Review

Review of wildfire detection using social media

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ABSTRACT

With the introduction of social networks and services, there has been an increase of information sharing on the Internet. The availability of Internet capable mobile devices equipped with various sensors has simplified and liberalized the generation of large amounts of multimedia data. Because of this, social media has played a critical role in disaster events over the last few years. This paper gives a review of current systems and methods that enable the use of social media as a human-centric sensor in large scale disaster events. We focus particularly on wildfire use-cases and discuss the approaches from other hazard management systems which could be applied in the domain of large area fires. Furthermore, we suggest a general social sensor based platform for wildfire detection and management, and propose possible directions of future research.

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1. Introduction

Wildfires are one of the leading hazards affecting everyday life around the world. Due to droughts, expansion of wildland-urban interface, and other factors, the frequency, intensity, and duration of wildfires are increasing worldwide [1]. Recent fires, such as the Black Saturday bushfires in the Australian state of Victoria (2009), the Texas bushfires (2011) and the Costa Del Sol fires in Spain (2012), had a big impact on the lives of many of our contemporaries. Because of their speed and destructive forces, they are one of the most serious threats to ecological systems, infrastructure and human lives, i.e. wildfire events that do not involve people and property are becoming rare [2]. To avoid large scale damage, timely and accurate detection is essential. The sooner the fire is detected, the better the chances are for survival and the lower the environmental and economical impact. However, early detection is not the only crucial aspect of wildfire management. It is also important to have a clear understanding of the fire development

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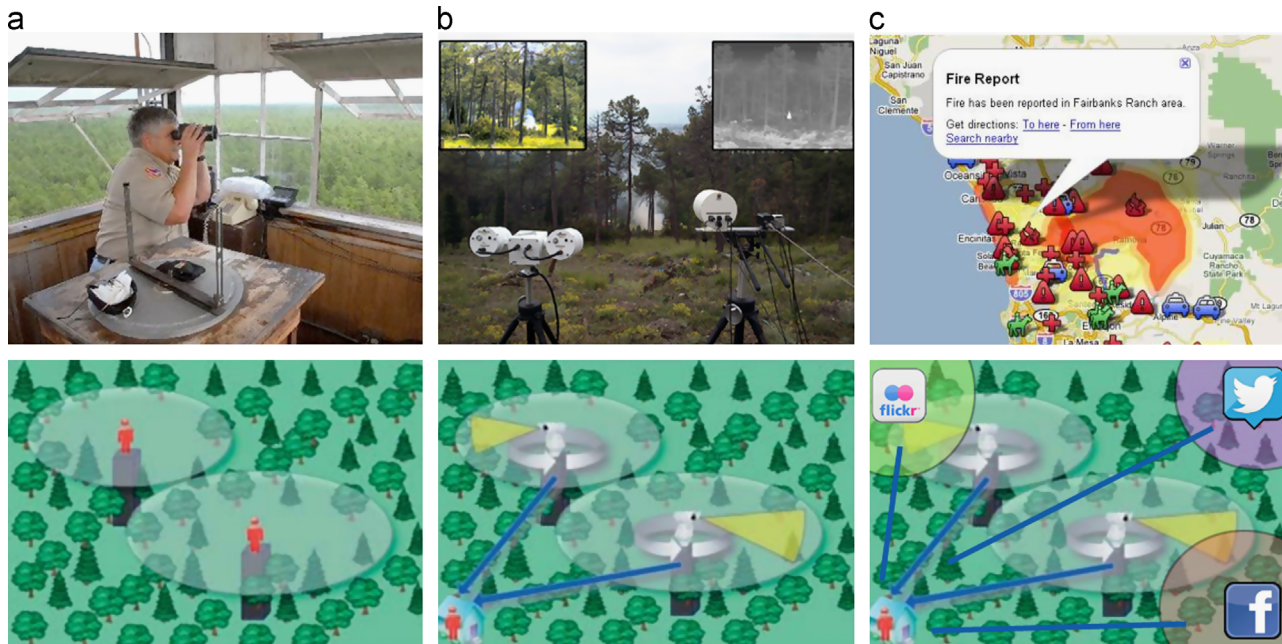
Fig. 1. Comparison among traditional human-based wildfire detection (a), camera based wildfire detection (b), and social media based wildfire sensing (c) based on a scheme proposed by Stipaničev [8].

and its location. Where did the fire start? What is the size of the fire? How fast is the fire growing? The answer to each of these questions plays an important part in safety analysis and fire fighting/mitigation, and is essential in assessing the risk of escalation [3]. Up to now, however, information about wildfire circumstances is still rarely available and difficult to measure.

1.1. Categorization of wildfire risk management systems

Over the last decade, great efforts have been put into the development of systems for early wildfire detection and wildfire risk management. In addition to the traditional method of human based wildfire surveillance, shown in Fig. 1a, modern automatic wildfire management systems can be further categorized into *terrestrial* and *aerial* systems.

Terrestrial systems are based on ICT and camera technology and are becoming more and more important [4–6]. Camera-based wildfire systems offer advanced automatic wildfire observation as a replacement for human observation. As illustrated in Fig. 1b, the video-based setup consists of several cameras and/or other sensor devices installed on monitoring spots (watchtowers). A computer system (or a human observer) analyzes the provided video data and generates potential alarms [7]. The main advantages of the camera-based wildfire detection systems are a wider area that can be covered (because one observer can monitor multiple cameras), zooming options (so that the observer can easily inspect suspected areas) and video storing capabilities for post-fire analysis [8]. Furthermore, heat and fire can be detected in occluded conditions, if camera systems with infrared sensors are used. Non-visual wireless ICT sensors exist which can be used within dense vegetation. On the negative side, terrestrial systems have to be deployed in networks to be able to cover large areas. Until today, the percentage wildland covered with camera technology and ICT sensors is still limited and time and money (to install these systems) are insufficient.

Aerial systems, on the other hand, such as manned and autonomous aircrafts and satellites (Fig. 2) can cover very large areas. Unlike terrestrially deployed systems, they can be more easily moved and used in affected areas. Aerial systems include a relatively high operational cost and can be affected by visibility conditions.

In order to be able to fight wildfires in an efficient way, new techniques and systems are needed as a complement to the existing approaches. Social media wildfire sensors, which are illustrated in Fig. 1c, are definitely on their way to become one of the wildfire monitoring tools of the future.

With the rise of social media, the communication landscape has changed radically. Starting from passive information dissemination, social media usage is evolving in the direction of active monitoring and proactive public engagement. The fact that social media platforms, such as Facebook, Twitter, and Flickr, facilitate instantaneous information sharing and are available to anyone-everywhere make them a powerful force. In the context of crisis communication, for example, social media can be used in order to reach more people, with more relevant and timely information than ever before. On the other hand, social media can also be used to collect (and analyze) user-generated sensor data [9]. This is the idea behind participatory or human-centric sensing. By combining sensor data from large groups of individuals, it is possible to derive new values for end users in ways that the contributor of the content even did not plan or imagine, and to perform functions that are either difficult to automate or expensive to implement.

1.2. Current status of social media in wildfire risk management

Recently, the tendency of participatory data gathering has also started to occur in the domain of disaster analysis. As the number of active users increases, the data that is produced on social media services can be a valuable additional source of information for prevention, detection, control, and localization of large scale natural disasters. Furthermore, the ubiquity of mobile communication devices and the fast diffusion of information on social networks render systems for social media information extraction suitable for critical emergency broadcasting. Although the deployment of automatic social media based systems for wildfire management is still at its infancy, relevant agencies for fighting wildfires are beginning to grasp the importance of social media and are progressing towards utilizing the available potential.