A Study for Agent-based Modeling of Migration Behavior of Shoppers

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As the trend to move toward “compact city”, social-economic importance of town centers is increasing more than ever. There have been growing needs for certain pedestrian behavior models in order to predict how people move around in urban central areas. Since it is important to understand the way of spatial movement of pedestrian for any design processes of facilities in various fields, not only urban planners or government officials but also retailers and advertising agents have been interested in pedestrian modeling.

Although there have already been several spatial behavior models, such as Huff model and Marcov-chain model, which is effective enough to estimate a potential attraction of a new shop, or to predict the approximate number of visitors or probability that a certain place will be chosen as someone’s destination, they can not deal with each pedestrian movement in more fine-scale environment such as commercial districts and shopping malls. Pedestrian models, which can be applied to erratic movements of users in such multi-purpose space are strongly needed.

The prime aim of this study is hence to develop a framework of multi-agent-based models for investigating pedestrian movements with more fine-scale considerations. In this paper, we analyze migration behavior of shoppers in a shopping centre to suggest a generic model of such behavior. The modeling process is summarized in figure 1 below.

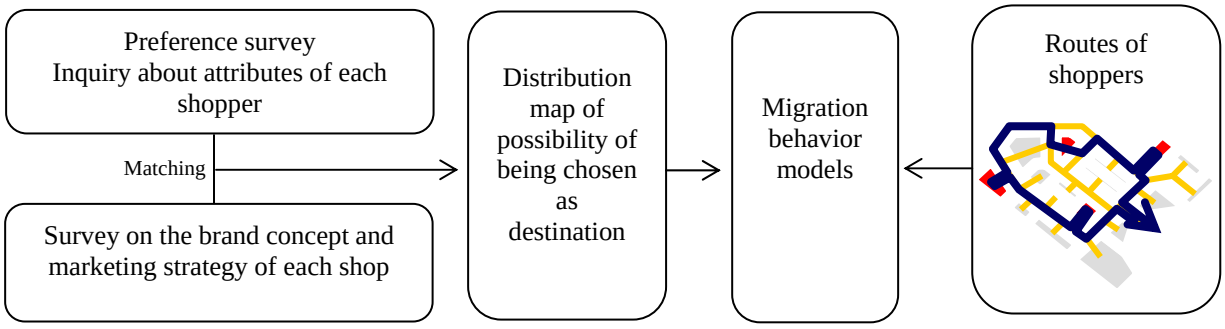

Figure 1: Flow of modelling process

As the first step of making a multi-agent based model, the route that each shopper took in the building of shopping mall was identified by measurement systems of pedestrian movements. In order to obtain as much detail of the movement of each shopper as possible, digital video cameras were used as main sensors of the measurement systems in this study. Using this measurement system, we conducted an experiment in a shopping centre to obtain real tracks for two-hour shopping of 18 shoppers.

Then, distribution maps were developed which show possible destinations of each shoppers. Questionnaires about profiles of shoppers with respect to their preference of shops and purpose of trip making are used in conjunction with marketing survey in order to classify their shopping style and to make these maps. Shoppers were also asked to put their impressions both of each shop and of whole tour in writing after the experiment. These demographic data are used for a correlation analysis between shopper's attributes and behavioral tendencies that were observed in the routing.

In addition, the panel technique was used in this study in order to see the influence of both accumulation of spatial knowledge about the shopping center itself and impression of each shop on the routing process that shoppers took. The same experiments were carried on once every two weeks for a total of three times.

Based on some analyses on these dataset, shopping styles can be classified broadly into four categories as listed below:

1. Shoppers who fix destinations at the beginning of their trip and follow almost the same route every time
2. Shoppers who fix destinations and routes that vary amongst trips
3. Shoppers who have rough or no prefixed routes but search for a certain products
4. Shoppers who have rough or no prefixed routes and enjoy window-shopping without any purposes of the trip

As the first behavioral pattern seems to follow the *utility maximization principle*, the estimated route by a simulation system were compared with the real footpath obtained in the experiments for verification this prevailing model (figure 2). The simulation model used in this study assumes that each shopper goes the rounds of all scheduled shops in the shortest route. Comparison of actual footpath data with the results of simulations suggested that shopper's spatial behaviour consists of a number of segments each of which they follow the *utility maximization principle* while their routing as a whole could not be explained. It can be concluded that this model is not sufficient enough to cover all aspects of migration behavior.

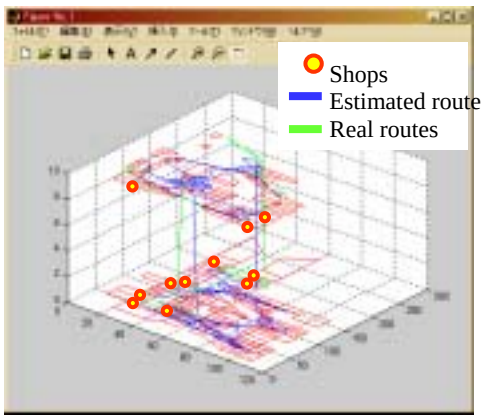

Figure 2: A result of simulation and an observed route

Thus, several factors should be included in the new framework; shopping style analysis showed high correlation between the preference of the shops and distribution map. What pedestrians already know about the environment is important to decide routes. Each shopper's loyalty to a certain shop also has an influence on their routing. For further development of the model, it is necessary to examine these possible factors to see whether each of them really have major influence on spatial movements.

A revised version of this abstract and full paper will be available during and after the CUPUM '03 Sendai at the website below.
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