ITU Kaleidoscope 2015

Trust in the Information Society

Network Failure Detection System for Traffic Control using Social Information in Large-Scale Disasters

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Outline

- Background
- Problem
- Objective
- Novelty
- Network Failure Detection System
  - Telephony Failure Detection
  - Location-aware Prioritization
- Network Control System
- Contributions
Overview of the Great East Japan Earthquake

- Occurred at 14:46 JST on 11 March 2011
- Magnitude 9.0
- 15,893 dead and 6,152 injured
- Wiped out by “Tsunami” (huge wave)

Otsuchi town

http://www.47news.jp/photo/

(http://www.tenki.jp/)

Barcelona, Spain, 9-11 December 2015
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Problem

- Difficult to grasp all network condition immediately using only information from sensors
Users care network condition and provide such information through social networking service (SNS).

Twitter is one of the most widely used SNS’s.
Objective

Achieve automatic/autonomic network control utilizing collective knowledge analyzed from social networking services
Novelty of this work

- We perform the network control using the collective intelligence of social networking service

- ITU-T Focus Group on Disaster Relief Systems performs the network control using wireless sensor networks

- Our approach is complementary to ITU-T Focus Group on Disaster Relief Systems
Network Failure Detection System

Collection of Tweets → Candidate Data Detection → Location Aware Classification → Calculation of Rate of Importance → Output Data

Network Control System

Earthquake Early Warning (EEW)

Tweet

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Keyword Search

Network Failure Detection System

1. Collection of Tweets
2. Candidate Data Detection
3. Location Aware Classification
4. Calculation of Rate of Importance

Output Data

Network Control System

- Set specific keywords that represent telephone trouble
- Collect the initial tweets

Earthquake Early Warning (EEW)
Candidate Data Detection Method

Network Failure Detection System

Collection of Tweets → Candidate Data Detection → Location Aware Classification → Calculation of Rate of Importance

Output Data

Earthquake Early Warning (EEW)

Network Control System

Candidate Data Detection

Tweets of Keyword Search → Location Information Detection → Characteristic Words Detection → Tweets Detection → Temporal Filtering
Cumulative occurrences of tweets exhibit exponential distributions

Determine a certain threshold to discard tweets

Time variation of cumulative frequency is similar to the cumulative distribution of an exponential distribution
Temporal Filtering

- Capture 80% of the event in 60 minutes
- Set the time filter to 60 minutes is reasonable
Location Aware Classification

Network Failure Detection System

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Earthquake Early Warning (EEW)

Calculation of Rate of Importance

Network Control System
Location Classification

Filter out tweets reporting telephony failures

I’m in Tokyo now. I cannot get through.

I cannot get through to Miyagi... I’m worried.
Filter out tweets with information on location associated with failures

To LocationA

I cannot get through to Miyagi... I'm worried.

From LocationB

I'm in Tokyo now. I cannot get through.
Prioritization

Network Failure Detection System

Collection of Tweets → Candidate Data Detection → Location Aware Classification → Calculation of Rate of Importance → Output Data

Tweet

Network Control System

Earthquake Early Warning (EEW)

Network Control System

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Calculation of Rate of Importance about Location Information

- It has three indicators
  1) Prediction of seismic intensity on the detected locations
  2) Rate of tweets reporting telephony failures to the detected locations
  3) Rate of increase of tweets in emergency

- Prioritize locations for the efficient area restoration
Rate of Importance in the Great East Japan Earthquake

- Locations with large damages are predicted with high priorities.
Network Control System

Network Failure Detection System

Collection of Tweets → Candidate Data Detection → Location Aware Classification → Calculation of Rate of Importance → Output Data

Earthquake Early Warning (EEW)

Tweet Collection of Tweets

Network Control System
Network Control System based on Analysis of SNS

- Use information on network condition detected by our system

- Optimize the network traffic automatically

- Use an architecture called FLARE[1]
  - Can access data in application layer
  - Compatible with our system that try to use social information
Implementation with Programmable Nodes: FLARE

- Integrate Network Failure Detection System into FLARE Central

Diagram:
- FLARE Central
  - Acquisition and Analysis of Social Data
  - Routing Control
- FLARE Switch
  - FLARE1
  - FLARE2
  - FLARE3
  - FLARE4
Routing Control based on Information of Social Networking Service

Before the earthquake

After the earthquake

Automatic route control with our system
Contributions of this work

- Design and Prototype of SNS-based Network Failure Detection System
  - Detect telephony failures with a high degree of accuracy
  - Prioritize locations using three indicators for the efficient area restoration

- Integration on SNS-based Failure Detection into Network Control
  - Perform the network control automatically using the collective intelligence of social networking service
References