Chapter 54
A Forest Fire Detection System: The Meleager Approach

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ABSTRACT

Forest fires cause immeasurable damages to indispensable resources for human survival, destroy the balance of earth ecology, and worst of all they frequently cost human lives. In recent years, early fire detection systems have emerged to provide monitoring and prevention of the disasterous forest fires. Among them, the Meleager[1] system aims to offer one of the most advanced and integrated technology solutions for fire protection worldwide by integrating several innovative features. This chapter outlines one of the major components of the Meleager system, that is the visual fire detection sybsystem. Groundbased visible range PTZ cameras monitor the area of interest, and a low level decision fusion scheme is used to combine individual decisions of numerous fire detection algorithms. Personalized alerts and induced feedback is used to adapt the detection process and improve the overall system performance.

INTRODUCTION

Reliable fire detection systems with minimum detection latency are of great importance for fast reaction to prevent fire expansion and minimize damages. Traditional forest watch towers tend to be replaced by automatic detection systems that range from IR sensors (Arrue et al., 2000), LIDAR (Light Detection and Ranging systems) (Utkin et al., 2002), satellite platforms (Akasuma et al., 2002), to computer vision based systems (Martinez de Dios et al., 2008; Li et al., 2005) and WSN (wireless sensor network) systems) (Lloret et al., 2009). Aligned with the latter, the Meleager system aims to offer one of the most advanced and integrated technology solutions for fire protection worldwide by integrating the following important innovative features:• A visual

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fire detection subsystem, which consists of high resolution cameras with embedded digital signal processing and machine vision algorithms.

- The simulation subsystem which has the unique feature of the parallel execution of multiple simulations for different scenarios of environmental parameters. The fire simulator handles the high variability of forest fires, by examining a set of environmental parameters (e.g., wind direction and speed) and creating dynamic hazard maps for the ongoing crisis. The fire simulator uses an innovative design that allows it to perform multiple snapshots of the perturbations from the average recorded values of environmental parameters.
- The data fusion subsystem that incorporates a two-tier data fusion scheme for better assessment of the field observations and for developing safer conclusions about the crisis and risk. The two-tier organization of the fusion scheme allows the scaling of the mechanism and the effective implementation of various versions of the Meleager system (large scale/prefectures, local authorities, private installations).
- **Open Protocols and Interfaces:** Meleager is based entirely on open standards for information exchange to ensure interoperability with existing systems, e.g., crisis management systems, GIS data, cartographic systems and systems for registration of land use.
- **Crisis Management with Advanced Algorithms:** The part of crisis management incorporates applications based on spatial data (e.g., firefighting resource management). The dynamic positioning of various resources allows more efficient treatment of environmental risk and minimizes the impact on the lives and property of citizens and firefighting forces. This subsystem can optimize the firefighting equipment deployment and the citizen evacuation process of the affected region.
- **Open GIS and Interfaces:** An innovative feature is the ability to record real-time information on the fire evolution, and reproduce at a later time and time scales selected by the system user (e.g., real-time reproduction, fast, slow, transition to a specific point in time).
- Implementation of personalized alerts/alarms and automatic activation of fire protection/sprinkler systems. The implementation of advanced technology and the major innovations incorporated in the system enhance the system functionality, usability, efficiency and interoperability while at the same time they can reduce costs.

This chapter aims to describe the visual fire detection subsystem that was adopted by the Meleager project. Video-based fire detection has many advantages over traditional methods, such as low latency response and theoreticaly no space limits. Numerous techniques have been proposed that make use of the visual features of fire and smoke including color, motion, geometry, flickering and texture. Some of these techniques are summarized in Section Related Work, where related work on computer vision based wildfire detection methods is presented. Section System Architecture outlines the Meleager system architecture for the fire detection subsytem, whereas Section Experimenatl Results presents some preliminary results. Finally, conclusions are drawn in Conslusions Section.

RELATED WORK

There is a lot of research for fire and smoke detection based on image processing. In general, fire detection algorithms are mainly based on the analysis of motion and color information in video sequences to detect the flames (Toreyin et al., 2006). In (Toreyin et al., 2005)) authors use