International Journal of Disaster Risk Reduction 13 (2015) 307–312

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Use of unmanned vehicles in search and rescue operations in forest fires: Advantages and limitations observed in a field trial

S. Karma [a,*], E. Zorba [a], G.C. Pallis [a], G. Statheropoulos [a], I. Balta [a], K. Mikedi [a], J. Vamvakari [a], A. Pappa [a], M. Chalaris [b], G. Xanthopoulos [c], M. Statheropoulos [a]

[a] National Technical University of Athens, School of Chemical Engineering, Sector I, Zografou Campus, 9 Iroon Polytechniou Street, 15773 Athens, Greece
[b] Hellenic Fire Service Headquarters, 4 Mourouzi Street, 10674 Athens, Greece
[c] Hellenic Agricultural Organization "DIMITRA", Institute of Mediterranean Forest Ecosystems and Forest Products Technology, 1 Patision & Androu Street, 11257 Athens, Greece

ARTICLE INFO

Article history:
Received 28 April 2015
Received in revised form
14 July 2015
Accepted 14 July 2015
Available online 17 July 2015

Keywords:
Forest fires
Search and Rescue
Entrapment
Evacuation
Unmanned vehicles
Risk management

ABSTRACT

Search and Rescue (SaR) in forest fires is usually applied in a broad area, under foggy or smoky conditions. It mostly involves location of entrapped fire crew or people in between fire fronts, as well as, safely removing them away from the dangerous zone. Moreover, SaR is applied in evacuation of rural residential areas due to heavy smoke impacts, or fire front approaching. Experiences achieved during a field trial, in which unmanned aerial and ground vehicles were deployed and used in a simulated forest fire SaR scenario, are presented. For planning and running the field trial a number of parameters were taken into consideration; logistics, safety plan, contingency plan, different agencies cooperation, time frames and ethical issues. Advantages of using unmanned aerial and ground vehicles in SaR operations include capability of planning and monitoring the operations, integration with the manned resources, connectivity with command and control centers, as well as, coordination of the different unmanned aerial and ground vehicles' platforms. Significant increase of personnel safety is possible through the capabilities of air quality monitoring and search over dangerous areas. Current limitations include limited heat resistance of vehicles and limited flying capability in strong winds and turbulence. Failure of communications is also possible due to rough terrain (autonomy limitations). Against all the limitations, a number of unmanned vehicles already exist that can be adapted successfully for SaR operations in forest fires.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Search and Rescue (SaR) can be applied in different terrains: ground, sea, mountain and urban areas. It can also be practiced in different environments (e.g. forests, rural residential areas, extreme weather conditions). In all SaR operations time is the most critical parameter; the first hours have the highest possibility for survival [1]. However, SaR operations have different characteristics depending on terrain and environment. For example, urban Search and Rescue (USaR) involves victim localization indoors, i.e. under the debris of a collapsed building and extrication. SaR in forest fires on the other hand, is usually applied in a broad area, under foggy or smoky conditions; it mostly involves location of entrapped fire crew or people in between fire fronts and safely removing them away from the dangerous zone. This type of accidents has been described in literature [2]. SaR is also applied in evacuation of rural residential areas, due to heavy smoke impacts or fire front approaching. SaR operations are characterized by procedures and regulations. Maritime SaR for example is regulated (IMO) [3]. Also, a number of standards are provided by INSARAG for USaR operations [4]. However, it seems that SaR in forest fires is not strongly regulated, despite the fact that recommendations and guidelines provided by various relevant organizations, exist. Recently, guidelines for the defense of rural populations, local communities and municipality leaders have been prepared in the framework of the Council of Europe, Network of Specialized Euro-Mediterranean Centers [5]. The response to a SaR incident usually proceeds through a sequence of five stages; awareness, initial stage, planning, dispatching/SaR, reporting/debriefing.

The present work aims at presenting different issues related to forest fire SaR stages, based on the lessons learnt from a recent research project (FP7 security project DARIUS) that focused on SaR operations using manned and unmanned resources [6]. More

* Corresponding author.
E-mail address: skarma@central.ntua.gr (S. Karma).

http://dx.doi.org/10.1016/j.ijdrr.2015.07.009
2212-4209/© 2015 Elsevier Ltd. All rights reserved.

Table 1
Recent research projects and their contribution in regard to unmanned vehicles, SaR operations and crisis management.

Title of project	Type of project	Contribution to unmanned vehicles/SaR operations/crisis management
DARIUS (Deployable SAR Integrated Chain with Unmanned Systems)	FP7-SEC-2011	DARIUS project aimed at providing unmanned platforms for Search and Rescue operations (maritime, urban, forest fire scenario), as well as at enhancing the interoperability performances of unmanned systems at procedural and technical levels.
CRISMA (Modeling crisis management for improved action and preparedness)	FP7-SEC-2011	CRISMA Integration Project focused on large scale crisis scenarios with immediate and extended human, societal, structural and economic, often irreversible, consequences and impacts. Typically, these crisis scenarios cannot be managed alone with regular emergency and first responder resources, but require multi-organizational and multi-national cooperation including humanitarian aid.
AIRBEAM (AIRborne information for Emergency situation Awareness and Monitoring)	FP7-SEC-2010	The major AIRBEAM objective was to propose a situation awareness toolbox for the management of crisis over wide area taking benefit of an optimized set of aerial (unmanned) platforms, including satellites.
AIROBOTS (Innovative aerial service robots for remote inspections by contact)	FP7-ICT-2009	The main objective of the AIRobots platform design process is to develop aerial prototypes which meet basic engineering principles in terms of expandability and flexibility.
OPARUS (Open Architecture for UAV-based Surveillance System)	FP7-SEC-2009	The goal of this project was to elaborate an open architecture for the operation of unmanned air-to-ground wide area land and sea border surveillance platforms in Europe.
CLOSE-SEARCH (Accurate and safe EGNOS-SoL Navigation for UAV-based low-cost SAR operations)	FP7-Galileo-2008	The goal of CLOSE-SEARCH was to integrate in a small Unmanned Aircraft (UA), a thermal imaging sensor and a multi-sensor BA/RINS/GPS-EGNOS-based navigation system with an Autonomous Integrity Monitoring (AIM) capability, to support the search component of search-and-rescue (SAR) operations in remote, difficult-to-access areas and/or in time critical situations.
DITSEF (Digital & innovative technologies for security & efficiency of first responder operations)	FP7-ICT-SEC-2007	DITSEF aimed at increasing the effectiveness and safety of First Responders by optimal information gathering and sharing with their command levels.

specifically, this work will present experiences achieved during a field trial in which unmanned vehicles were deployed and used in a simulated forest fire scenario, where both location and rescue of entrapped personnel, as well as, evacuation of rural residential area took place. In this paper, possible risks from forest fires are also highlighted; especially, smoke impacts when the fire front expands to rural residential areas and/or possible threats in case the forest fire front reaches territories contaminated with chemicals [7], or unexploded ordnance areas [8]. In this framework, advantages and current limitations of using unmanned aerial and ground vehicles in Search and Rescue operations during forest fires are examined.

2. Risks when forest fire front expands

In recent years, huge forest areas have been destroyed by large-scale forest fires; over 1,400,000 ha in total have been burnt in five Southern Member States in the last five years [9]. Severe forest fires can cause a number of environmental, health, security and safety impacts [10,11]. First priority is suppression and control of the fire, even though severe SaR incidents may occur. Usually, SaR operations are applied when firemen or people are trapped in between fire fronts, or when areas may need to be evacuated from residents. In most countries, emergency operating protocols were evolved over the years to meet the specific demands of such incidents. However, most of these do not provide consistent procedures and hence, a number of problems might be encountered; limited control, difficulties in the communication flow among agencies, safety risks for SaR personnel. The last is more significant especially when there is no sufficient prior training of personnel or protection equipment. Additionally, incompatible communication systems and in general lack of interoperability, may complicate situations. In these cases there is a need to survey large areas, which are very difficult to be approached by manned resources. There are particular risks when the forest fire front expands outside the forest to different nearby areas, such as rural fields, rural–urban interface, illegal waste or landfills; plastics, fertilizers, pesticides, and fungicides, wastes can also be burned together with the forest fuel and hence, the resulted smoke may have additive or synergistic toxicity impacts [7]. Forest fire smoke has significant impacts, such as visibility impairment and health effects on the exposed population and the fire fighters [12–14]. It is a chemical mixture consisting of substances that can cause acute, short-term and long-term health implications. More specifically, a number of respiratory irritants, such as aldehydes (e.g. acroleine), asphyxiants (e.g. carbon monoxide) and carcinogens (e.g. benzene, benzo (a)pyrene) are some of forest fire smoke components. Particles also contained in forest fire smoke are hazardous, especially the fine ones, such as nanoparticles (with diameter less than 100 nm) and respirable particles (with diameter between 0.1 and 10 μm). It has to be noted that smoke inhalation can be more aggressive especially for vulnerable groups of population, such as infants, children, pregnant women, the elderly and people with health problems [11,15]. Data regarding health impacts of population and hospital admissions, correlated with large scale forest fires can be found as a case study in literature [16].

3. Unmanned vehicles in SaR operations

Using unmanned vehicles in SaR operations combined with manned resources is currently an option. It can be applied in complicated situations, where fast response and protection of personnel from possible risks is necessary. A number of representative research projects relevant to unmanned vehicles, SaR operations and crisis management that have been implemented the last years, are shown in Table 1 [6,17–22].

There are also cases in which real field deployments of robots have been recorded in order to improve disaster preparedness, prevention, response and recovery (CRASAR) [23]. Focusing on SaR cases in large scale forest fires, unmanned vehicles can have a number of missions [24]; fire detection by locating fire spots, fire front surveillance and monitoring. The support of SaR operations is also possible. In addition, potential missions include location of entrapped crew or people, supporting of the evacuation process of an area, providing with first aid kits to victims, monitoring air quality and detecting toxic compounds.

In the following paragraphs, a brief presentation of different types of unmanned vehicles is given, focusing on Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs), which are mainly of interest in case of forest fires.

Download English Version:

https://daneshyari.com/en/article/7473231

Download Persian Version:

https://daneshyari.com/article/7473231

Daneshyari.com