama pictures of 3 head units

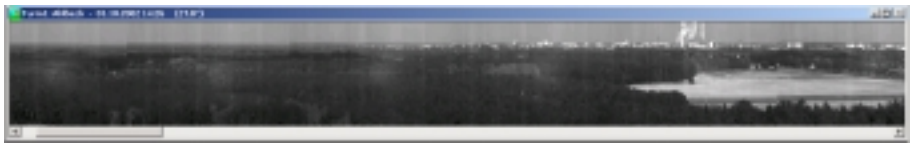

Illustration 8
Panorama picture

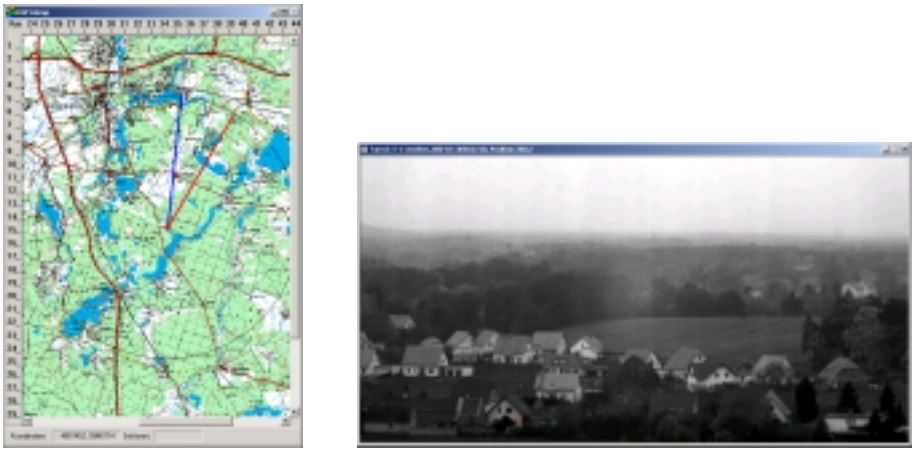

Illustration 9
General map / picture frame

Remote control of the camera is possible. One monitoring computer can administer up to 5 cameras (towers). The user in the control centre is at any time able to reconstruct the movements and data processing of the detection unit on the tower (the archives can be accessed locally, without interrupting the smoke detection sequence) and, if necessary, participates interactively. An uninterrupted power supply insures the operating of the control centre for a specified period of time in the event of power failure.

General system data

The required minimum life span of the forest fire early recognition system of 10 years is justified by appropriate selection of the technology.

During the active period of operation of FIRE WATCH a maintenance service is possible according to the range of the systems, the regional distribution and local requirements.

Operating variants of FIRE-WATCH

The basic variant of FIRE WATCH is used for an automatic remote observation of dumps, industrial areas, power stations etc, over large distances (distances to approximately 25 km) for security instances, military authorities and protection of buildings. An infrared camera is used instead.
The system can also be adapted for extensive long-term investigations of biological objects and surfaces to assess the impact on the environment (i.e. insect attacks, change of chlorophyll, plant growth etc.)
Remote monitoring of country borders.

Co-operation

The implementation of the system is a joint venture between the companies involved, which assures a high level of expertise in all instances.

The continuous supply of FIRE WATCH is legally guaranteed by the continued and agreed availability of the license for the smoke identification software by the Deutsche Luft und Raumfahrt (DLR e.V.).

The installation of the surveillance system for security purposes is progressing rapidly, based on the success and good track record of the systems already installed.

Abbreviations

AWFS	automatic forest fire early warning system
POTS	analogue participant final connection
ISDN	digital participant final connection
CCD	Charge Coupled Device
LWL	Fiber-optic cable