Student Forum on Industrial Electronics

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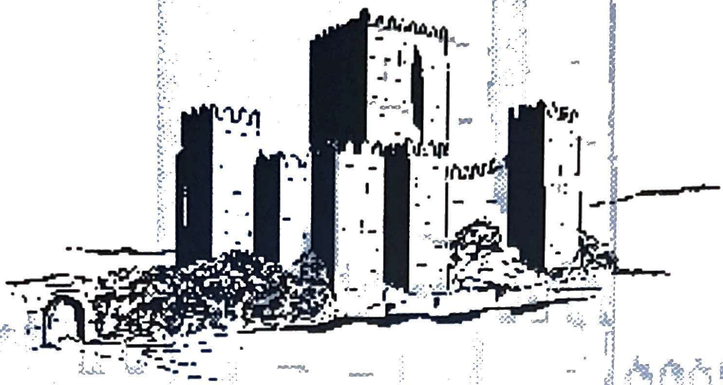

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Forest Fire Observation Post in the Infrared Band

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Abstract – **This paper describes a fully automated system for remote infrared and visible light detection and surveillance of forest fires.**

The project includes the set-up of a laboratory demonstrator. Topics such as image acquisition, automatic control and radiation levels detection are discussed.

I. INTRODUCTION

Forest fires cause enormous damage, both economical and environmental. An important aspect to combat this calamity is an early stage fire detection to permit a fast intervention of the local firemen. Until now, the supervision of the forest was made by people standing many hours in towers strategically placed. This process, very expensive, obliges to uncomfortable work conditions and can be unreliable due to insufficient coverage, tiredness and other human limitations.

So, there are strong reasons to complement this workers by ground-based systems with automatic detection. They should detect automatically a fire at the beginning and give images of all interesting areas, reducing costs and allowing the installation of remote fire detection at very isolated places [1].

II THEORETICAL STUDY

A fire is always followed by an increase of the temperature, because chemical reactions are exothermic. The results are visible light and infrared (I.R.) radiation.

During the II Great War, electronic instruments were developed for military purpose to detect I.R. radiation [3]. After 1950, scientists began to explore the potential of I.R. detection to other areas, such as medical applications or fire detection. The basis for the development of fire detection devices trough I.R. radiation come from the direct relation between an object temperature and the wavelength of the electromagnetic wave radiated. So, an electronic device sensitive to the electromagnetic waves produced by the fire can be used to detect the source, contrasting with the background temperature (forests, lake, air,...). This also means that sensors are able to take images at night.[4].

The I.R. window goes from 1 to 1000 microns, but most of all the wavelength emitted by a fire ranges between 1 and 5 microns [3]. Nevertheless, most of the electromagnetic waves emitted are absorbed by the atmosphere before they can reach the sensing device. Only narrow bands of the I.R. spectrum are not attenuated by atmospheric conditions. These bands can be called *windows*.

Studies indicate that the most appropriate window for I.R. detectors correspond to the 5 microns wavelength window [3].

III DESCRIPTION

This prototype of an observation post is a part of a more complex detection system, which is composed by a set of remote observation posts, and a central station, where the operators will be able to watch distinct images simultaneously. A simple sketch is presented in Fig 1.

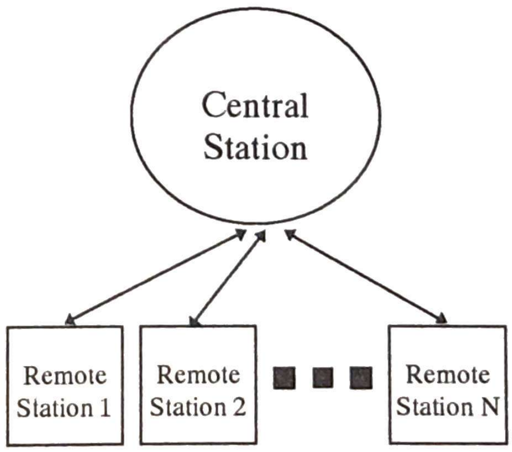

Fig. 1 Architecture of a fire detection system

The remote stations are geographically placed in strategic points. They are composed by different devices, technologies and applications, like infrared, visible and meteorological sensors.

The modules of the system who contains radiation detectors should have the following characteristics :

- Fully automatic
- Economic and cheap manufacturing
- 360 º horizontal observation angle
- Sensitive to the distance of the fire
- High coverage area

One of the main objectives is to maintain a low cost over the all project. Charged Couple Devices (CCD) I.R. cameras and related products are too expensive. Instead, we will use discrete sensors. The radiation detected should come only from fire and reject all the rest of the spectrum. The use of an adequate band-pass filter is necessary.

One way to increase the capability of discrete sensors to visualise a bigger vertical line, is to get many points by moving the active device up and down. But this is not a practical solution. Using a moving mirror the results can be identical (Fig. 2).

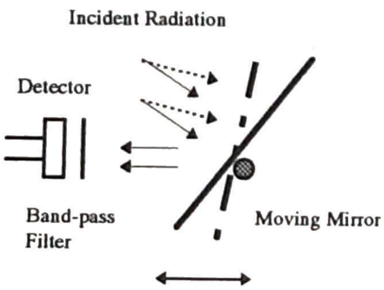

Fig. 2 - Diagram of the sensing mechanism

Simultaneously, the observation post must rotate 360 º to cover efficiently all the surrounding forest. To accomplish this objective, all the system is placed on the top of a platform moved by a stepper motor. The rotating movement must be synchronised with the mirror : between two consecutive steps, the mirror must accomplish one sweep. With this method, an image can be constructed.

Unfortunately, good resolution can't be accomplished, but Using a CCD detecting visible light, the image obtained by the I.R. detector can be completed.

To improve the signal-to-noise ratio, it is necessary to maintain the temperature of the sensors below a critical level. To do so, a closed-loop cooler can be physically coupled with the detectors. All the radiation coming from the outside must reach the detecting module through the telescope, and the need of an adequate isolator is required.

All the system would be useless without a telescope. This device acts like a directional optical antenna which amplifies the signal for long distances (a kilometres). Coverage area and overall efficiency are increased substantially (Fig. 3).

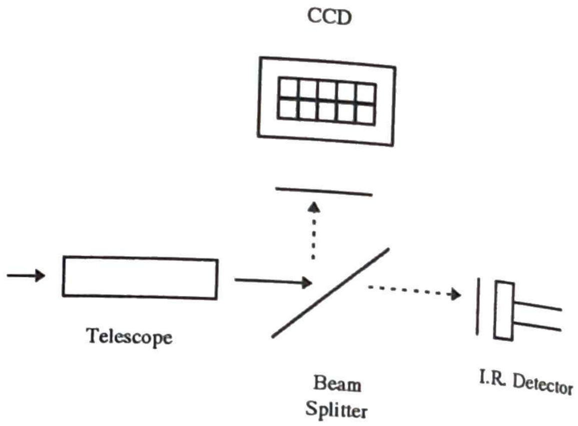

Fig. 3 - Optical and sensing module

When a fire is detected, the signals generated are modulated and transmitted to the central station. Two images can be generated, one by the I.R. detector and the other by the visible light CCD.

The radiation intensity reaching the detectors is inversely proportional to the square of the distance. This fact implicates the need of a decision level modified accordingly to the local where the fire is taking place.

IV CONCLUSIONS

At this moment, the prototype is not totally accomplished, but some conclusions can be outlined. All the system can be completely automatic. The overall cost of one observation post is substantially lower than other system using CCD I.R. devices. The resolution is low (64x200), but can be increased using additional electronics and faster detectors, without attenuating to much the frame acquisition time.

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