The MIRROR AppSphere: the case of crisis management

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Abstract. In this paper we focus on learning from experience in crisis management and how it can be supported with mobile applications. The proposed approach focuses on the adoption of multiple lightweight applications (1) to collect data during an event, and (2) revisit the data to reconstruct the event and reflect on it, enriching current practices of debriefing. The paper briefly presents three applications that we have developed, a demonstration scenario, and the technical infrastructure that supports data exchange. With the paper we aim at opening a discussion about the role of simple dedicated Apps in crisis management, the requirements that they pose in terms of interoperability, and the challenges connected to an approach to crisis management that is holistic in perspective, but based on a necessarily fragmented support.

1 Introduction

Training in crisis management is challenging and has to take into account the need to learn specific skills, e.g. how to operate specific tools, as well as soft skills, e.g. appropriate communication styles and coping strategies (Sagun et al 2008). Challenges are connected not only to the complexity of the work to be performed, but also to its sporadic and discontinuous nature. Approaches to promote learning for crisis workers and volunteers include traditional training, coaching, simulated emergencies (Roberts and Lajtha 2002), serious games (Di Loreto et al 2012), and structured debriefings to reflect on and learn from specific work experiences.

Learning from experience is critical because crises are rare events and it is important to learn from each single occurrence. Despite protocols are carefully designed each event is highly situated and might lead to unexpected situations. Learning from experience can help workers, and their organizations, to improve their crisis preparedness and learn how to perform better in the future.

In our research we focus on how mobile and ambient technology can be used to support learning from experience, with focus on *reflection on action*. Reflection can be seen as a re-visiting and re-evaluation of experience, involving a return to previous experience with explicit attention to ideas, behaviour, and emotions (Boud et al. 1985). Debriefing sessions, with workers gathering together after real or simulated events, are an example of reflection on action. To be useful, they need to be fed with

information useful to trigger learning. This is challenging because crisis work is highly distributed (in time, space, competencies, roles, ...) and it is therefore difficult to capture *the* relevant data, accounting for multiple perspectives, and making sense of it. Also, focus is often on organizational level, neglecting citizens and workers on the field, while giving them voice might lead to important lessons learned.

Technologies can support reflection on action in different ways (Krogstie et al. 2012). In this paper, we present three applications: WATCHiT, CroMAR, and TimeLine. Together they can be used (1) to collect data during an event, and (2) to revisit the data to reconstruct the event and reflect on it, enriching current practices of debriefing.

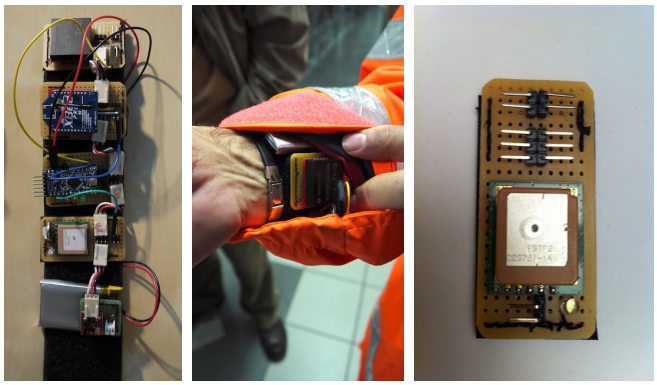
In the paper, after the presentation of the application, we outline a demonstration scenario showing how these applications can be used to support different levels of reflection and promote integration between different steps of crisis management. The technical infrastructure supporting data exchange is also introduced.

2 Apps for supporting reflection

The scenario includes three main applications: WATCHiT, CroMAR, and TimeLine.

WATCHiT (Cernea, Mora et al 2012) is a wearable computer (Figure 1a) sewn in a wristband to be worn under the work uniform (Figure 1b). WATCHiT allows emergency workers to capture information while being on the field and without interrupting the rescue work. Data captured can include information from the individual, for example stress levels, moods and personal notes; and information sensed from the environment like temperature, gas or radioactive exhalations. WATCHiT has a strong focus on a modular design therefore the set of information captured can be defined beforehand by plugging-in specific sensor modules to the main board (Figure 1c). Moreover each piece of information captured embeds its own GPS coordinates and timestamp of creation to allow locating the information in time and space. The user interaction exploits gestures and haptic feedbacks to allow the worker to send information without interrupting the rescue operation, as well as getting notifications from the system using distraction-free tactile feedbacks on the user's wrist. The hardware is based on Arduino[1] and open-source hardware.

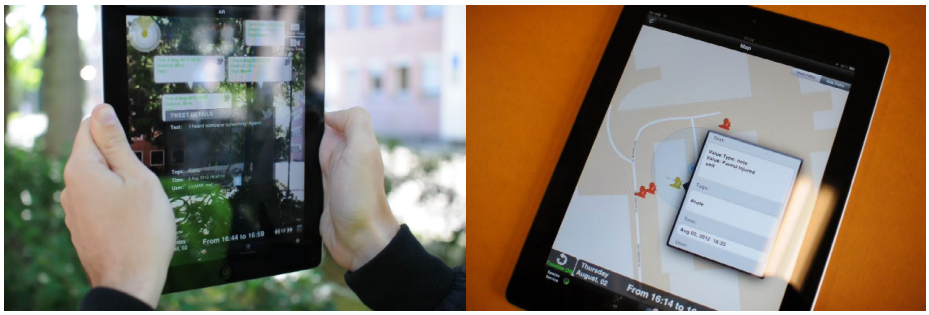
[1] www.arduino.cc
[2] http://www.apple.com/ios/facetime/
[3] http://www.dopanic.com/solutions/panic_ar.html



a b c

Figure 1: Prototype of W. (a), W. worn on the worker's wrist (b), a W. module for location sensing (c)

CroMAR (Mora et al. 2012) is a mobile augmented reality iPad App to support viewing and navigating across information (e.g. social media, radio communication, WATCHiT data, photo and video feeds) generated during a crisis, directly on site. The information is intended to support debriefing and reflection for civil protection workers who are deployed on the field. CroMAR allows for navigating information along the space, time and keyword dimensions using both augmented reality and map-based visualizations (Figure 2). In this way we can expect the reflection process to be grounded in a context that helps to make sense of the information and reflect on alternative path of actions. Because debriefings and reflection are a collaborative activities CroMAR allows synchronous collaboration via FaceTime[2] videoconferencing and asynchronous collaboration via an recommendations text editor and a email sharing of the set of information the user is looking at. CroMAR is implemented in a prototype for iOS tablet devices and powered by the PanicAR framework[3]. The source code is available open source (https://github.com/ubiAle/CroMAR).



a b

Figure 2: Augmented Reality (a) and Map (b) visualizations in CroMAR

[2] http://www.apple.com/ios/facetime/

[3] http://www.dopanic.com/solutions/panic_ar.html

TimeLine (Kristiansen et al. 2012) is a mobile application to support reflective learning through timelines. The application, running on Android devices, allows users to capture traces of working and learning experiences in a timeline with the aim to provide data that can be used to promote reflection. The application supports capturing of different types of information, ideas, behavior, and emotions (Figure 3). By using the notion of timelines, the application provides a way to organize and visualize the information. The visualization on a timeline provides a temporal contextualization, and any piece of information is presented together with other relevant information that users might have decided to collect, shedding light on different aspects of an event. Furthermore the application provides the possibility to build shared timelines, capturing in a coherent representation different perspectives of an event and supporting people in comparing their input with the ones of other group members.
Timeline is available free of charge on the Android Market, code is released open source[4].

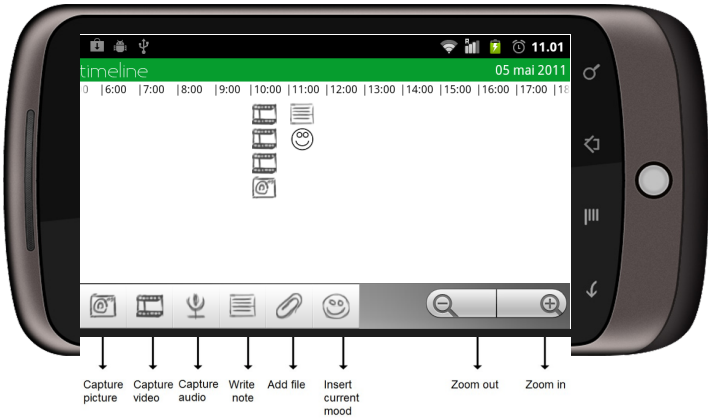


Figure 3: The timeline user interface and main annotation types

3 Demonstration scenario

The following scenario is based on user studies with the Italian Civil Protection and has been validated with field experts. A simulation of the scenario is documented in a video available at http://youtu.be/8RU50Lih72M.

Context

A major flood is causing serious disruption and material damages at *SomeTown*. With the worsening of the weather conditions, also the population is at risk and there are a number of missing persons.

[4] https://github.com/andekr/Timeline-App

Step 1 – work (set-up, during crisis)

Giacomo works as a volunteer in a unit with search dogs and they have been called in to help with searching missing persons. His coordinator, *Mirco*, decided to provide all the members of his team with **WATCHiT**, configured to collect but not share the heart rate; collect and send to the coordination team the location a person has been found; visualize messages from the coordination team.

Step 2 – work (during crisis)

The data that Giacomo (volunteer) collects in the field through WATCHiT is sent to the coordination team. Getting updated and reliable information allows them to take at any moment informed decisions. They also use it to send back information to the field (e.g. when an area needs to be evacuated).

Step 4 – Individual reflection (situated, after crisis)

Mirco (coordinator) is not completely satisfied because he feels that finding some of the missing persons has taken too long. Therefore, after a couple of days he goes back to the area covered by his team and starts a debriefing session with **CroMAR**. By looking at the information in the system and at the actual territory, he realizes that the searching would have been more effective if he had distributed his team differently. It was difficult to see this at the time, when it was dark, windy, and rainy.

Step 5 - Team reflection (not situated, after crisis)

Mirco (coordinator) calls his team for a debriefing session. It is impossible to get all of them out where the event took place, so they cannot use CroMAR. They rather meet in their office and use the **TimeLine** to check their shared timeline of the event. The timeline collects the public input from the WATCHiT devices of all the team, together with pictures and short SMSs that they have posted during the event to take note of interesting issues. During the session, some of the team members decide also to share information that they have collected in their individual timelines. Mirco also shares some of the information he collected in CroMAR. Using their individual perspectives and comparing them with the data collected in the field, they manage to get a good understanding of their strengths and weaknesses as a team.

Step 6 - Organizational reflection (towards preparedness)

The disaster manager is checking all the recommendations that they have received from the different reflection sessions conducted by the various teams. It seems that the coordination among different units has not been at its best. Looking at the visualization of the notes in the map, it is also easy to identify one problematic spot. The disaster manager will summarize all the lessons learned into a shared document that collects critical points and can be re-used in future emergencies.

4 The MIRROR technical infrastructure

An abstract view on the information flow between WATCHiT, CroMAR, and TimeLine is illustrated in Figure 4. In the described scenario, WATCHiT acts as pure data provider, while TimeLine is a pure data consumer. CroMAR is both: it consumes data provided by WATCHiT and it provides data accessed by the TimeLine.

The data exchange between the applications is realized with the MIRROR Interoperability Framework. The applications send their data to *spaces* provided by the MIRROR Spaces Service (Schwantzer 2012). When data is sent to a space, all applications registered at the space are notified and the payload is delivered to them in real time. In the scenario, two instances of MIRROR spaces are created: a private space owned by Giacomo, only visible to him through multiple applications, and the "Flood Event" team space, accessible by everybody involved in the operation. Both spaces are configured to be persistent and spaces can be re-configured anytime using a web application, which allows for example to create and destroy spaces or to add new users to an existing space. The data is exchanged over XMPP publish-subscribe nodes, which are managed by the MIRROR Spaces Service and can be accessed by all members of the space. The interaction between users, apps, and spaces is illustrated in Figure 5.

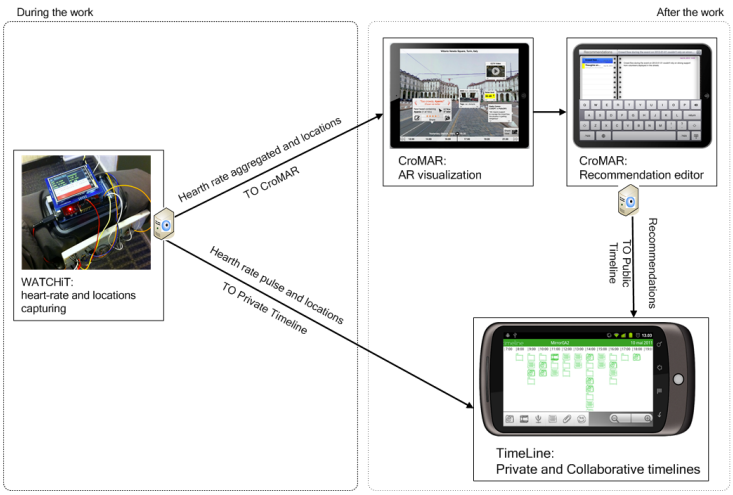


Figure 4: Information flow between involved applications

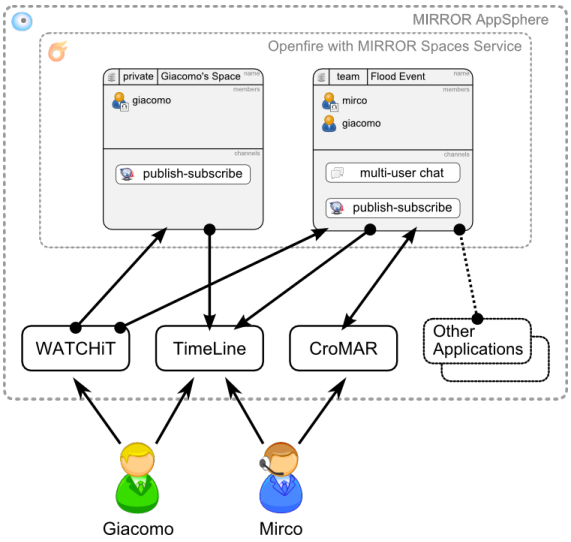


Figure 5: Interaction between users, applications, and spaces

5 Discussion and conclusions

In the paper we presented the combined use of a set of individual and collaborative lightweight applications to support work and reflection at different levels. We are fully aware that crisis management requires also the usage of more comprehensive organizational tools. At the same time, given the complexity of learning and working in crisis management, an ecological approach might successfully complement existing more traditional solutions. Though an ecological approach might lead to applications that are simpler to use, it is also important to understand how to provide the workers with a meaningful experience of the provided support, avoiding the risk of fragmentation.

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