Techniques for reducing false alarms in infrared forest-fire automatic detection systems

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Abstract

This paper presents techniques to reduce false alarms in forest-fire detection systems based on infrared cameras. Several software components to implement these techniques are discussed. The components are based on thresholds, oscillation detection, matching of visual and infrared images, memory, meteorological information, motion, size, shape, solar conditions and location. The paper includes a description of experiments in two forest environments, showing the ability of the proposed techniques to discriminate between forest fires and false alarms. © 1999 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Wildfire detection and monitoring is required to minimize damage to forest, wilderness and agricultural areas, and hazard to people. In particular, forest surveillance and early forest-fire detection have significant relevance. These activities have been traditionally carried out by means of lookouts in the affected areas. Experienced people in watchtowers is the most extensively used method. Surveying from an aircraft has also been done in critical seasons with high risks for wild fires.

However, the high cost and the subjectivity of human surveillance play an important role. Notice that in some regions, such as the countries of southern Europe, long periods of high forest-fire risks exist. Thus, the development of sensor technologies and automatic surveillance and detection systems is an important research and development topic.

It should be noted that several sensor technologies have already been applied in forest-fire detection. Thus, satellite-based techniques using meteorological satellites

have been proposed to collect real-time information. Detection is based on the use of NOAA AVHRR images (Illera et al., 1995). These techniques are valuable in large and homogeneous regions. However, in many areas, the detection period and the resolution provided by these systems is not yet adequate for early fire detection.

Early wildfire-detection techniques using smoke plume identification have also been presented (Vries and Kemp, 1994). The principle is based on detection against a background of vegetation or sky. The basic method of detecting a smoke plume at the beginning of a wildfire is based on a comparison of subsequent images. In particular, a sensor using three cameras, each employing a linear charge couple photo diode detector array (CCPD), has been developed. The detector process relies on the detection of color differences rather than differences in light intensity. Thus, varying natural background illumination does not generate false alarms.

This paper deals with infrared detection systems in the framework of the project ‘distributed environmental disaster information and control systems (DEDICS)’ funded by the European Commission (DG XIII) in the telematics application program (environment area). DEDICS is being designed to be adapted to a wide range of disasters (Wybo and Jaber, 1996). However, its first application is concerned with forest fires, which constitute

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Fig. 13. Result of a correlation technique for the solar reflection in experiment 3.

to their origins: heated objects, solar reflections, artificial lights and combustion sources due to human activities.

Some detection software components have been proposed. These components are based on thresholds, oscillation detection, matching of visual/infrared images, memory, meteorological information, motion, size, shape, solar conditions and location.

The analysis of infrared images can be used to discriminate fires from solar reflections. Heated objects are characterized by their low average brightness level, so they can be identified using appropriate dynamic thresholds. Solar reflections are characterized by having considerable stability in the value of the pixels. They can be distinguished from fires by the use of oscillation-detection techniques. Combustion sources due to human activities, and artificial lights, can be detected by the use of infrared/visual matching methods and topographic and fuel maps.

The false alarm reduction system has been implemented on a Pentium 120 MHz PC with a Mutech MV-1000 digitizer card.

The total time required for the application of the false-alarm reduction components is lower than 15 s. In many cases, only a few components are needed, and this time is greatly reduced. Furthermore, this time is not relevant when considering the detection cycle (time to cover the whole surveyed area using the positioning system) in the observatories, which is about 4 min.

Further work will include its integration within the full DEDICS system, and a demonstration of this Telematic system in daily operation.

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