Improving emergency response: citizens performing actions

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ABSTRACT

The role of common citizens within the emergency management (EM) process is crucial in order to support efficiently the operators' activities during the response phase. Moreover, their participation is strictly related to their profile and their experience in previous events. In a previous contribution we identified the different roles that the citizens can play for an effective cooperation with the EM workers. In this paper, we introduce an emergency tool based on a mobile application designed to support the activities of the citizens acting as *Agent*. The *Agents* have specific capabilities recognized by the EM Operation Center (OC) to execute actions under the remote supervision of the EM operators. The proposed tool allows the *Agents* to receive information from the OC and to visualize it through an advanced visualization modality. In particular, available information is previously collected by the center from the witnesses and the affected people that have alerted about it.

Keywords

Community Engagement, Mobile Application, Situation Awareness

INTRODUCTION

Nowadays modern mobile phones and social networks are commonly used in a plethora of daily activities, ranging from entrainment to office tasks. Furthermore they are so sewn into the social fabric that are incrementally used by citizens to deal with crucial tasks. It is not uncommon, in fact, that during an emergency, citizens use their mobile phones to share information on the crisis evolution or on their positions. As stated by Fugate, an administrator of the FEMA (i.e. Federal Emergency Management Agency, U.S. Department of Homeland security), the emergency authorities consider interesting the increasing amount of information available on the social networks that can be exploited to better cope with the crisis (Fugate, 2011). In fact, in order to improve the communication ability with citizens, it would be better to adapt the information systems used by the emergency agencies to the channels that people are already used to (e.g. Twitter or Facebook).

A good example is given by the last tsunami disaster in Japan. During this event, the authorities realized that a big amount of updated information was broadcasted in Twitter (Ichiguchi, 2011). Therefore they quickly opened several governmental accounts to notify updated information about the current situation. Moreover, they promoted the usage of fixed hashtags to organize the large amount of shared data. In this way, Twitter users were could link them as unique semantic keys to become part of the information distribution and consequently to easily follow up of the crisis evolution. Palen et al. (Palen et al., 2010) had already stated that the proactive role of citizens during an emergency response and the usage of modern technologies (e.g. social networks and mobile devices) can be considered an essential support for the entire emergency management process (EM hereafter).

Within this context, the emerCiEn (Emergency management and civic engagement) is aimed at deploying sociotechnical platforms that promote effective and reliable collaboration in EM among different stakeholders. The stakeholders come from a large variety of different groups including first responders, decision and policy makers, volunteers and citizens. Therefore, one of the goals of the project is to explore how technology can be exploited to increase substantive citizen contribution to the EM processes. In our research we take into account

that citizens cooperating during the EM operations should not interfere with the protocols of the EM corps and agencies and do not make the response less efficient. Moreover, we consider that citizens need to be substantively empowered to be capable of contributing to the decision making process as stated in (Rich, Edelstein, Hallman, & Wandersman, 1995).

In a previous contribution (Diaz et al., 2013), we identified the different roles that the citizens can play to support EM operators in the context of a disaster: from passive *Citizens*, to active information and data providers (called *Sensors*, *Trusted Sensors*, and *Nodes*) to active *Agents*. Moreover, several prototypes were developed to guarantee their cooperation in a way that is aligned with the goals and necessities of the EM corps and agencies. These prototypes are part of the EmergenSYS project that aims at establishing a bidirectional communication channel between EM operators and citizens (Onorati et Al, 2013). Each tool has been designed to support a particular citizen's role. In this paper, we focus on a new role called *Agent*: people with this profile can perform actions under the supervision of the EM operators.

In the next section, we will detail the different roles a citizen can play within the response phase. In the third section, we focus on the role called *Agents* and we show the architecture and the prototype designed for supporting their activities. In the last section, some conclusions are given.

THE ECOLOGIES OF PARTICIPANTS

In (Diaz et al., 2013), the authors introduced the five different kinds of profiles that citizens could have in emergency situations. The resulting *ecology of participants* consists of the following roles: *Citizens*, *Sensors*, *Trusted Sensors*, *Nodes* and *Agents*. Each one of them is associated to a specific action as contribution for improving the participation in the emergency response phase.

- The *Citizens* represent the simplest level of participation. They include common people that receive information about an event from the operation center. This information could be also a feedback related to an alert that people have previously sent to the corresponding authorities.
- Respect to the *Citizens*, the *Sensors* can also send notifications to the operation center. As witnesses or victims of a disaster, they are aware about interesting data that could be useful for the response activities. Not only short messages or phone calls, but also social network or any other communication channel could be used for sending messages to the authorities. The information sent must be filtered by EM operators that decide in each case is it can be considered reliable or useful.
- *Trusted sensors* are participants that the EM organization consider reliable so that their data can be directly processed. Their role includes those of *Sensors* but they are reliable because the operation center has proven information on them. Indeed they could be retired workers, volunteers or citizens who have informed in other occasions or simply citizens that have built a reputation on social networks and therefore they can be trusted.
- *Nodes* can also process data and provide more elaborated information, for instance they can evaluate the damages or the kind of assistance required. According to the experts, to become a *Node* you need to have accredited experience in the domain. For instance, if the operation center knows you are a citizen who has participated in drills for a specific kind of disaster (e.g. nuclear risks) and you were trained to evaluate damages you can be granted this level. Granting the Node level is, consequently, an action in charge of the EM organization.
- Finally, *Agents* can execute actions under the supervision of the EM organization, for instance, they could lead an evacuation process. All the participants agreed that some citizens can become *Agents*, particularly if they could receive directions from the EM workers, for which IT based tools might be very convenient. Consequently you do not need to go through the *Node* role before becoming an *Agent*.

In order to support this ecology and improve the participation of these profiles in the response phase of an emergency, ad-hoc IT tools have been developed in the form of mobile applications in order to exploit the ubiquitous characteristic and advanced computational potentiality of modern smartphones. In (HIDDEN), we already presented the different prototypes designed for supporting the cooperation among the different kinds of roles that citizens can play and the EM authorities with an exception: the role of the *Agent.* The first prototype developed to support this active role is presented in the next section.

THE CITIZEN-AS-AN-AGENT PROTOTYPE

Agents are citizens with an adequate preparation and a high level of reliability who can execute actions under the supervision of the EM organization. Examples of *Agents* are retired members of EM corps and agencies, well-trained citizens or volunteers. They could lead an evacuation process as well as give first aid to people or simply help people to get to the gathering points.

In order to act, *Agents* have to receive orders or at least permission from the EM Operation Center (OC hereafter) and, consequently, they need an easy communicational channel to stay in touch with EM operators. They also need to get a whole picture of the situation and the objectives to be reached. Even though *Agents* are citizens who are in the field, they might have a partial understanding of the situation limited to the place they are. The EM information system is supposed to have a more global information of the situation built with all possible information sources, ranging from data provided by volunteers, citizens, physical sensors, cameras, etc. Consequently, information about the situation in the OC has to be filtered and sent to the right *Agents* in a way that can be understood and used efficiently. In our model, such information is collected from different sources including both physical sensors and citizens playing the role of *Sensors*. The architecture of the system is described in Figure 2.

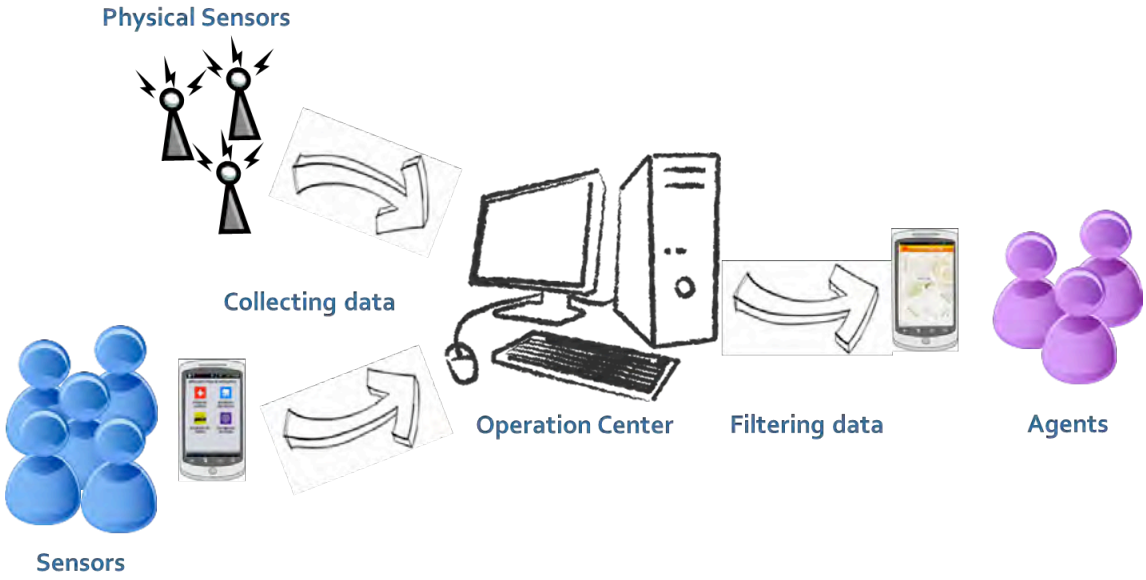


Figure 2. The communication channel between *Sensors* and *Agents*

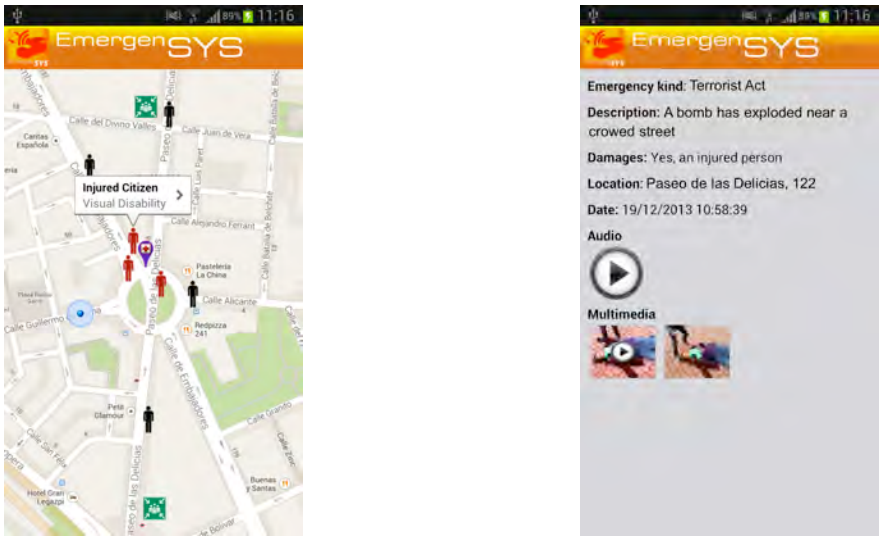
Following the proposed architecture, we have developed a first prototype in collaboration with the Police Department of the City Hall of Valencia and a group. The prototype is based on a mobile application running on a Samsung Galaxy S3 with Android 4.1 OS. Since the application is not used by EM operators but by civilians collaborating with them, we have designed the application with an interface as easy as possible for users familiar with modern smartphones. Provided functionalities are detailed in the following paragraphs.

1. *Communication with the OC*. The application provides users with a messaging system allowing textual and audio communication between the EM operators and the *Agents*. In this way they can choose the communication channel that best fits with their needs. For example, if there is a lot of noise a textual message is more effective than an audio recording.
2. *Situation Visualization*. The main functionality is the visualization of critical data that will help *Agent* to build a better situation awareness (Endsley, 1988). The kinds of data to be visualized are heterogeneous. They range from audio and image formats to geographical and plain text ones. Such data are combined together and visualized by means of a map exploiting the geographical component. The data are represented on the map through a color and icon language in order to represent their different meanings as described in Table 1. Both the icons and their meanings have been designed during a focus group organized in collaboration with the Police Department of the City Hall of Valencia. In particular, the different emergency kinds are an adaptation of the official categorization used by the 112 to the particular scope of the developed application.

Icon	Color		Meaning
	Red		Injured citizen
	Brown		Disable citizen
	Black		Witness
	Blue		Domestic Accident
	Yellow		Traffic Accident
	Purple		Criminal/Terrorist Act
	Green		Natural Disaster
	/////	///	Meeting Point
	/////	///	Damaged Road
	/////	///	Shelter

Table 1. Used icons in the application with the available colors and the related meanings.

Figure 3 shows the *Agent* view on a possible emergency scenario. During the day of the bicycle a terroristic attack occurs. A bomb placed in a hidden place of a street suddenly explodes damaging streets and hitting people. People start alerting authorities sending pictures and information about the event. Therefore, the OC starts planning the emergency response. First of all, it checks if there is any *Agent* available near the disaster site. It identifies two of them with a profile suitable for this kind of emergency. Then the OC sends them personalized information about the specific mission to accomplish. In the case of figure3, the *Agent* is near to the bomb's place, he is in charge to help some victims and to lead people towards the nearest gathering point. The green icon in Figure 3(a) represents the gathering point, blue point is the *Agent*'s position. The red little men are the victims to be helped while the black ones are the *Sensors*.



(a) **(b)**

Figure 3. Two screens of the application: (a) the map with the icons, (b) detailed information about the specific event

Tapping the emergency icon, the *Agent* visualizes the description of the situation provided by the OC as shown in Figure 3(b). The description is based on multimedia data that can be reproduced directly into the application. The speech bubble gives additional information about the victim like his name or his special needs (e.g. *Visual Disability* in the example).

CONCLUSION

Different sources and organizations state that citizen cooperation during a crisis can help rescuers and emergency operators to give a more efficient and effective response (Palen et al., 2010). In (Diaz et al., 2013), we introduced for the first time the ecology of participants. It is a framework describing the different roles that citizens can play to cooperate to an emergency response. In this paper we examine in depth the role called *Agent* played by citizens that are able to perform actions during a crisis situation under the supervision of an official emergency organization. Moreover we propose a first mobile prototype developed and designed to a) support the communication between the OC and the *Agents* b) visualize heterogeneous and complex data by means of an intuitive mobile user interface. Even if in the last years citizens participation has been considered relevant in order to improve the current response techniques, as also White explains in (White, 2012), it was still missing a clear separation of the roles that citizens can play to support the response at different levels of participation. Another significant lack is related to the applications aimed at supporting a high level of active participation. Actually applications such as SafetyGPS (www.safetygps.com) allow common people to cooperate sending data to the authorities but not to be engaged in other kind of activities. On the other side, applications such the one described in (Paolino et Al, 2010) are designed to support decision makers working on the go in a disaster site but they do not consider the cooperation with citizens.

We are planning for the immediate future to evaluate the prototype with experts and potential stakeholders in order to obtain feedback from a quality and quantity point of view. Moreover, from a technical point of view, further work should focus on other phases of the EM process particularly those that could help to establish a continuous relationship with citizen both to guarantee they will be able to use the tools when a crisis happens and also to engage them in the process. From a social perspective, further research should aim at identifying models of participation that allow the cooperation among citizens playing the different roles of the *ecology* in order to improve the effectiveness of the emergency response.

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