Mobile Software during Disaster Events: A Motivational Discussion

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Abstract

Disaster events are complex socio-technical environments including diverse stakeholders and limited resources for preparation, response, and recovery. I present here a discussion of software engineering challenges to produce reliable, usable, and socially-aware mobile apps during and for disaster events.

Introduction

The ubiquity of mobile and wearable computing devices has set unprecedented opportunities for innovation in the computer-mediated society in which we live. By its definition, the term "mobile" implies a portability and transportability of a device. For more than thirty years, advancements in cellular, battery, and software technology, as well as the economic shift between hardware and software since the birth and development of computer technologies [3], have given rise to more mobile-based interactions. By becoming more mobile, the computing device has transcended, in design and in use, from the workplace environment into more personal ones, such as the home and a pocket.

But the definition of "mobile" also implies a flexibility and adaptability that is not often thought of. Being "mobile" certainly means that it is a new arena for innovation. It carries remnants of the traditional "desktop" metaphor, which was borne from early work at the XEROX Corporation [18] that helped bring the desktop computer from the workplace to the home. We see this in the way that mobile devices such as PDAs and BlackBerrys in the late 1990's and early 2000's assumed that users wanted a replica of their desktop computers on smaller screens. Truthfully, however, we see that the mobile space has made more personal content - photos, videos, music, and social media - first-class entities, and that efforts to design mobile devices around this content has largely been successful. Facebook status updates and friend requests, Twitter notifications, SMS messages, Instagram photo sharing, and ESPN GameCenter updates exemplify this content and bring the social and personal aspects of technological use to the forefront. The mobile device is an extension of the personal self, not just the professional one.

One can argue, however, that the mobile device is much more than a personalized computing device whose smaller form factor helps connect to others on a wider, quicker, and more accessible scale. What if mobile devices were also viewed as a means to participate in digital mapping? What if they can be used to broadcast to family and friends that you are "OK" after a natural disaster? Indeed, if the pervasiveness of mobile computing is a mechanism for connecting with others and an extension of the personal self, then new innovations involving the use of a mobile device have yet to be explored. In this short essay, I discuss research directions in the field of software engineering that address how the social and technical aspects of mobile connectedness can be applied to a new and burgeoning field of study - crisis informatics.

Crisis Informatics

Research to study the prevalent use of online technology - particularly social media - in disaster events has been the focal point of an emerging interdisciplinary field called crisis informatics [12]. Diverse fields of study, such as work from natural language processing, software engineering, policy, human-computer interactions, and the social and information sciences, link to crisis informatics because of the wide challenges that test our ability to prepare for, respond to, and recover from natural and man-made disaster events. At the scene, a disaster event involves many stakeholders including official emergency response personnel, relief organizations, volunteer-based communities, and, of course, the affected. Information and communication technology (ICT) in the hands of emergency management creates information pathways to connect members of the public with - for example - status reports centered around the hazards of the event and resources for more information, food, water, and shelter. Commonly, such ICT are manifested through channels such as SMS broadcasting, periodic media and press release, and through official emergency management web portals. In this frame, the disaster event can largely be seen as a socio-technical environment in which information is managed in a top-down push-down fashion by governmental bodies on a municipal, state, and federal level - information is served in one direction to the general citizenry, and response efforts are allocated to areas of most concern.

However, disaster sociology such as work from Dynes [6] informs us of a greater-in-number, more timely force that become the true "first responders" at the scene - members of the public. Briefly, they are the first to identify power outages in residential areas, find out who is missing and who is safe, coordinate trips to store large amounts of trash in empty parking lots, and maintain emotional and mental welfare. In the online world, most notably, they converge onto social media sites like Twitter and Facebook to engage in remote and collective problem solving of the aforementioned work items. Work conducted by Palen and colleagues examines several cases of this digital volunteerism, including the routing and verification of information produced in Twitter by those needing to connect with victims of the 2010 Haiti earthquake [14], the case management of lost and found pets during the aftermath of the 2012 Hurricane Sandy [20], and the pronunciation and emergent practices that are defined by new online communities like Humanity Road [16] and OpenStreetMap [19] to perform online cooperative work in the domain of humanitarian relief. The public citizenry are not only collectively helping one another in times of crisis; they incorporate themselves into online communities whose raison d'être is to constantly monitor developing events, activate when necessary, and save lives with proper information dissemination and production.

Remote and on-the-ground work being done in the public realm has indeed proven to aid those in need when disaster response personnel cannot address them right away, but it has also given rise to a number of questions that emergency management has yet to address. For example, "How can public and open data about the disaster event be measured for accuracy?" or "What software platforms can be built for consumption of public data, and what does it look like?" In addition, observational studies in [13] have shown that formal response and "informal" public response to an event do not always co-adapt - it is often the case that emergency management finds self-proclaimed volunteers responding to cries for help a dangerous situation and increases the overhead for response and coordination. With the spur of mobile technology into the hands of the common layperson, one that enables unprecedented capability in sharing content and connecting with others, these challenges describe the shaking of the information divide that separates the public and the formal response during disaster events [10, 12]. Further, members of the public are natural-born information seekers and will stop at nothing to glean as much information to optimize local conditions [11, 15]. With mobile technology that is accessible, the public citizenry are now mobilized to produce and disseminate important data that may be of use to formal disaster response efforts.

Software Engineering Challenges

In this socio-technical environment, designers and developers share opportunities for new applications and services that may disrupt the use of mobile technology and encourage it to be used during disaster events. These include mobile apps that help users stay in touch with close friends and family relatives (e.g. Microsoft HelpBridge), report lost and found pets and post them to a centralized gallery [1], and of course, take pictures to embed within tweets and Facebook posts. In the humanitarian sector, software development has transcended the halls of co-located space and operationalized the workforce into a decentralized environment. Distributed volunteer workforces such as Ushahidi [8], Sahana [5], and OSM and the Humanitarian OpenStreetMap Team (HOT) [19], are constantly rethinking how to self-organize and govern themselves [2, 4] and design apps to be used by as many people as possible to contribute to crisis mapping and reporting.

With this type of development environment, there are challenges to confront. It has been observed in [7] that coordination - creating dependencies from one developer to another - falls off as the distance between those developers increases. A number of coordination mechanisms have been introduced into

developer workspaces, including company social networks, mailing lists, and integrated chat channels inside integrated development environments (IDEs). However, efforts to understand how such mechanisms enhance or degrade coordination in co-located and decentralized teams across different software team configurations are sparse. For software development during crises, a domain in which developers are most often split across time-zones and time-criticality, user-centered design, and reliability are first-class concerns, there is much to learn.

While difficult enough, the coordination challenges for designing and developing software within distributed teams does not embody the difficulty in adoption and proliferation of software use. How can we guarantee that emergency management teams will effortlessly incorporate new tools into existing workflows? How do we understand the public use of a mobile app during disaster events? Work done with observational studies of existing apps and tools, as well as designed interventions in this area, can help us understand how mobile technology can bridge publicly produced data and the requirements that are articulated by formal response. Software engineers need to be cognizant of these socio-technical concerns as well. Systems that presume plans for how they are used without knowledge of their actual use are brittle and risk user churn [9, 17].

Concluding Remarks

Disasters are socio-technical environments in which diverse stakeholders are engaging in on-the-ground and remote work to ensure safety from the hazard, produce and disseminate reliable information by and through social media and other ICT, design and build software to aggregate and report on crisis data, and save lives. This essay is a shorthand survey through the crisis informatics and software engineering literature that motivates why mobile computing is a new arena for innovation and how such personalized and social devices can become gateways to increase communication between these stakeholders. Mobile devices allow users to become citizen journalists and collect important information to make more informed decisions on behalf of formal and informal disaster response.

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