People with Difficulty in Returning Home after a Devastating Earthquake

Toshihiro Osaragi and Satoshi Tanaka
Department of Mechanical and Environmental Informatics,
Graduate School of Information Science and Engineering,
Tokyo Institute of Technology
osaragi@mei.titech.ac.jp

INTRODUCTION

In the Tokyo metropolitan area, a large number of people are traveling for variety of purposes within long distance from home using rapid transit railways. In the event of a devastating earthquake, public transportation including buses is expected to be paralyzed and unavailable for transport, leaving an extremely large number of people in the city and with difficulty returning home. The government assumes therefore that there is no alternative way, excepting walking, to get home.

Give this background, disaster managers have attempted to estimate the number of refugees who would have difficulty returning to their homes (stranded refugees) in the aftermath of an earthquake. Tokyo Metropolis has attempted to carry out the calculations of stranded refugees in the Tokyo metropolitan region. Such studies generally assume that all people away from their homes will attempt to return to their homes. However, individuals' intentions depend on many factors in addition to the distance to their homes—the time of the disaster, the person's status (working, student, age, etc.), and the availability of information about family members. Therefore, in this study, people were surveyed on their intentions with regard to returning home immediately after a disaster, and their responses were employed as basic data to construct a model ("*model of intention to return home*") for describing the probability that any individual will actually attempt to return directly home ("*probability of intention to return*").

In the estimates for the Tokyo population, subjects express their judgment on the basis of the distance to home (return distance) from their location at the time of the disaster. This is a simple method for evaluating people's activities following a disaster, when most relevant factors are quite unpredictable. However, this model does not account for differences in stranded refugees' capabilities due to age and sex. Therefore, in this paper, survey data on people's vigor and athletic ability are used to estimate the distances people would be able to travel on foot, based on age and other factors. These estimates are then used to create a model ("*walk-home model*") for describing situations in which people who have attempted to return home have reached the limits of their strength and given up.

MODEL OF INTENTION TO RETURN HOME

A neural network model (3-layer perceptron) was used in the present study, in order to describe people's intention to return home. The model was trained using the survey data on subjects' intentions to go home. Using the model, we estimated the probability that a subject, as a refugee, will decide to walk home on the day of a disaster, by the model of intention to return home.

WALK-HOME MODEL

When considering the actions of individuals in returning home after a disaster, one must account for several factors. (1) People may start out with a firm intention to go home, but reach the limits of

their physical strength on the way and give up. In order to account for this behavior, the model must include how the subject's age and sex might affect the distance he or she can actually walk. (2) Some people will also give up the attempt to return home if the sun sets before they get home. It is necessary to consider how many people will be swayed by this factor, which also involves (3) the time elapsed between the subject's start toward home and nightfall. Finally, (4) the density of pedestrians in the streets also affects walking speed. If everyone leaves out to home simultaneously after a disaster, the streets will become quite congested; this could slow the refugees' progress. Based on (1) – (4) above, we constructed a walk-home model for estimating the number of refugees who would or would not be able to walk back home after a disaster.

SIMULATION OF ACTIONS TO RETURN HOME

The model of intention to return home was used to calculate the probability that the refugee would actually decide to attempt walking home. The inputs for the model were the characteristics of the refugee (age, sex, cohabitation with family) and network distance to home. Using road-network distance to home, time of sunset, start time and walking speed in the walk-home model, a simulation was performed for the people who wished to return home. Geographical coordinates of the locations of people who gave up on the way due to fatigue or nightfall were obtained.

The simulation model provided us with information concerning; (1) the congestion of streets at the peak levels (assuming the disaster strikes at noon) if everyone sets out for home at the same time. (2) the variations in the number of transient occupants divided into the following five groups: those who have not yet started; those currently on their way home; those who will eventually give up due to fatigue; and those who will eventually give up due to nightfall; those who eventually arrive at home. (3) the spatiotemporal distribution of five populations.

SUMMARY AND CONCLUSIONS

Transient occupants of Tokyo were surveyed on their intentions regarding walking home after a disaster, and survey data were employed to create a model of individuals' intentions to return home. This model accounts for several factors besides distance to home, including the timing of the disaster, the characteristics of the refugee and the safety of the refugee's family. A walk-home model was also constructed to describe the process of returning home on foot. A simulation was carried out by combining the model of intention to return home and the walk-home model. Estimated data of street congestion and the spatiotemporal distribution of stranded refugees were generated. The results may be useful as basic supporting data for earthquake and other disaster management planning.

ACKNOWLEDGEMENTS

This work was sponsored by a Grant-in-Aid for Scientific Research (21310105).