

Crowdsourcing for Emergency Response

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Abstract - *In the past decade the importance of social networks and mobile technologies has been growing rapidly. The convenience, ease of use and affordability of handheld devices have caused an unprecedented increase in Internet connectivity across all age and social groups in various sectors of our lives, including emergency services. An ongoing movement among crisis management organizations is the incorporation of Web 2.0 and Web 3.0 tools into their practices for the improvement of their critical situations response. Simultaneously, the level of trust in the capabilities, safety and reliability of social networks demonstrated by the general public has been growing equally quickly. As a result, social media is becoming a ubiquitous part of the process of disaster management. In this paper, we provide a detailed discussion on how social media are rapidly overtaking traditional methods for emergency response and review current ideas, examples and trends for the usage of online services for disaster control and the seamless transition between platforms and device types.*

Keywords: crowdsourcing; social networking; mobile applications; emergency response

1 Introduction

The influence of social media is growing rapidly. According to the Search Engine Journal (SEJ) [20], as of 2012 nearly 91% of American adults who are online use social media for a variety of purposes ranging from private to business matters. Social networking sites such as Facebook, Twitter, LinkedIn, Google+, and others are starting to be considered mainstream sources [17] of information and entertainment for hundreds of millions of people around the globe. And while the overall growth rate of content creation and active usage is starting to slow down as a part of the natural process of maturation of the web, two exceptions to the rule are *social networking* sites and *mobile applications*, both of which continue to grow rapidly [8]. In fact, by September 2014 the number of unique mobile users in the world surpassed 50% of the world's population [30]. Consequently, it has become a staple for content providers to have information available in a variety of formats and versions for both mobile and desktop devices. Thus, the possibilities for their use have grown far beyond their initial entertainment, socialization and recreational purposes. From raising awareness about important social issues, to creating precise demographic profiles of millions of web users for the purpose of targeted advertising, to winning political campaigns, the power of online networking is significant, and

the knowledge it offers is immense. The problem many institutions have is that with all this information available, choosing the most useful pieces of it becomes a challenging task.

Simultaneously, another trend has arisen—the use of social networking for disaster management and improving public health and safety. Earthquakes, tsunamis, tornadoes, violent storms, influenza epidemics and unpredicted acts of mass aggression (e.g., Boston Marathon bombing) have proven difficult to manage despite all of our technological advancements. When a disaster occurs, sometimes the best (or indeed only) way to save numerous lives is to generate a timely reaction to its outcomes. That puts extra emphasis on the importance of high-quality information management for emergency communications. This is particularly visible in critical situations because internal and cluster communication within law enforcement, relief groups, non-governmental organizations, civil societies and other agencies is crucial to getting their work accomplished in a timely manner. Without sufficient coordination due to inadequate information flows, we end up witnessing great devastation which could have otherwise been reduced. One example is Hurricane Katrina (2005) in the southern part of the United States where at least 1,836 deaths [28] and property damages estimated at \$81 billion USD [16] were recorded. According to Mahamed Gad-el-Hak in his book *Large-Scale Disasters: Prediction, Control and Mitigation* [9, page 129]: “inability of disaster response managers to validate and process relevant information and make decisions in a timely fashion” resulted in greater than anticipated losses.

Historically, society has modeled its responses through circumstantial observation, using trained professionals (e.g., police, fire, EMS) and occasionally volunteers. But more recently, many of the leading rescue and disaster management organizations have been turning towards social networking websites to take advantage of their huge user base, accessibility, and fast response. [8][13] Hence, one of the positive characteristics of social media, which is its capacity to harness collective knowledge for learning and problem-solving, is no longer being overlooked. Additionally, in 2015 a new trend among online platforms for advancements in interconnectivity and shared content has been on the rise. Examples such as Vine allows its users to be posting simultaneously on Twitter, Facebook and Tumblr through its mobile app [25], and services such as Share This permit a completely customized social networking experience in a one-stop-shop location for posting, monitoring and content

analysis are becoming the new power players in the interim between our transition from Web 2.0 to Web 3.0. As a result, the “crowd” feels more knowledgeable in their decision-making and more empowered in their efforts of bringing attention to socially impactful situations, such as mass-scale disasters.

The advantages of mining data coming from various sources (and the consequent creation of fine-grained maps of the surroundings following a disaster) have earned praise from both citizens and government. As a result, we have witnessed a number of cases where online networks have been a primary source of information for both victims and rescue authorities. One of the most recent examples is the 2012 Superstorm Sandy which was ranked by the National Oceanic and Atmospheric Administration (NOAA) and the American Red Cross (ARC) [2] as the number one US weather event for 2012. Throughout Hurricane Sandy, the public turned to social media for updates and assistance, and more than ever before, response agencies, organizations and community groups used social media to organize and direct resources where needed. For example, the New York Office of Emergency Management provided hourly updates and evacuation orders via Twitter, and New Jersey Gov. Chris Christie relayed updates about the storm, available aid and evacuation orders via his personal Twitter account.

The reason behind the rising usefulness of social networks is their highly crowdsourced information, constant availability, increased accessibility and ease of use. While the local widespread communication and information services (e.g., telephone, television, radio) often crash during large natural disasters, the fabric of the social networking websites can remain intact due to its distributed and agile nature. Social networking can provide a reliable means of communications for both those involved and those witnessing an incident.

2 Applications of Social Media

Social networks can provide detailed knowledge about their users (consider Facebook that knows your age, job title, music preferences, etc.) With that kind of data, advertisers can easily and cost-effectively customize their products and advertisements for the correct target groups, predict future trends, and keep themselves updated with the latest consumer feedback about their brand. But the uses of social media do not end there. For instance, LinkedIn (a vastly popular professional business network), provides ways for smaller inner networks to develop such as the *Advanced Social Work Practice Network* (ASWPN) [1] with nearly 1,000 active members from around the world. The purpose of that inner-circle network is the enhancement of good practices and continuous professional development of advanced practitioners from the UK. Another such group is the *Network for professionals working with vulnerable children and adults* [14] which includes social work and health practitioners, managers and academics.

Vivid examples of the use of social media can be seen in the fields of health and social welfare. Websites providing first-person experiences and advice make it easier for patients and survivors to open up about their conditions and ask for help. A popular one is the *patientslikeme* website [15] where over 150,000 people look for answers to unusual, embarrassing, or simply hard-to-talk-about health-related questions. It is a safe community where people feel protected behind their online personas, and no longer experience discomfort when revealing their real-life stories to others because it is a place of shared sympathy and understanding. Additionally, many social networks for survivors or friends and families of victims of disastrous events exist; they are used for connecting people needing that kind of support to cope with their grief or share their inspirational survival stories. The social importance of such communal social networks has been recognized by various authorities, including the Red Cross, and the Association for Computing Machinery (ACM) [7] [22] which is the world's largest educational and scientific computing society.

Social media has a vast presence in the academic world as well. From huge professional and educational online communities like the ACM itself, to smaller Twitter groups (e.g. @Info4Practice, @LSEImpactBlog), and Facebook pages of universities/colleges or scientific groups, social networks are everywhere helping to establish better connections between the students and the educational organizations. That helps in building not only better communications between both sides, and increased flexibility and accessibility as well, but also a sense of pride in the institution.

In the last couple of years local authorities have also embraced social media to enable their staff to connect more effectively with the local communities. That is a direct way for them to engage with residents, community groups and partners using blogs, Twitter, Facebook, YouTube, Flickr and LinkedIn. These social networks allow local authorities to get involved in local conversations or collect “the wisdom of the crowd” about events occurring in their locality. These organizations are slowly increasing their level of recognition

2.1 State-of-the-Art Solutions

State-of-the-art solutions for disaster response are based in part upon data retrieval from social networks. Many crisis response systems turn to social networks (Twitter, Facebook, etc.) to both locate and provide the latest news relating to a critical situation. Growing demand makes the development of successful and effective tools even more vital and urgent. And with the increased acknowledgement of the power of crowdsourced data, even organizations that have been slow to adapt, such as the Federal Emergency Management Agency (FEMA), have joined the effort to harness the power of the crowd [5]. Currently, numerous examples of somewhat successful systems used even in large-scale situations exist such as:

Ushahidi [6] is an open source crisis map platform created in 2007, and deployed in multiple locations, inc. Kenya, Mexico, Afghanistan, Haiti, New York, California, and Washington DC. It leverages web technologies for multiple source data integration (phones, e-mail, social media sites such as Twitter and Facebook) and provides an up-to-date publicly available crisis map that is in turn available to relief organizations. The platform uses crowdsourcing for information collection, and support cooperation enabling among various organizations. Ushahidi was a prominent player in the management of the massive *Snowmageddon* snowstorm in the District of Columbia in the winter of 2010.

GeoCommons [7] is a tool for the community of GeoIQ users for building an open repository of data and maps for the world. Some of the features it provides are map visualization, temporal analysis visualization, data upload and search features, filter and access data features, and dataset show-and-edit features.

Both of those technologies were successfully used in Haiti in 2010, and more recently in the big Texas floods of 2015, and helped in saving hundreds of lives there. A direct gathering of information coming from the online ‘crowd’, fortified with quick sorting and analysis of that data, were of tremendous help for shedding light in a moment of disorder and panic.

Another highly cited and exemplary work is the technology developed in *Earthquake Shakes Twitter Users: Real-time Event Detection by Social Sensors* [23] from The University of Tokyo where Twitter is used for earthquake detection and reporting. In that work, the micro-blogging service is used as a source of immediate textual responses to an earthquake, which are then analyzed, and a conclusion about the occurrence of an earthquake is made. In places with very technologically savvy users such as Japan, that system was even capable of detecting real earthquake events with a probability as high as 96%.

2.2 Issues of Existing Systems

Sadly, most of the information coming from social media sources cannot be considered entirely trustworthy. These publicly available websites normally do not perform any data integrity checks. Therefore, the entries could be malicious, or sent for the purpose of creating confusion. That is a problem some have attempted to investigate and deal with but without affirmative success. An exemplary work is *Seeking the Trustworthy Tweet: Can Microblogged Data Fit the Information Needs of Disaster Response and Humanitarian Relief Organizations* [3] which discusses the untrustworthy nature of data coming from social media, as well as the different types of issues arising from it. As stated in that paper, currently no solutions exist—but what looks promising as the most scalable and effective approach is the use of machine learning, entity extraction, and text classification techniques for data analysis.

Another side of the social networking approach is its decentralized nature. Post, tweets, and blog entries are spread throughout the entire Web. While the distributed way of collecting and presenting information could be considered good for data richness, it also means people often need to visit several different data centers to locate all the information they seek. Also, that information is usually not in any purified state (cleansed of “noise”), but instead comes in a variety of forms, each of which requires additional effort on the part of the user.

3 Social Importance of Applications

In the past few years, the level of respectability and social acceptance of social networks has grown exponentially. According to recent nationwide surveys [19] the percentage of job offerings online on social networking sites surpasses 75% of all positions available, and the majority of hiring managers want to use online resources for recruiting purposes. Similarly, online websites are also present in most other aspects of our lives and are rapidly penetrating even the most resistant areas of business and governmental. As a result, many new opportunities for using Facebook, Tumblr, Twitter, etc. have arisen, and the social importance of those websites is increasingly appreciated.

A vivid example of just how significant online networking is for society was its use during the earthquake and resulting tsunami in Fukushima, Japan in 2011 which has 8,649 confirmed deaths and over 13 thousand missing persons. Lacking knowledge about the health and safety of loved ones, and with mobile phone networks jammed due to overloading, many people chose social media sites such as Facebook, Twitter, Mixi (an exclusively Japanese website), etc. to establish communications and find out the latest news.

According to the annual Twitter report there was an almost immediate growth of over 500% in tweets in Japan right after the Tōhoku earthquake as people reached out to their loved ones. Later on in June, Twitter posted a visualization of the tweets sent to and out of Japan within one hour of the disaster striking (see Fig. 1,2, for video see [24, 25]). That gave a powerful message of just how heavily people depend on simple online platforms for immediate connection and help in case of danger.

What allows accessing online social networks, when even standard calls are impossible to make because of excessive network traffic, are the different telecommunication standards and protocols such as SMS used for mobile Internet in comparison to those used for telephone calls [27] [29]. Hence, neither of those services affects the other one.

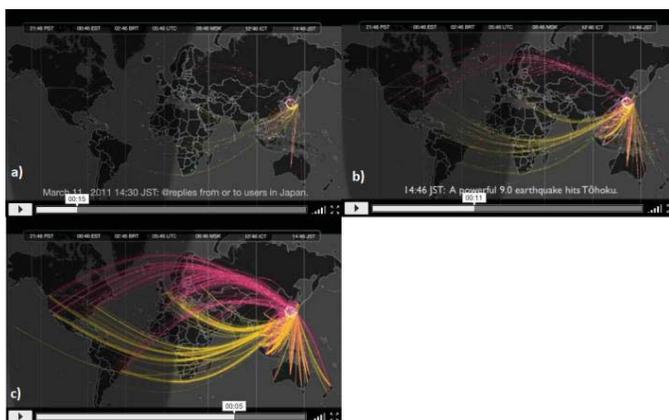


Figure 1. Tweets within one hour of Tōhoku earthquake (yellow represents tweets coming from Japan, pink represents tweets going to Japan). a) Normal Tweet load before earthquake; b) Immediate response after earthquake; c) One hour after earthquake.

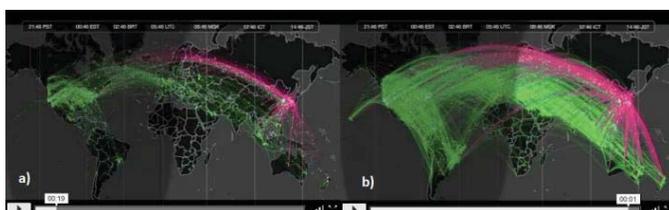


Figure 2. Retweets of Tweets originating in Japan within one hour of Tōhoku earthquake (pink - original Tweets, green - retweets). a) First several minutes after earthquake; b) One hour after earthquake.

Whereas previously these social media sites might have been joined out of curiosity, suddenly they ‘came of age’ in Japan and became a lifeline for thousands around the globe. Survivors used it for keeping in touch with the rest of the world, rescue organizations collected data for analysis, charity groups raised money for the needy, governments made appeals for public order, while everyone else kept a wary eye on current events. With record numbers of users (over 11 million active users of Facebook and over 17 million active users of Mixi in Japan alone), the social arena became an additional layer of our lives where we can go to search for those lost in the devastation, donate, support, pay respects, or simply keep up-to-date with the latest happenings [18][24].

Another example of online networking power was the 12 January 2010 cataclysmic earthquake in Haiti. According to reports from the Red Cross, within less than 48 hours from the disaster striking, more than US\$8 million in donations was received via text messages due to campaigns spread across the social media websites. Numerous videos, images, and texts of the personal experiences of witnesses of the earthquake were available online within a few minutes of it happening. That was a major wake-up call for many about the undeniable power of social networking in various online communities. According to online reports [12], tools as simple as Facebook mobile application widgets were a central way of organizing rescue missions and saving hundreds of people stuck under

debris with no other means of communication but social media sites.

Many more examples exist as well, but what we gather from each and every one of them is just how big a role social networks really play in our lives nowadays. Online networking is without a doubt here to stay. The social importance of websites such as Facebook, Twitter, Google+, and many others is growing day by day, and will soon introduce us to a world where our online presence will go hand-in-hand with our real-life personas as two inseparable parts.

4 Future Trends

As mentioned by Craig Fugate in his statement on the FEMA website [4], much has been done to aid the operations of relief organizations via social media. At the same time, most local governments still employ outdated intranets within their organizations, and very few Web 2.0 and Web 3.0 technologies are being used [10][11]. In order to make the practices of the officials more efficient, effective, and inclusive a number of cities have plans for increasing their involvement in online communities. And the next step to be taken in that direction is going mobile. So, making mobile versions of websites, creating relevant applications, and urging for expanded collaborations with existing networks (e.g., Craigslist, Google, Apple, Microsoft) and traditional organizations through mass-technology tools, are the likely choices of the rescue authorities in the years to come.

Another very new trend is building NASA-style mission control centers (MCC) for social media. As information coming from networking websites could be so vast, both in terms of numbers of entries but also in their interconnections, it has become increasingly difficult to maintain a constantly up-to-date stream of easily comprehensible data about the latest events. Therefore, growing numbers of global organizations are building multimillion-dollar control centers: dedicated physical hubs for monitoring and responding to the torrent of social commentary and queries flooding in via Facebook, Twitter and other channels. An example of such a MCC related to disaster management is the latest Red Cross Digital Operations Center (see Fig. 3).

With help from this new MCC the Red Cross is hoping to be able to expand its outreach to volunteers willing to help out to those in need at the right time and place.



Figure 3. ARC Digital Operations Center for Disaster Monitoring through Social Media

5 Conclusion

There is a plethora of articles, scientific works, reports and applications of social media available at the moment. Naturally, by creating more accessible materials about a certain topic they only attract even further curiosity and discussion, and the popularity of the topic grows exponentially. A similar phenomenon can be seen in the field of emergency management through crowdsourcing and online media. Tools that did not exist even 5 years ago are now primary means of communication for hundreds of millions around the world. Regardless of its mass recognition, this is still a field which is yet to be fully explored. The importance of social networks is bound to increase dramatically over the next decade. We are currently in a greatly prolific stage for the Web 2.0 technologies which are steadily becoming a standard of work in numerous organizations. Slowly but surely, even more advanced Web 3.0 technologies are finding their way into commercial software which disaster management organizations will eventually adopt.

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