Mobile augmented reality for supporting reflection

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Abstract
In this paper we discuss the usage of Mobile Augmented Reality to support reflection on past events, using reflection on crowd management as scenario. The paper identifies the main challenges of the scenario to Mobile Augmented Reality in terms of organization and usage of information.

Keywords
Augmented reality, reflection, collaboration

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Introduction
Reflecting on action is critical to learn from past experiences and performing better in the future [1, 2]. Different tools have been developed to support reflection, as an individual or collaborative activity. An example is provided by life logging applications, which promote reflection in the context of behavior change, and witness the potential of mobile applications to capture information on the move and use it for reflection.

Information about past events is important to support reflection not only to complement human memory, but also to allow bringing in multiple perspectives on collaborative processes. Different metaphors have been proposed to organize this information, e.g. timelines and tag clouds.

In this paper we investigate the usage of Mobile Augmented Reality to support reflection on work practices that rely on deployment and management of resources in space and that have therefore a strong spatial dimension. The importance of space in collaborative settings has been largely recognized, starting from [3]. Space-based services for storage and interaction with information are widely used both for work (google maps mashups) and for leisure

(Foursquare, Yelp). Augmented Reality is recognized as an interface to show space-based information to support an ongoing activity (e.g. to search for the closest restaurant) in a user-friendly way. In this paper we investigate the usage of Mobile Augmented Reality for supporting reflection and discuss related challenges building on a scenario of crowd management. More specifically, we aim to promote reflection of workers who are deployed on the field to operate as crowd managers during a planned outdoor event (concert, sport game, talks). The scenario is based on observations we have collected during a large event in a large Italian city.

The scenario we envision is the following. During the event information is continuously exchanged to coordinate activities, often mediated by different tools; sensor and camera feeds from mobile and static checkpoints are recorded. We also envision that event's attendees can send media from their smartphones, e.g. about dangerous situations. After the event, we envision enriching the current practices of debriefing and reflection by introducing a tablet-based augmented reality viewer that shows information collected during the event. Information is presented in layers and can be shared among colleagues. The system guides users to different locations where information was generated. Reflection is expected to take place at the same physical location of the event.

We believe that the usage of Mobile Augmented Reality can be beneficial because it allows grounding reflection in the specific place where the event took place. AR can help to layer information about the event and access spatial information that might be relevant to re-think the event. For example, comparing a photo of a square during an event with the real space under normal conditions might help to reconsider actions that have been taken and possible alternatives, e.g. alternative escape routes. Looking at the space in normal conditions might help a worker to re-assess more critically his level of stress during the event.

Visualization of information

The large amount of information collected during an event and the fact that the information will be visualized on a tablet-device screen make the process of layering the information critical. The user should be enabled to visualize different kinds of information depending on what he/she wants to reflect upon. Information can come from different sources, from:

- Context/environment, e.g. a photo captured by a mobile unit or an indicator of noise level
- Participants, e.g. a tweet sent in by a participant to the event to signal something not functioning or from a worker to signal his stress level in certain conditions
- Applications supporting work, e.g. the recording of radio communication during the event or information from the event management system

Another categorization of information can be done based on the semantic of the information, according to Boud's model [1]:

- Ideas , e.g. suggestions by an worker on how to handle a situation differently
- Behavior, e.g. GPS tracks of emergency vehicles
- Feelings, e.g. stress level of workers expressed with textual messages or emoticons

In addition, the layering could take advantages of existing conceptualization of places, considering e.g. the historical, psychological, and social dimension of a place. In any case, one of the challenges is to select an appropriate set of information to visualize in order to support reflection situated in a specific context. This might require a pre-processing of the information by the system to avoid the visualization of similar information for a certain location/situation. A possible solution could be the use of Information Retrieval (IR) techniques to extracts important keywords from textual messages and picture captions in order to categorize them.

In addition to the spatial dimension, time might also play an important role. It is therefore important to be able to capture and present the temporal evolution of a place.

The right association of information to places and capturing the right level of granularity depending on the context is also a challenge. For example, when one looks at a square, is he interested to the whole area or only to a small sub-area? How to get the right level of granularity? Also, considering that information is sent in by different actors, often under time constraints, how can we capture the right association of the information to a place?

Usage

Crowd management involves a number of actors with different roles. We therefore look at the related reflection on the event as necessarily collaborative. Even when the reflection is done by an individual, it must necessarily be based on information provided by others.

In our scenario, fragments of information come from actors operating in different contexts to achieve different goals. They are pieces of a puzzle that must come with an embedded context (e.g. geotags, timestamps, comments …) which allow setting them together in time and space to be compared, clustered, layered, shared and re-used across multiple representations. Information should not be seen in isolation, but as part of a *Common Information Space* [4] that supports reflection on the practice. In this perspective, the system should be able to support sense making processes to allow meaningful action. Also, it is important to provide the right level of sharing – depending on roles and respecting privacy issues.

One additional challenge is constituted by the need to support exploration and make sure that the information relevant for a certain reflection session is explored. In our mockups we envision supporting navigation and exploration of the information not only using the spatial dimension, but considering also connection among the information (e.g., the usage of similar tags) and the time dimension (e.g. all the information in a location that has been submitted in a certain period of time).

Finally, there is a need to support different forms of collaboration. For the time being, we plan to support indirect collaboration through the annotation and rating of specific pieces of information; the sharing of a specific type of information; the sharing of a specific view, i.e. a picture of the location and the specific information that one is looking at in the moment the view is captured. Additional user studies might help to identify additional forms of cooperation.

Conclusions

In this abstract we have presented challenges connected with the usage of Mobile Augmented Reality to support reflection on collaborative practices with a strong spatial dimension. Some challenges are discussed in relation to visualization of information and its usage. The additional material that we have provided in attachment presents some mock-up of the system to illustrate the main ideas. At the workshop, we expect to present also the results from the initial evaluation of the ideas with users.

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