Short-term Research Visits (Project No.: 28S-01)

Project title: Windstorm Hazard and Vulnerability Characterization using "Human-Sensor" Data
Principal Investigator: Frank LOMBARDO
Affiliation: University of Illinois at Urbana-Champaign
Name of DPRI collaborative researcher: Kazuyoshi Nishijima
Period of stay: October 8, 2016 ~ October 17, 2016
Location of stay: Section of Wind Engineering and Wind Resistant Structures, DPRI
Number of participants in the collaborative research: one from DPRI, one from non-DPRI
- Number of graduate students: 0 (for this stay)
- Participation role of graduate students: Although no graduate students directly participated in this stay, analysis of the data is beginning at the University of Illinois through one graduate student.

Anticipated impact for research and education

This project has the possibility of significant impacts in research and education. Natural hazards will continue to significantly affect locations worldwide and rapid information on the extent of these impacts are crucial. This short-term research visit is the first step in trying to understand how to use 'human-sensor' data in a scientific context, which can provide rapid information. Integration of this data into traditional disaster analysis has the potential to revolutionize the way disasters are understood and how recovery can be improved.

Research report

(1) Purpose

The purpose of the visit to DPRI was for the PI and Co-PI will extract event-relevant "human-sensor" data for further analysis from Twitter data. This extraction included identification of specific keywords related to events of interest (both U.S. and Japanese tornado events), the time of message and the location from where it was sent. The keywords, developed by the PI and Co-PI included descriptive text such as "wind", "damage", "tornado"; the name of the storm or location it took place (e.g., Tsukuba City) or magnitude terms (e.g., extreme).

(2) Summary of research progress

During the short-term visit, the PI focused on extracting and analyzing the data from a single U.S. tornado event – Kokomo, Indiana on August 24, 2016, while the DPRI collaborator focused on using the code developed by the PI and translating to Japanese events and he also tested several GIS platforms for the purpose to automate the process of event extraction. During the visit, the PI was able to extract all relevant Twitter data from the U.S. event and wrote a short report describing the findings. A summary of these findings, and avenues for future work between the PI and Co-PI are found in the next section.

(3) Summary of research findings

Windstorms are the cause of significant losses throughout the world, including the U.S. and Japan. Due to the small-scale of some events, measurements often fail to capture relevant details of the event due to poor-resolution or outright lack of sophisticated measurement devices in developing countries. As 'human-sensors' (e.g., iPhones, computers) become ubiquitous they become a promising source of supplementary data for hazard and damage analysis as well as other potential research avenues. In this short-term visit, samples of Twitter data, including times, text and images relating to a number

messages were extracted and archived, using MATLAB, for particular windstorm events in the United States and abroad. A case study focused on a damaging EF-3 tornado that occurred in Kokomo, IN on August 24, 2016. Text analysis from the Tweets revealed the approximate time when a Starbucks suffered catastrophic damage (i.e., collapse) as well as highlighted frequent occurrences of keywords (e.g., starbucks, tornado, kokomo) that suggest location and damage properties. Image analysis revealed 426 of 1000 sample tweets contained a still image, many of which showed different angles of the Starbucks damage.

Information collected from Twitter data such as the large volume of text and images offer rich avenues for future research. These interrelated research avenues include the following:

- Correlation of text and image properties with actual measurements and intensity of windstorm events. This research could include relating mentions of a specific keyword increasing abnormally compared to 'ambient' tweets coupled with actual wind speed and/or damage measurements.
- Geolocation and prediction of events for decision-making and public awareness including sending pertinent information back to social media sources
- Accessing the full archive of Twitter data in addition to continuous 'real-time' Twitter analysis
- Improved text and image analysis of Twitter (e.g., sentiment analysis, point-cloud model creation)
- Estimation, validation and mapping of windstorm hazard and damage characteristics similar to DYFI using social media data as catalyst
- Extracting and archiving videos on Twitter for further analysis (e.g., photogrammetry)

An example roadmap of these (and other) research avenues planned for windstorms and human-sensor data are included in Figure 4 of the detailed summary report, which can be downloaded at the link below.

The developed platform by the short-term visit of the PI was applied for the Itoigawa fire event in Japan that occurred on December 22, 2016. As is the case for tornado events, fire events are very local. Through the case study with this fire event, the Twitter data and other social media data was found to be useful information source for analyzing the event development at micro scale. One of the challenges is that the location information is often not available with text messages and pictures. This challenge may be overcome by carefully investigating the background behind the objects in the pictures taken: Now by hand, but in the future presumably by automated image matching.

(4) Publication of research findings

As of today (April 24, 2017), no formal publications have been attempted. However a 'white paper' that describes the work undertaken in the short-term visit will sent be sent to the DPRI collaborator in the hopes of spurring publication of the work.

A more detailed summary of the DPRI Research Visit is available at:

URL: http://publish.illinois.edu/ftlombardo/files/2017/04/DPRI_ResearchSummary_WhitePaper.pdf