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Towards a Mobile Augmented Reality System for Emergency Management: The Case of SAFE

Angelo Croatti, University of Bologna, Cesena, Italy
Alessandro Ricci, University of Bologna, Cesena, Italy
Mirko Viroli, University of Bologna, Cesena, Italy

ABSTRACT

The impressive development of wearable computing and augmented/mixed reality technologies that has been occurring in recent years allows for devising ICT systems that can bring a disruptive innovation in how emergency medical operations take place. In this paper the authors describe first explorations in that direction, represented by a distributed collaborative system called SAFE (Smart Augmented Field for Emergency) for teams of rescuers and operators involved in a rescue mission. SAFE is based on the integration of wearable computing and augmented reality technologies with intelligent agents and multi-agent systems.

KEYWORDS

Augmented Reality, Emergency Management, Hands-Free, Healthcare, ICTH-2015, Rescue

INTRODUCTION

In the last decades, advances in mobile computing technologies have had a fundamental impact in devising ICT systems supporting the daily work of people involved in healthcare. More recently, the developments in wearable computing – e.g. smart glasses – and augmented reality (AR) technologies allowed for conceiving a new generation of systems that can further reshape the way in which people work and collaborate (Starner, 2013) (Costanza, Kunz, & Fjeld, 2009).

A main specific healthcare context where such technologies can bring a disruptive innovation is *emergency*. While mobile computing and network technologies have already been largely exploited to devise innovative ICT systems that improve the effectiveness of rescue operations (Chan, Killeen, Griswold, & Lenert, 2004) (Dolly, 2005) (Bessis, Asimakopoulou, & Xhafa, 2011), to the best of our knowledge augmented reality techniques and hands-free systems are largely unemployed in the design and engineering of collaborative technologies for emergency.

In this paper the authors describe an ICT system called SAFE (Smart Augmented Field for Emergency), which aims at supporting the work of teams involved in emergency/rescue scenarios, based on the integration of wearable computing and augmented reality technologies along with intelligent agents and multi-agent systems.

Based on the notion of Augmented Field (AF), the SAFE system described in this paper is meant to improve emergency management and rescue operations in two main aspects. First, the effectiveness of the action of individual rescuers engaged in the physical field where the rescue takes place; secondly, the interaction and coordination among rescuers, as well as other team members that follow the rescue

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mission from remote control rooms. This contribution is organized as follows: next section provides a background analysis on the healthcare emergency scenario, describing its key points, analyzing the limitations of the current state-of-the-art (in term of software systems applied to that context) and providing a briefly technological overview. After that, SAFE is presented from requirements analysis to architectural design details and prototype evaluation. An investigation on related works followed by the definition of the challenges and future works for SAFE concludes the contribution.

THE HEALTHCARE EMERGENCY SCENARIO

In case of disasters, an efficient coordination of rescuers' activities is essential to achieve the best usage of all available resources, which are typically very limited. First-aid treatments must be carried out rapidly and rescuers should have the capability to evaluate the injured people's health status, performing a primary medical treatment, if necessary.

All rescue actions on the mission field are carried out as a set of collaboration and cooperation activities, involving one or more teams acting within a specific environment with a very dynamic (and potentially unpredictable) context. In particular, teams should act cooperatively, sharing information with the purpose of making each rescuer aware of the global state of all actions performed on the field, or a subset of it. Each disaster area could have different characteristics, most of them potentially critical: for instance, communication infrastructures may be damaged or overwhelmed, and some sub-areas could be impossible to reach. Moreover, not all rescuers may have the same skills and duties (we can distinguish them between general-rescuers, nurse and medics) and, generally, a set of coordination mechanisms is needed to achieve a fruitful collaboration (Pipek, Liu, & Kerne, 2014).

The introduction of smart software systems supporting rescuers' operations allow for tackling better the complexity of the rescue scenario, improving the effectiveness of both the individual actions and whole team coordination and collaboration.

Software Systems for Emergency: State of the Art

Several software systems applied to healthcare emergency management were proposed in last decades; in particular, most of them are focused on the automatization of the triage procedure (Mercadal, Robles, Martì, Sreenan, & Borrell, 2012) (Gao, Greenspan, Welsh, Juang, & Alm, 2006). For a more detailed investigation of proposed systems see Related Works section below.

In most cases, each rescuer has a smart device that is able to guide her to perform actions on victims. With the help of the smart device, rescuers can evaluate a patient's health status and, in some cases, even communicate in some way (and under some restrictions) with the mission coordination center. These ICT systems essentially provide a computerization of the classical paper-based approach, with the objective of reducing (1) the duration of a triage procedure, and (2) the amount of skills that rescuers need to possess to perform their actions in an emergency. In some existing software systems for emergency management, there is also the concept of mission coordination center (also defined as operative center, central unit, and the like), able to receive data and information sent from operators for monitoring and persistent storage purposes.

However, existing systems are mainly focused on the single rescuer/operator: in other words, they does not provide a direct support to the cooperative work (collaboration between rescuers). Only the mission coordination center, if available during the mission, is aware of the global state of ongoing actions. Rescuers are only aware about their own actions and, typically, the system does not facilitate the collaboration within the rescue team—for example, to send each other (implicit or