WILDFIRE MONITORING AND EARLY WARNING SYSTEMS

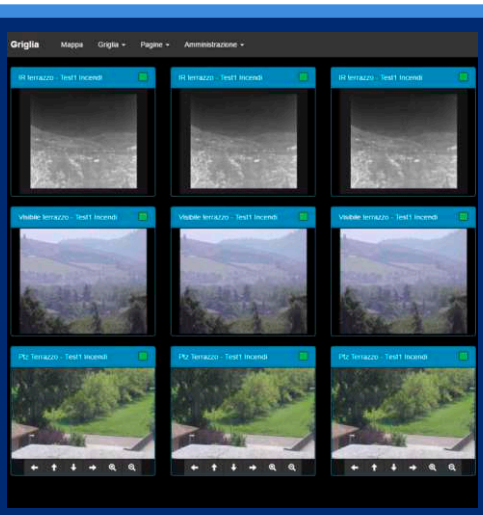
Wildfires are one of the most important causes of change in the environment and deterioration of the landscape, cause serious consequences for the natural balance and require a long time for the forest ecosystem and environment to recover. They also facilitate the instability of slopes which cause the surface soil to slip and be removed in case of intense rain.

The wildfire monitoring system offered by CAE aims to support the decision-making process by the various entities operating within the scope of Emergency Services, and is particularly suitable to protect the population and to support timely and effective intervention by the fire-fighting authorities.

The infrastructure is based on the MHAS platform (Multi Hazard System), a complete state-of-the-art multi-risk tool. The system can:

- **Calculate ignition risk indexes**;
- **Continuously visually monitor the area**, by means of high-zoom cameras that can also be controlled remotely;
- **Identify the ignition of a fire hotspot early**;
- **Integrate forecast models** that allow displaying the probable spread of the fire front over the landscape on geo-referenced maps.

Overall, the system can process the data that were received and identify precisely and timely all fire hotspots that are detected by the optical system as soon as they arise. The system consists of **automatic lookout stations** based on **heat cameras**, **camcorders** and **software tools** to be used in a control and surveillance Centre.



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DETECTION STATION

The fire hotspots are identified by means of a system of **extremely sensitive cameras** to detect **thermal images**, which are analysed by the system in real-time. The purpose is to identify with the maximum accuracy any fire hotspot and to **determine the geographical coordinates of the detected fire by a combination of visible and thermal images**. The system can be configured to be more or less sensitive in detecting hotspots. The **cameras** can be **controlled** in real time from the central control station allowing the operators in the operating rooms to **video-monitor** the area covered by the detection stations, zooming in powerfully to check and validate automatic alarms generated by the hotspot detection system. Furthermore, a **video stream is always active and used by the system to save an interval** of images, pertaining to the stages preceding the detection of the fire hotspot. In this way the natural or human causes that ignited the fire can be examined during post processing.

Each lookout station comprises:

Sensors to measure the main weather parameters

Normally these are sensors for wind speed and direction, humidity, rain, temperature and solar radiation, useful to transfer information to the central control station in order to feed the forecast models being developed

Overall built-in system *controlled remotely*

HD camera for the visible spectrum

This generates a high-definition visible spectrum image of the ignition hotspot identified by the heat camera

Heat camera sensitive to infrared radiation

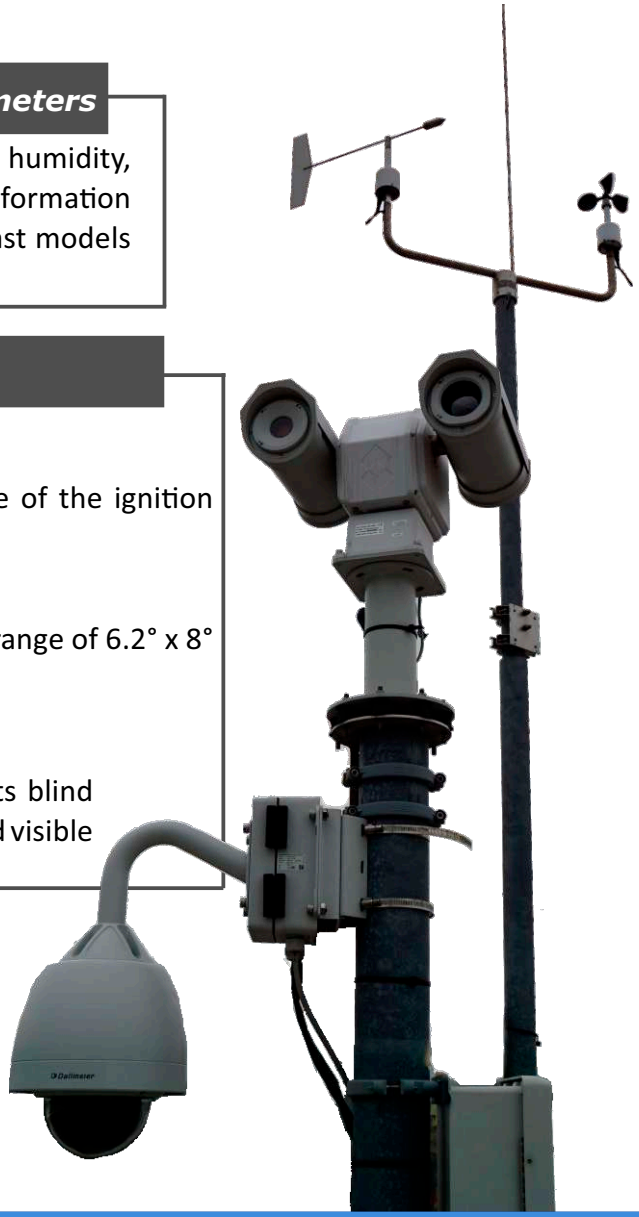
This detects the ignition or presence of a fire in a visual range of 6.2° x 8° with heat sensitivity of <50mK f/1.0

360° panning system

This filters any areas that are not relevant and prevents blind areas. It ensures the perfect overlap between thermal and visible images

Dome camera

equipped with remotely controlled PTZ (Pan, Tilt and Zoom) and able to provide 360° control of the surrounding area. Furthermore, its powerful zoom allows the operators to view the scene by means of **automatic or manual aiming**



The cameras acquire a significant stream of data and a **broadband connection** is required to send all this information to the central control station. CAE provides a **microwave network** with high-capacity backbone sized appropriately in order to manage the camera video streams and any other equipment installed on site. The equipment provided by CAE can also interface with existing microwave backbones. Weather data can be transferred via GPRS or UHF radio.

CONTROL UNIT

The control unit consists of various IT hardware and software elements combined in synergy with each other to form a **reliable DSS** (**Decision Support System**) for operational use.

The service continuously analyses the IR images that are received, in order to timely identify potential fire hotspots. The specific processing algorithm **identifies any thermal spots** within the single acquired frames.

The workstations in the control room warn operators of potential dangers and allow them to ascertain whether a fire is taking place. The system, based on the Fi.De.Sys software, provides useful information to decide the method of intervention as well as to coordinate fire-fighting operations remotely.

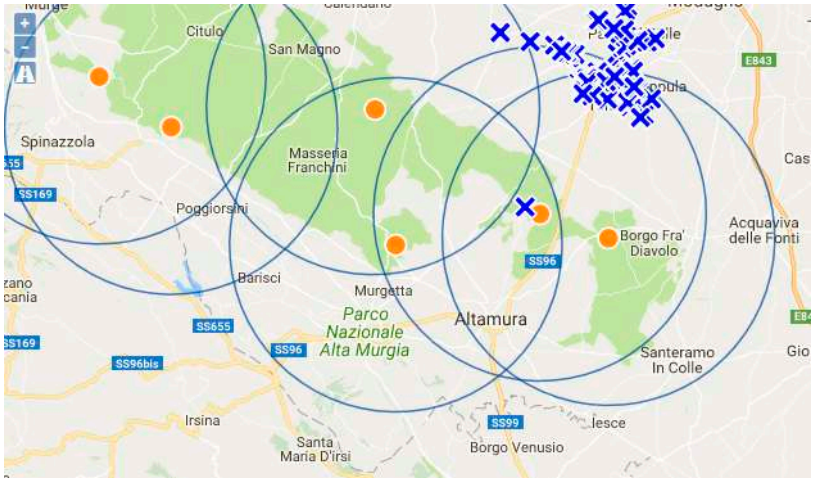
THE FI.DE.SYS ANALYSIS SOFTWARE

The software developed by CAE to process information coming from field equipment is called Fi.De.Sys (Fire Detection System) and it is the core of the early warning system. The software analyses images coming from the lookout stations and warns the system users when an event is detected. Due to advanced image processing techniques, false alarms caused by environmental interferences and by any sources caused by pre-set human settlements can be sorted out.

The software **architecture** is **web-based** and highly modular. Each module can perform simpler functions which allow establish an application cooperation both for consultancy and interaction between several entities and authorities.

The user can use the software interface to:

- **display thermal images** which allow detecting any points of interest over the surrounding landscape;
- **display video streams in real time**;
- **automatically or manually aim the high-zoom camera** to the pre-set of the fire detected by the system;
- **analyse the status of alarms** of the system, acknowledge them, **aim the dome camera**, geo-reference the ignition of fire and assess its spreading.



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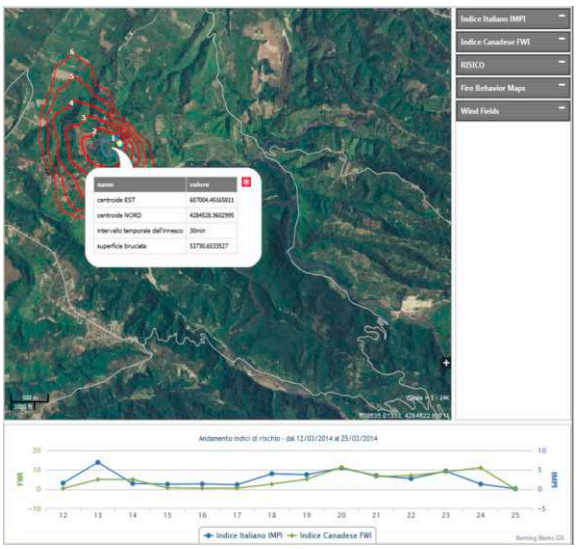
Following the issuing of an alarm, the software - equipped with geo-referencing algorithm and basing its processing on the known position of the lookout station, **projects the 2D coordinates of the point where the fire started as detected by the heat camera on a DTM (Digital Terrain Model)**, obtaining the exact position of the hotspot in terms of latitude and longitude with a minimum error margin.

The performance of the supplied IR camera, management of pre-sets and specific implemented algorithms allow detecting fire hotspots up to 15 km away.

The operator can always monitor the general situation thanks to clients with custom screens according to the emergency needs.

The **availability of Fi.De.Sys on mobile devices** such as smartphones, tablets and web clients provides an essential tool to manage emergencies. The operator coordinating the activity on site can continue to monitor the development of fire fronts in real time and on the move, thanks to the images from the top of the DOME camera and the software-simulated spreading of the fire.

THE EVOLUTIONARY MODEL



The software contains an evolutionary model to optimise assets when actively fighting wildfires, aiming to assess the risk of fire over the landscape by means of geo-referenced maps and tables. **The evolutionary model is the final output of the processing performed by the system to assess the spreading of the fire front**.

The modelling is based on a multi-layer approach.

In particular, the following modelling levels are used:

- **modelling at 1 km resolution** of two indices for assessment of fire risks based purely on weather: the Italian index of Fire Risk (IMPI) and the Canadian Fire Weather Index (FWI);
- **modelling at higher resolution (250 m)** of two indices to assess the behaviour of fire, based on the fuel available in the target areas (Forest Fire Behaviour Prediction System– FBP – and Fire Risk and Coordination System - RISICO).

The final output of the modelling algorithm is the estimation of the spread of fire, taking into account local parameters and maps to estimate the advance of the fire front with a 25 m resolution. The interactive map in the software makes various information available to users, such as isochronous propagation fronts that, in addition to the direction of propagation, provide information about the burnt area and its coordinates.

The result of the model, which can be consulted through Fi.De.Sys, contains several **information layers** in addition to those of risk maps. Once the user confirms the alarm through Fi.De.Sys, the software becomes a critical tool to assess the presence of houses, reservoirs, landfills or in any case places of interest to fire fighting activities.

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