Moving Towards Crowd Tasking for Disaster Mitigation

Daniel Auferbauer
Vienna University of Technology
daniel.auferbauer@tuwien.ac.at

Roman Ganhör
Vienna University of Technology
roman.ganhoer@tuwien.ac.at

Hilda Tellioğlu
Vienna University of Technology
hilda.tellioglu@tuwien.ac.at

ABSTRACT

Advancements in information and communication technology (ICT) offer new possibilities when dealing with crisis situations. In this paper we present the design for a crowd tasking tool (CTT) that is currently under development. We describe how the tool can assist disaster relief coordinators during a crisis by selectively distributing tasks to a crowd of volunteers. We also compare the CTT with an already existing ICT based solution for supporting volunteerism during crisis. The differences between these two tools are addressed and the implications for volunteerism are discussed. The paper concludes with an outlook on future work emphasizing a form of volunteer involvement that offers potential for gathering information that is more relevant and easier to digest for decision-making than information provided solely by self-organised volunteers through social media.

Keywords

Crowd tasking, volunteers, resilience, crisis informatics, community management.

INTRODUCTION

Recent years have seen the occurrence of several large scale disasters worldwide, such as repeated bushfires in the U.S. during drought season (e.g., California, USA in 2007 and Oklahoma, USA in 2009), the Haiti earthquake of 2010, the earthquake and following tsunami that hit Japan in 2011, hurricane Sandy in 2012, or the floods that affected multiple countries in the south-east of Europe in 2014. The increase of pervasive information and communication technology can offer new possibilities for improving resilience and mitigation of such events. This has been recognised and prompted investigations into how social media is being used (Starbird & Palen, 2013) and how the organisation of community efforts is affected (Soden, 2014). Examples for such activity that have been examined include the usage of micro blogging during wildfires and floods (Vieweg, Hughes, Starbird, & Palen, 2010), the utilization of an open mapping platform during the Haiti Earthquake (Soden, 2014) as well as a wide range of ICT being used during and after the shooting on Virginia Tech campus (Palen, Vieweg, Liu, & Hughes, 2009). The research testifies a willingness among people to provide help and

support. This could prove to be an asset to formal organisations concerned with disaster relief. For example, it is important for decision makers to have access to up-to-date information from a disaster site. Such information can be provided by volunteers that are already on site, yet the amount of information running through social media can be overwhelming (Hiltz & Plotnick, 2013; Hughes, 2014; Verma et al., 2011). Observing the interconnection between disaster relief organisations and volunteers seems a promising area for further investigation.

In this paper we present intermediate results of a project that is currently being conducted in Austria investigating the potential of volunteers supporting formal emergency services by means of information and communication technology. We discuss the preliminary results and compare them with a project that successfully attracts volunteers for disaster relief since its inception in 2007. Both projects attempt to lower the barriers for volunteers by utilising ICT, however, the degree of formalisation differs vastly.

This paper is organised as follows. First, we give a short overview of previous work that is relevant to this field. Second, two approaches to volunteerism during and after crises are presented; one that has been in use for several years and a second that is currently under development. Third, we discuss the differences between these two projects and the implications they have. Finally, we conclude with an outlook on future work.

RELATED WORK

The different forms of ICT usage by the general public during an extreme event have been subject to investigation for some time. Uses vary from purely self-organised grassroots approaches as described in (Palen et al., 2009; Starbird & Palen, 2011, 2013; Vieweg et al., 2010) to mediation between volunteers and official disaster relief efforts (Cobb et al., 2014; Hofmann, Betke, & Sackmann, 2014; Lanfranchi, Wrigley, Ireson, Ciravegna, & Wehn, 2014).

Apart from academic efforts, disaster relief organisations from various countries have also shown interest in accommodating the usage of new media to support and encourage volunteers. Most of them require a pre-registration for volunteers stating their availability for help during future crises. For example, the American Red Cross has launched a mobile application[1] for volunteers to provide helpful information during crises. Another example, *PulsePoint*[2], aims to notify pre-registered users in the area of an incident according to their skills. Other examples are: *Team CP*[3], which tries to educate convergent volunteers in advance, *Team Morava*[4], *Team MV*[5], and *Team Austria*, which is described in detail in the following section.

INVOLVING VOLUNTEERS IN DISASTER MITIGATION

Crowd tasking is defined as a process where certain tasks are matched to specific volunteers, thus, forming a more specialised form of the broad term *crowdsourcing* (Schimak, Havlik, & Pielorz, 2015). The challenge for the emergency service is the deliberate selection of volunteers and the distribution of tasks to these volunteers. We now discuss projects incorporating the concept of "crowd tasking" (Neubauer et al., 2013), allowing emergency services to make meaningful use of volunteers' efforts in a unidirectional manner.

Current Efforts – Team Austria

In August 2007 the Austrian Red Cross, together with a nationwide radio station, started organising a community effort towards disaster mitigation that was named "Team Austria". The aim was to engage the public in supporting emergency response teams and to improve resilience against the consequences of disasters by community building and preparedness. Through nationwide media campaigns approximately 24.500 volunteers were recruited – this number has increased to over 35.000 as of 2013. We analysed the current workflow employed by Team Austria by studying their emergency plans and supporting literature, conducting expert interviews and focus groups.

[1] http://www.redcross.org/mobile-apps/volunteer-app
[2] http://www.pulsepoint.org/
[3] http://www.roteskreuz.at/site/team-civil-protection/home/
[4] http://www.teammorava.cz/en/who-is-team-morava
[5] http://www.team-mv.info/

Team Austria pursues a closely governed approach in that the volunteers have a lot of face to face interaction with the emergency service provider, in that case the Austrian Red Cross. Once a volunteer has signed up via the project's website s/he receives an invitation to introductory courses that are hosted on a regular basis by the Austrian Red Cross. Whenever the Red Cross and public safety authorities decide to involve the volunteers of Team Austria during an emergency, text message notifications are sent to selected volunteers. The selection process is based on various parameters such as age or place of residence. The volunteers respond likewise via short message service. To avoid manual parsing by the emergency service the response is expected to be formatted according to a given template. Subsequently, detailed information about a pre-deployment briefing is sent to the volunteers that have responded. The process of notifying and inviting more Team Austria volunteers will be repeated, sensibly with an expanded target audience, until a sufficient number of attendees have responded. At the pre-deployment briefing volunteers receive further information about the current situation at the disaster site and the tasks they are going to fulfil. Attendees that are not members of Team Austria have the opportunity to sign up on the spot. Those volunteers who are actually taking part in relief effort have to sign a document stating their informed consent to legal implications of their actions. This document exempts Team Austria from punishment or regression whenever volunteers transgress the boundaries of law in the name of disaster relief. After the briefing has finished volunteers are split into groups and move out to execute their assigned tasks. They are supervised and guided throughout by representatives of the Red Cross. Work is done in shifts until the situation is resolved, at which point all participants gather again for a debriefing and are subsequently dismissed. For the duration of relief efforts the Austrian Red Cross organises transport, lodging, and provisioning for all attending volunteers.

Proposed Approach – RE-ACTA

"Resilience Enhancement by Advanced Communication for Team Austria" (RE-ACTA) started in 2013 with the goal of improving resilience in all stages of disaster management, utilising new media and mobile handheld devices. At the core of RE-ACTA lies a workflow to push sets of tasks to the mobile devices of selected, pre-registered volunteers. The workflow may be split into three distinct categories: the mobilisation of potential volunteers, the execution of crowd tasking, and visualisation of the data that has been gathered. In the following section these stages are described in detail.

1) Preparation and mobilisation: RE-ACTA hosts a website allowing volunteers to sign up by providing their names, skills, and place of residence. To take part in disaster relief efforts the volunteers have to download and install a mobile application (app) for their smartphone. The purpose of this app is to push situational and task related information to the volunteers. This information is created and distributed via a crowd tasking tool, operated by a trained member of an emergency relief organisation; we will refer to him/her as the "crowd tasking manager". After the official declaration of a crisis by the local or national government, the crowd tasking manager sets up a pool of volunteers by defining one or more criteria, such as a person's current location or skills. Persons fulfilling the criteria will receive a notification asking for their participation, which they may accept, decline or simply ignore. Ignoring a call for a pre-defined amount of time will be treated as if having actively declined. However, every volunteer who accepts the request becomes a potential recipient for tasks over the course of this crisis.

2) Task distribution and execution: The crowd tasking manager creates tasks consisting of one or more steps, each having a well-defined result. Possible result types for a step are: an image, a video, an audio recording, pre-defined text values (single or multiple choice), or free text. After tasks are defined the crowd tasking manager groups them into lists and pushes the lists to selected volunteers via the app. Recipients may select or deny a number of tasks to complete.

3) Analysis of results: The data that is submitted by volunteers is aggregated (where possible) and displayed on an interactive map. This feature is intended for the commanding members of the emergency response organisation, providing easily accessible intelligence about the current situation. The cycle of defining, completing, and processing tasks as well as the evaluation of their results continues until the crisis is declared resolved.

Designing the workflow for RE-ACTA followed an iterative user centred process, where the term "user" refers to the crowd tasking manager as well as the

volunteers that carry out the tasks. A first step in designing was to gather and analyse the requirements for a crowd tasking system. This requirement gathering included surveying existing best practices as well as conducting interviews and focus groups with experts and users. Based on the results a tentative design was developed in two iterations. As the compiled process model was rather extensive (containing almost six dozen pages of sequence diagrams, among others) and required knowledge about specific internal procedures it was illustrated utilising real-world examples. Furthermore, a devised scenario was provided to outline a frame for common use cases – the importance of scenarios has also been discussed in (Borglund, 2014; Florez, Charles, Lumière, & Lauras, 2014). Within the boundaries of our setting we exemplified each of the many sequence diagrams by "instantiating" it in the context of a situation that could occur during a real case of emergency. This approach was received favourably and provided two benefits. First, we managed to keep the participants engaged throughout the evaluation meetings. Second, it helped to attune all parties in understanding the intended usage of the system. Whenever certain functions were unclear they were explained using examples and real world scenarios.

DISCUSSION

Team Austria and RE-ACTA are two distinct applications for the same use case, complementing each other. The main difference between these two projects is the level of volunteer involvement. While Team Austria provides insurance, personal briefings, supervision and more, none of these services are present in RE-ACTA. Consequently they differ in the types of tasks that are distributed. The tasks within Team Austria often include physical work such as building protective barriers during floods, whereas RE-ACTA focuses on awareness and information distribution. In general, the latter allows faster, easier, and less time consuming participation. Volunteers in RE-ACTA do not need to attend training courses or assignment briefings to perform tasks. Additional information is available directly through RE-ACTA's mobile app, which we consider a main contribution in lowering the entry barrier for volunteers. Participation may start with the next mobilisation call – the frequency of which depends on the situation and varies between minutes and days. Tasks in RE-ACTA are not time consuming and do not require intense physical work, allowing a broader demographic to take part. We expect that Team Austria and RE-ACTA are appealing to different demographics; however, this is a research area for future investigations.

The decision to bundle several tasks into lists before pushing them out to volunteers was made to achieve a more even distribution of tasks among the recipients. It was noted by disaster relief experts that volunteers often tend to accept the first tasks and neglect others. To mitigate this uneven distribution, the mobile app randomises the order of tasks in the list pushed to a user. We also assume that offering users the ability to choose their tasks from a list could be preferable to making them decline or accept single items. In another attempt to achieve evenly distribution in crowd working, RE-ACTA avoids over-satiation of tasks through automated routines that rely on parameters such as an upper limit for accomplished tasks.

In contrast to existing grassroots approaches, RE-ACTA relies on emergency response entities coordinating the crowd tasking through all phases in a crisis. Thus, spontaneous contribution by volunteers is not supported. If there is no task defined by the crowd tasking manager, volunteers are not allowed to submit information on their own initiative. However, volunteers can try to bypass the rigid structure of the system by submitting unrelated information through task submissions. If and in what manner this happens will be subject to investigation at a later point. Not allowing ad-hoc contributions is a downside as it prevents potentially relevant information in reaching the crowd tasking operators. The emergency response entities in charge receive only intelligence they are specifically asking for, leaving out additional information identified by the crowd.

Formal channels of information distribution and communication are often regarded to be slow and inefficient (Lanfranchi et al., 2014). Crowd tasking can potentially improve the speed of information acquisition while maintaining the favourable aspect of filtering and verification by professional and formal emergency response personnel. This helps in preventing negative effects of citizen journalism as described in, e.g., . However, the challenge to identify the important and valuable information remains. Choosing a rigid workflow limits the amount and variety of information while improving its relevance and process-ability by automated systems.

FUTURE WORK

A proof-of-concept prototype for RE-ACTA is currently under development. An evaluation of this prototype is planned as part of a drill exercise in the spring of 2015 where we will observe the deployment of crowd tasking from both perspectives: that of the volunteers in the field as well as the coordinator in the operations centre. In this stage of development we will evaluate user uptake, acceptance of the general concept of crowd tasking as well as usability of the tools. We intend to focus on usability issues of the interface (both mobile app and crowd tasking tool), user behaviour during task execution, the level of user involvement, and entry barriers for volunteers.

Beside organisational aspects, legal concerns are currently being scrutinised. Due to the utilisation of user's location via GPS as an integral part of the software and process design privacy concerns are also examined. There is also the matter of liability and responsibility if a person is harmed during the execution of a task.

Technologically we rely on working communication channels such as cell phone networks. Jennex (Jennex, 2012) points out that the availability of such high-level infrastructure during a state of emergency is not certain. Mitigating power outages and bypassing incapable cell towers will be subject of further investigation.

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REFERENCES

1. Borglund, E. A. M. (2014). Creation of an Exercise Scenario: A Collaborative Design Effort. In *Proceedings of the 11th International ISCRAM Conference* (pp. 488–492). University Park, Pennsylvania, USA.
2. Cobb, C., Mccarthy, T., Perkins, A., Bharadwaj, A., Comis, J., Do, B., Sites, P. (2014). Designing for the Deluge: Understanding & Supporting the Distributed , Collaborative Work of Crisis Volunteers, 888–899.
3. Florez, J. V., Charles, A., Lumière, U. L., & Lauras, M. (2014). Designing Realistic Scenarios for Disaster Management Quantitative Models. In *Proceedings of the 11th International ISCRAM Conference* (pp. 180–189). University Park, Pennsylvania, USA.
4. Hiltz, S. R., & Plotnick, L. (2013). Dealing with Information Overload When Using Social Media for Emergency Management: Emerging Solutions, (May), 823–827.
5. Hofmann, M., Betke, H., & Sackmann, S. (2014). Hands2Help – Ein App-basiertes Konzept zur Koordination Freiwilliger Helfer/ Hands2Help – An App-based Concept for Coordination of Disaster Response Volunteers. *i-com*, *13*(1), 36–45.
6. Hughes, A. L. (2014). Participatory Design for the Social Media Needs of Emergency Public Information Officers. In *Proceedings of the 11th International ISCRAM Conference* (pp. 727–736). University Park, Pennsylvania, USA.
7. Lanfranchi, V., Wrigley, S. N., Ireson, N., Ciravegna, F., & Wehn, U. (2014). Citizens' Observatories for Situation Awareness in Flooding. In *Proceedings of the 11th International ISCRAM Conference* (pp. 145–154). University Park, Pennsylvania, USA.
8. Neubauer, G., Nowak, A., Jager, B., Kloyber, C., Flachberger, C., Foitik, G., & Schimak, G. (2013). Crowdtasking – A New Concept for Volunteer Management in Disaster Relief. In J. Hřebíček, G. Schimak, M. Kubásek, & A. Rizzoli (Eds.), *Environmental Software Systems. Fostering Information Sharing SE - 33* (Vol. 413, pp. 345–356). Springer Berlin Heidelberg.
9. Palen, L., Vieweg, S., Liu, S. B., & Hughes, A. L. (2009). Crisis in a Networked World: Features of Computer-Mediated Communication in the April 16, 2007, Virginia Tech Event. *Social Science Computer Review*, *27*, 467–480.
10. Schimak, G., Havlik, D., & Pielorz, J. (2015). *Environmental Software*

Systems. Infrastructures, Services and Applications (Vol. 448, pp. 56–70).

11. Soden, R. (2014). Resilience - Building and the Crisis Informatics Agenda: Lessons Learned from Open Cities Kathmandu. In *Proceedings of the 11th International ISCRAM Conference* (pp. 339–348). University Park, Pennsylvania, USA.
12. Starbird, K., & Palen, L. (2011). "Voluntweeters": Self-organizing by Digital Volunteers in Times of Crisis. In *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11* (p. 1071). New York, New York, USA: ACM Press.
13. Starbird, K., & Palen, L. (2013). Working and sustaining the virtual "Disaster Desk." *Proceedings of the 2013 Conference on Computer Supported Cooperative Work - CSCW'13*, 491.
14. Verma, S., Vieweg, S., Corvey, W. J., Palen, L., Martin, J. H., Palmer, M., … Anderson, K. M. (2011). Natural Language Processing to the Rescue? Extracting "Situational Awareness" Tweets During Mass Emergency. *Proceedings of the Fifth International AAAI Conference on Weblogs and Social Media*, 385–392.
15. Vieweg, S., Hughes, A. L., Starbird, K., & Palen, L. (2010). Microblogging during two natural hazards events. *Proceedings of the 28th International Conference on Human Factors in Computing Systems - CHI '10*, 1079.
16. Watson, H., Finn, R. L., & Scifo, S. (2014). Citizen (in) security ?: social media, citizen journalism and crisis response. In *Proceedings of the 11th International ISCRAM Conference* (pp. 294–298). University Park, Pennsylvania, USA.