2nd Workshop on Mobile Resilience: Designing Mobile Interactive Systems for Crisis Response

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ABSTRACT

Information and communication technologies (ICT), including artificial intelligence, internet of things, and mobile applications, can be utilized to tackle important societal challenges, such as the ongoing COVID-19 pandemic. While they may increase societal resilience, their design, functionality, and underlying infrastructures must be resilient against disruptions caused by anthropogenic, natural and hybrid crises, emergencies, and threats. In order to research challenges, designs, and potentials of interactive technologies, the second iteration of the workshop investigates the space of mobile technologies and resilient systems for crisis response, including the application domains of cyber threat and pandemic response.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in ubiquitous and mobile computing*; *Mobile devices.*

KEYWORDS

Mobile Resilience, Interactive Systems, Crisis Informatics, Cyber Incident Response, Social Media Analytics

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1 BACKGROUND

The digitalization by information and communication technologies (ICT), including recent innovations based on artificial intelligence, internet of things, mobile applications, or social media, exert an increasing influence on contemporary and future societies. Thus, the terms of smart cities and smart rural areas were coined to leverage digital innovation in urban and rural areas [9, 17]. Besides everyday use, ICT can be used to enhance societal response to anthropogenic (e.g., bombings, cyberattacks), natural (e.g., earthquakes, floods, hurricanes), or hybrid disasters [10, 16, 18], which is currently demonstrated by the deployment of contact tracing apps during the COVID-19 pandemic [1]. However, others challenges arise from this:

- How can the functioning of societal and related ICT be secured in anthropogenic, natural, or hybrid extreme situations, crises, and catastrophes [15, 22]?
- In light of an increasing exposure of digital infrastructures, how can we increase preparedness and response capabilities against cyber threats [6]?
- How can big crisis or social data be prepared for a meaningful analysis by authorities and organizations, also mitigating the issues of information overload and low information quality [13, 21]?
- How can the availability, integrity, reliability, and resilience of critical infrastructures in digitally interconnected areas be improved in the future [2, 5]?

These are only some questions that society needs to address to increase its *resilience* [4]. In this context, resilience can be understood as "the ability of a [socio-technical] system to cope with perturbations such as crisis and shocks while preserving its functions" [8]. While *resilient systems* have been described by the characteristics of absorption, recovering, adaptation, or transformation [3], research characterized *(mobile) technologies for resilience* by the properties of accessibility, diversity, evolvability, and usability, amongst others [14]. At the same time, the research field of crisis informatics [19] increasingly investigates the potentials and limitations of artificial intelligence [11], social media [20], and mobile technologies

such as crisis and warning apps [7], which constitute a relatively new public service for citizens and are specifically designed for the dissemination of disaster-related information and communication between authorities, organizations, and citizens [12]. However, another emerging challenge lies in fighting "infodemics", i.e., the dissemination of misinformation in pandemics [23]. Furthermore, if critical communication or energy infrastructures fail, for instance, the distribution of recommendations and warning messages is challenged and requires alternative infrastructures [2].

2 GOALS

In this workshop, we want to explore the overlapping space that both *mobile interactive technologies* and *resilient systems* yield as fields of research. Specifically, in the second iteration of the workshop it is of interest to us how to integrate mobile applications into cyber incident and pandemic response. Thus, we seek to produce empirical findings related to design opportunities for resilient mobile and interactive systems. Furthermore, we aim at working out the state of research in the fields of mobile interactive technologies and resilient systems. Lastly, avenues for further research and the potentials of both fields are in the scope of this workshop. Key topics of the workshop include but are not limited to:

- Case studies, surveys, use cases and theories on mobile, social and, technological resilience, including application domains such as crisis response, cyber threats, infodemics, or pandemics
- Algorithms and systems for user-centered analysis of big crisis data, including cyber situational awareness, open source intelligence, social media analytics, credibility and relevance assessment, or social sensors
- Concepts and technologies for contact tracing in pandemics or stakeholder collaboration, including authorities, computer emergency response teams, rescue organizations, and citizens
- Human and technical factors in decentralized infrastructures, edge computing, and wide area networks for crisis management and response
- Innovative analysis, (interaction) design and, evaluation of resilient mobile or social (crisis) information systems
- Functionality, robustness, usability und user experience of resilient technologies such as mobile crisis and warning apps or wearables
- Best practices, methods, and strategies for the development and deployment of resilient (mobile) technologies in diverse application domains

3 CONTRIBUTIONS

The submissions for the workshop address some of the open issues mentioned above. Researchers from fields such as human-computer interaction, cyber security, crisis informatics, emergency communication, mobile information systems, and digitalization of human agglomerations were invited to submit abstracts or short papers for presentation and discussion at the workshop. The following contributions have been accepted for presentation:

The first contribution "*Optimal Rescue Sequences Under Time Pressure Induced by Degrading Health States*" by Rabeaeh Kiaghadi and Martin Fränzle examines the use of robots to resuce several patients exposed to possible fatal incidents under time pressure. In this approach, a time-variant survival function is allocated to each patient which illustrates the decreasing probability of them surviving over time, whether being rescued or self-healed. The desired task for the agent, which has been defined as a dynamic travelling salesman problem (TSP), is to maximize the expected number of rescued alive patients considering time as its primary budget resource. The algorithm consists of a modified genetic algorithm with a heuristic cost function that considers all changes at each step of the robot's path and replans when it is necessary. Similar to actual search and rescue missions, the severity of patients' condition is categorized into different groups of high, medium, low, and lost.

The second contribution "*A Concept for Creating Mobile Games for Enhanced Disaster Preparedness in Cooperation With Local Communities*" by Michael Klafft, Ivana Harari, Agnieszka Dudzinska-Jarmolinska, Ricardo Antonio Gacitua Bustos, and Solhanlle Bonilla Duarte presents a concept on how to use local knowledge and user-generated content from previous disasters in order to create mobile games that support disaster risk awareness and disaster preparedness. The concept involves students or pupils from the area at risk who will not only create the games but also act as multipliers and disseminate the games and disaster knowledge locally, thus increasing the resilience of the local population. The approach is currently being tested as part of a mobile computing class at Universidad Nacional de La Plata in Argentina. During game design, a particular focus is placed on accessibility issues, thus ensuring that the designed games are suitable for a wide-ranging audience.

The third contribution "*Deploying Mobile-based Disaster Relief Systems Trained on Social Media Data*" by Thomas Chen outlines the limitations of existing machine learning datasets for damage assessment based on satellite imagery or social media data. As for datasets sourced from social media, a notable recent development is the Incidents Dataset from Google Images, which is comprised of images of damage incidents largely resulting from natural disasters. The baseline model that the author employed was tested on data from Twitter und Flickr. Instead of utilizing satellite-based remote sensing, this data sourced from on the ground presents new opportunities. However, given that the dataset is a very recent development, there have not been enough subsequent studies based on it to determine its efficacy compared to satellite imagery pipelines.

The fourth contribution "*Towards Strategies and Technologies for Actor-Specific Communication of Cyber Threat Warnings*" by Marc-André Kaufhold, Ali Sercan Basyurt, Marc Stöttinger, Stefan Stieglitz, and Christian Reuter presents both qualitative and quantitative empirical findings on the use of traditional, mobile, and social media for crisis communication. While previous research focused on the use of mobile devices during natural harzards, this contribution also discusses challenges for communicating anthropogenic hazards, especially cyber threats and their potential impact on critical and sociocultural infrastructures. Finally, it presents a mobile app established in Germany for communicating natural and anthropogenic hazards, also describing strategic and technological potentials to increase citizens' prevention and response capabilities against cyber threats, which is subject of research within the CYWARN project.

4 PROGRAM COMITTEE

The interdisciplinary workshop on mobile resilience was organized by the following people:

Marc-André Kaufhold is a postdoc at the Chair of Science and Technology for Peace and Security (PEASEC) in the Department of Computer Science at the Technical University of Darmstadt, Germany. He is project manager in CYWARN (2020-2023, BMBF), researcher at the ATHENE mission SecUrban, and associated member of the LOEWE centre emergenCITY. His research focuses on the user-centred design and evaluation of mobile apps and social media in the context of crisis and security research, comprising more than 70 scientific articles in the fields of Crisis Informatics, Human-Computer Interaction, and Information Systems.

Christian Reuter is Professor at Technical University of Darmstadt, Germany. His chair Science and Technology for Peace and Security (PEASEC) in the Department of Computer Science with secondary appointment in the Department of History and Social Sciences combines computer science with peace and security research. On the intersection of the disciplines (A) Human-Computer Interaction, (B) Cyber Security and Privacy, and (C) Peace and Conflict Studies he and his team specifically address (1) Crisis Informatics and Information Warfare, (2) Usable Safety, Security and Privacy, and (3) Technical Peace Research.

Tina Comes is Associate Professor at the faculty of Technology, Policy and Management at Delft University, the Netherlands and Full Professor in Decision-Making & Digitalisation at the University of Maastricht, the Netherlands. Tina also serves as Scientific Director of the 4TU Center on Resilience Engineering and is a member in the Norwegian Academy of Technological Sciences. Her research focuses on the collaborative and informational aspects of resilient societies. Tina investigates the role of information in urgent and ill-defined problems to design better sensemaking and decision support systems, which are applied in areas such as critical infrastructures, supply chain risk, and humanitarian logistics.

Milad Mirbabaie is Assistant Professor for Management Information Systems at Paderborn University, Germany. He has published in reputable journals such as Journal of Information Technology, Internet Research, Information Systems Frontiers, International Journal of Information Management, and International Journal of Human Computer Interaction. His work focuses on the use of digital technologies in the digital society. His application domains are crisis management, digital work, and digital health. In 2017, one of his articles was awarded with the Claudio Ciborra Award at the European Conference on Information Systems for the most innovative research article.

Stefan Stieglitz is a Professor and head of the research group for Digital Communication and Transformation (digicat) at the University of Duisburg-Essen, Germany. In his research, he investigates how to make use of social media data. Moreover, he analyzes user behaviour and technology adoption of collaborative information systems in organizational contexts. He is director and founder of the Competence Center Connected Organization. His work has been published in reputable journals such as the Journal of Management Information Systems, European Journal of Information Systems, Journal of Information Technology, and Business & Information Systems Engineering.

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