EERI-NSF Rapid and Research Needs Workshop

Breakout Session Title: Information Technology
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Session Overview: Information technology plays a critical role during and after a disaster such as the Haiti Earthquake. To help the affected people, decision makers, and first responders, we need to gather, manage, use, and disseminate information within emergency response networks and to the general public. Many organizations need timely information to work together to save lives, preserve infrastructure and community resources, and to reestablish normalcy within the population. The quality of these decisions in turn depends upon the timeliness and accuracy of the information available to the responders, the NGO's, the survivors, and their family. In recent years, tweets, social media, and mobile technologies have enabled real-time crowd sourcing and the rapid spreading of textual information, images, and vidoes at a scale that has not been possible in the human history before. For instance, tweets regarding donation efforts, missing people, and other related topics quickly spread in the cyberspace after the Haiti Earthquake. These new type of real-time information regarding extreme events raise important needs of research, which are categorized in the following three areas: (1) adaptive real-time analytics, (2) large-scale distributed sensing and cloud computing, and (3) complex systems and networks.

1. Adaptive Real-time Analytics

- We need to better aggregate a large volume of real-time information from multiple sources with relevant information to develop early warning, early assessment, and early response plan that address the needs of different people and organizations in a disaster (e.g., affected people, decision makers, first responders, NGO's, etc). The provided information needs to be real time and adaptive, since they can change rapidly even on an hourly basis due to the nature of a disaster.
- We need to facilitate the rapid assessment of damage to the existing infrastructure (physical and cyber) in the affected region such as its networks, power suppliers, towers, so that we can prioritize solutions to repair the infrastructure and plan the deployment of solutions that are feasible within the infrastructure.

2. Large-Scale Distributed Sensing and Cloud Computing

- We need to study crowd sourcing using mobile technologies for extreme events so that information needs can be posted, and relevant information can be gathered and aggregated more easily. For example, suppose someone wants to assess the damage in an area (e.g., an isolated village that can not be reached by vehicles). If users in the area can use their mobile phones to submit information about the damage, the information can be aggregated across the area. There are several challenges regarding

crowd sourcing. For example, how to assess the reliability and the accuracy of the collected information? If we want to make a decision with a certain confidence, how much data needs to be sampled? How to make people more motivated to collect useful and reliable information? What is a good payment model for them? These research questions need to be addressed by interdisciplinary research involving, but not limited to, social science, computing and information science.

- Remote sensing data from airborne or satellite platforms offer the opportunity for rapid collection of spatial information through imaging sensors. However, integration of such information with that from ground sources requires analytics that is not likely to be available at a single disaster site. Hence, the interaction of distributed analytics with local responders is critical and represents a gap that can only be addressed with a new complex system-based approach. The integration of technical and system approaches with the human and social requirements of responders is a topic that requires interdisciplinary research involving computational, information, and social scientists.
- Two key challenges in processing the large volume of real-time information and disseminating them to meet the demands of all types of users in response to an extreme event are the scalability and the cost-effectiveness of the cyber infrastructure. As demonstrated by Google Person Finder project, which was developed on the Google App Engine framework on the cloud, cloud computing offers a promising computational framework to handle the influx of information after an extreme event. However, it raises several important research questions. For instance, how to design and deploy adaptive real-time analytics (e.g., powerful search services) using clouds? How to schedule and balance the workload in a cloud to ensure the reliability and the quality of information services based on their priority, which can change over time and space?

3. Complex Systems and Networks

- Perception, comprehension, and predictions (i.e., situation assessment) about the states of the affected people, infrastructure, resources, and organizations after an extreme event is not only a key to timely response, but also critical to effective long-term recovery and rebuild. These understanding and comprehension require a new kind of interdisciplinary study that integrates social science, complex systems, network science, computational and information science, and statistical analysis. For instance, we need to study the structure, the dynamics, and the interactions among various heterogeneous multidimensional networks, such as social networks, communication networks, transportation networks, energy networks, etc. We need to study these networks to obtain useful information. For example: how do we analyze social networks and Tweets to study and track the diffusion and contagion of information, sentiment, and mood? How do we use the analysis of multidimensional network to predict critical point and the effect of interventions?
- Because the size of these networks can grow rapidly during an extreme events, we also need to investigate multi-disciplinary and interdisciplinary theories and methods for conducting large-scale multidimensional network analysis using cloud computing.