MEMORIAS

7ᵐᵒ CONGRESO INTERNACIONAL ᴇɴ CIENCIAS COMPUTACIONALES

CiComp 2014

UNIVERSIDAD AUTÓNOMA
DE BAJA CALIFORNIA

FACULTAD DE CIENCIAS (Ensenada)
FACULTAD DE CIENCIAS ADMINISTRATIVAS Y SOCIALES (Ensenada)
FACULTAD DE INGENIERÍA, ARQUITECTURA Y DISEÑO (Ensenada)
FACULTAD DE CIENCIAS QUÍMICAS E INGENIERÍA (Tijuana)
FACULTAD DE INGENIERÍA (Mexicali)

Coordinadores:
José Ángel González Fraga
Evelio Martínez Martínez
Sergio Omar Infante Prieto
Adrián Enciso Almanza
Everardo Gutiérrez López
María Victoria Meza Kubo
Manuel Castañón Puga

5 al 7 de noviembre de 2014
Ensenada, Baja California, México
www.cicomp.org

Modeling Pedestrian Mobility Preferences using BDI-Agents with Fuzzy Perceptions

Donald Rodriguez-Ubeda, Dora-Luz Flores, Luis Palafox,
Manuel Castanon-Puga, Carelia Gaxiola-Pacheco, and Ricardo Rosales

Faculty of Chemical Sciences and Engineering,
Autonomous University of Baja California,
Calzada Universidad. 14418, 22390 Tijuana, México
{donald.rodriguez,dflores,lepalafox,puga,
cgaxiola,ricardorosales}@uabc.edu.mx

Abstract. User modeling can be used to enhance the usability and the accessibility of different human creations intended for use by human beings. Buildings, recreational areas, software, tools, etc, can be adapted or built considering the user needs, capabilities and preferences represented as user profiles. Different approaches have been taken in this field but further research and development is necessary, in particular addressed to consider diverse capabilities persons and how their capabilities influence their preferences.

More specifically, one of the main challenges of pedestrian modeling is the absence of a common approach for integrating people with diverse capabilities and functionalities. For example many user profiles are created from different points of view: shopping preferences, psychological profiles, collective behavior and considering many other sources of information for the modeling.

Keywords: modeling, agent, BDI, preferences, pedestrian

1 Introduction

User models are abstract representations of user properties including their needs, preferences, knowledge, as well as physical, cognitive, and behavioral characteristics [2]. The characteristics are represented by variables. User models are instantiated by the declaration of these variables for a particular user or group of users. Such instances of user models are called user profiles. A user profile captures the kind of information about an individual user that are essential to evaluate the usability, and accessibility of a design.

User modeling can be used to enhance the usability and the accessibility of different human creations intended for use by human beings. For example human user interfaces, buildings, tools, recreational areas, roads, etc, can be adapted or built considering the user needs, capabilities and preferences represented as user profiles.

Today society is striving to further integrate all people, in particular it is trying to evaluate the usability and accessibility of buildings and public spaces

in order to perform the necessary modifications to provide those environmental areas with the elements needed to facilitate the mobility of people in a secure and comfortable way.

Actually that evaluation is done by physically inspecting the current buildings [1], and for the new ones there is a visual inspection of the layouts, before the construction get started. However, there are projects focused on modeling and assessing the mobility of people in buildings considering certain aspects of human behavior, as can be shopping preferences [2], perceptions of ease of access to [3]. Such projects demonstrate that it is possible to study the mobility of individuals from a construction layout.

We argue that if we observe the pedestrian behavior of people, we find that this is the product of different elements that together define the profile of each individual.

In this paper we propose the construction of a computational model, which incorporate the attributes that describe the functional capabilities of individuals; in order to obtain profiles that facilitate the study of its pedestrian behavior and preferences. In particular the present paper propose the use of an agent architecture called BDI – which we extended to process fuzzy perceptions– as a tool that facilitates the construction of such model.

2 Related works

This work has been inspired by the works of various authors who have made significant contributions in the construction of models to describe the human behaviour [2–6].

The project named GATHERING [4], based on the principles of the theory of perceptions control, is used to simulate the experiment of collective locomotion. The programs ability to reproduce the collective behavior observed in the field and in the experiment provides evidence of the usefulness of the theory of individual behavior in which the program is based. The simulation proves the assumption that collective behavior is the result of similar reference signals. This project allow us to make the following questions: How the collective locomotion affects the accessibility of places? And how collective locomotion affects the use of them by disabled people?

The work of [2] demonstrates that it is possible to use multi-agent systems to model and simulate the behavior of humans in a mall, where they focus on the distribution of physical spaces and the interests of each individual to navigate through mall, they also solved the issue of collecting information about the routes followed by visitors through surveys.

The research project [3] shows some advances related to modeling the accessibility perception by individuals, applying fuzzy logic to the micro-spatial analysis of individual trip patterns and duration, while taking into account various types of households and a large set of activity nodes, allows measuring the actual willingness-to-travel of urban dwellers, thereby building more subtle and comprehensive accessibility indexes.

This paper could be related to projects as the simulator proposed by Helal et al. [5], who in his paper presents a simulator called Persim 3D, which provides a 3D graphical user interface to help users spatial perception, sensors that operate in real-time, similar to actual sensors, and a virtual character that lives in a virtual environment. The main goal is to allow users to generate longitudinal simulation data and eventually contribute to activity recognition research. As mentioned [5] the virtual character lacks from real autonomy and it will be more real if they provide it with a human sensory capability.

Another, very interesting, projects [6] focuses on some aspects related to the influence on beliefs on the agent behavior and proposes the use of bayesian belief networks to solve the problem of belief construction, they also offers results on simulation about the human decision on evacuation scenarios. The paper of Young et al. [14] extends the work of Lee [6] and proposes a interesting approach related to the simulation of human behaviour in decision-making, learning, and interactions.

Moreover, we believe that projects such as those mentioned above can benefit from the use of BDI-Agents with fuzzy perceptions, such agents can emulate the human behavior in a more realistic way, because in the real world everything is perceived diffusely; for example is usual to hear the expression " I feel that the current temperature is warm", nobody says the "current temperature is X amount of degrees". Even if we use a sensor to measure the temperature, it will do it with a degree of imprecision, and we will have to formulate a belief from that measurement.

3 Agents

An agent is a reactive system that exhibits some degree of autonomy in the sense that we can delegate some task to it, and the agent itself will determine the best way to achieve it.

The name agents is because they are perceived as active entities, a kind of purposeful producers of actions; it is possible to send them out into the environment to achieve some goals, and they will actively pursue them, figuring out for themselves the best way to accomplish such goals, so they don't need any human guide that tell them in a low-level detail how to do it. We can imagine such agents being delegated a goal like booking a flight and hotel for us, bidding on our behalf in an on-line auction, or cleaning our office space for us if they are robotic agents [15].

As mentioned above, agents are systems situated within some environment which maintain a frequent interaction with it. Therefore, agents need to perceive their environment (using sensors), and must have a repertoire of possible actions that they can perform (via effectors or actuators) in order to interact with (or modify) such environment.

The key question facing the agent behaviour is how to go from sensor input to action output: how to decide what to do based on the information obtained via sensors. Deciding what to do and how to do it is achieved by manipulating

plans and there are many approaches trying to explain and solve that question; such approaches are known as cognitive models or agent architectures like SOAR [16, 17], ACT-R [18] and BDI [19, 20].

3.1 The BDI model

The BDI model (called the belief-desire-intention model or architecture) originated in the work of the Rational Agency project at Stanford Research Institute in the mid-1980s. The spirit of the model is located within the theory of human practical reasoning developed by the philosopher Michael Bratman [19]. BDI agent systems have a substantial role in many implemented systems that are used for challenging applications such as air-traffic control, space systems [15] and human decision making simulation.

The concepts of the BDI paradigm (originally based in folk psychology) allow the use of a programming language to describe human reasoning and actions in everyday life [6]. Because of this straightforward representation, the BDI paradigm can easily map extracted human knowledge into its framework, described by [20].

Therefore, BDI is a software model developed for programming intelligent agents, which is characterized by the implementation of an agent's beliefs, desires and intentions. BDI also provides a mechanism for separating the activity of selecting a plan (from a plan library or an external planner application) from the execution of currently active plans.

Intention and desire are both pro-attitudes, in fact, both of them are mental attitudes concerned with action, but intention is distinguished as a conduct-controlling pro-attitude. Commitment is the distinguishing factor between desire and intention, noting that it leads to temporal persistence in plans and further plans, being made on the basis of those to which it is already committed.

However, it should be observed that before an agent can achieve his goals, first must formulate a course of actions (the plans). Those actions successfully will be carry out as long as his beliefs about the state of the world around him are true. In fact, the trustworthy of the agent's beliefs is a consequence of his skills to perceive (with some degree of confidence) the changes in the environment.

Inaccurate (or vague) perceptions can be combined and processed to construct beliefs [22] that later will be integrated into the BDI logic of Rao and Georgeff [21], preserving the features of the logic while adding to it in ways that complements and aids in the building of BDI agents that have the skills to construct their own beliefs. Such method enables those BDI agents to get a more real picture of their surrounding environment. Therefore we propose the use of BDI agents with fuzzy perceptions to create models that represents the human capabilities and functionalities, like the perception of the surrounding environment.

4   Case of study

For our case of study, we propose a BDI agent pedestrian model, which has the ability to create its beliefs from the inaccurate perceptions of its environment. As shown in Figure 1, this model includes the necessary elements for the agent to process the perceptions and combine them with its intentions to select the path according to the agent preferences.

We argue that the locomotor behavior of individuals is affected by their preferences, which in turn are affected by their capabilities and functionalities. Therefore for the case study it was decided to model the mobility preferences of disabled. In order to demonstrate how certain limitations in the capabilities can affect mobility preferences.

As a starting point for the case of study is considered the analysis of information obtained from surveys and observations of people walking. From this analysis we will get the necessary information to create the profiles of agents' models, and the statistical information to validate the results for the model execution.
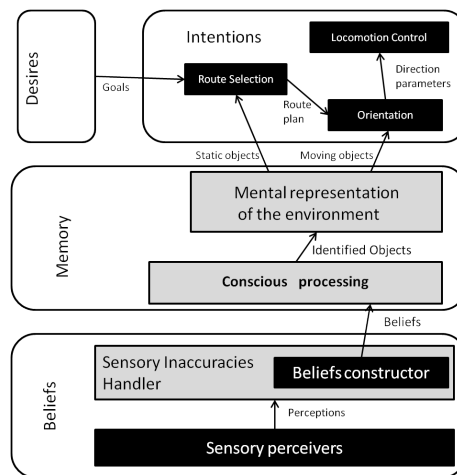

Fig. 1. Beliefs Desires Intention Extended Model for a Pedestrian Agent

We are currently in the phase of the necessary information identification to create profiles, we are taking as reference the World Health Organization: International Classification of Functioning [23], which establishes the health conditions, body functions and capabilities of human beings.

5 Conclusions

Modeling the pedestrian mobility preferences can be of great benefit because their results would contribute in the search for solutions to improve the distribution of physical spaces, which would lead in very different benefits:

- ergonomics, since it can help to improve the safety and comfort of the individuals who walk through these spaces.
- economic, because they allow to improve and direct the flow of people in commercial spaces, as they can be shopping malls, tourist areas, museums, etc.
- social, as it can facilitate the search for solutions to create spaces where people can meet and communicate.

References

1. Comisión Nacional de los Derechos Humanos, México (2009). *Muestra Diagnóstico Nacional De Accesibilidad en Inmuebles de la Administración Pública Federal.* Retrieved from: http://www.cndh.org.mx/index.htm
2. W. Ali, B. Moulin: 2D-3D Multi-agent GeoSimulation with knowledge-based agents of customers shopping behavior in a shopping mall, Springer-Verlag Berlin Heidelberg (2005)
3. M. Thriault and F. Des Rosiers, Modelling perceived accessibility to urban amenities using fuzzy logic, transportation GIS and origin-destination surveys, 7th AGILE Conference on Geographic Information Science, Greece, 2004.
4. Sociologyindex, Collective behavior, social move-mints and activism. Sociologyindex. 2011. [Online]. Available: `http://sociologyindex.com/collective_behavior.htm` [Accesed: march 2011].
5. Helal, A., Cho, K., Lee, W., Sung, Y., Lee, J., Kim, E.: 3D Modeling and Simulation of Human Activities in Smart Spaces, In: 9th International Conference on Ubiquitous Intelligence and Computing and 9th International Conference on Autonomic and Trusted Computing, pp.112–119. IEEE Press, New York (2012)
6. Lee, S., Son, Y. J., Jin, J.: An integrated human decision making model for evacuation scenarios under a BDI framework. ACM Transactions on Modeling and Computer Simulation. 20(4), 1–24, (2010)
7. Aucher, G.: A combined system for update logic and belief revision. In: Intelligent Agents and Multi-Agent Systems,3371(132), pp. 1–18. Intelligent Agents and Multi-Agent Systems (2006)
8. Shapiro, S., Pagnucco, M., Lesperance, Y., et al.: Iterated belief change in the situation calculus. Artificial Intelligence. 175(1), 165–192 (2011)

9. Sardina, S., Padgham, L. A BDI agent programming language with failure handling, declarative goals, and planning. Autonomous Agents and Multi-Agent Systems. 23(1), 18–70 (2011)

10. Casalia, A., Godob, L., Sierra, C.: A graded BDI agent model to represent and reason about preferences. Artificial Intelligence. 175(7-8), 1468–1478 (2011)

11. Wu, X., Zhang, J.: Rough set models based on random fuzzy sets and belief function of fuzzy sets. International Journal of General Systems. 41(2), 123–141 (2012)

12. Jing, X., Luo, X.: A fuzzy dynamic belief logic. In: ICAART 2013 - International Conference on Agents and Artificial Intelligence, pp. 289–294. Nguyen N. T., eds., Barcelona, Spain (2013)

13. Farias, G. P., Dimuro, G. P., Costa, A. C. R.: BDI Agents with Fuzzy Perception for Simulating Decision Making in Environments with Imperfect Information. In: The Multi-Agent Logics, Languages, and Organisations Federated Workshops (MALLOW 2010), O. Boissier, A. E. F. Seghrouchni, S. Hassas, N. Maudet (Eds.), Lyon (2010)

14. Son, Y.J., Kim, S., Xi, H., Mungle, S.: An Extended BDI model for Human Behaviors: Decision–Making, Learning, Interactions, and Applications. In: Proceedings of the 2013 Winter Simulation Conference, pp. 401–411. E. R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, and M. E. Kuhl (Ed.) (2013)

15. Wooldridge, M., Bordini, R. H., Hubner, J. F.: Programming Multi-Agent Systems in AgentSpeak using Jason. Wiley, West Sussex (2007)

16. Laird, J. E., Newell, A., Rosenbloom, S.: SOAR: An Architecture for General Intelligence. Carnegie-Mellon University Technical Report AIP-9. (1987)

17. Laird, J. E.: The Soar Cognitive Architecture. MIT Press, ISBN 978-0-262-12296-2. (2012)

18. Anderson, J. R.: How can the human mind occur in the physical universe?. Oxford University Press, ISBN 0-19-532425-0. New York (2007)

19. Bratman, M. E.: Intention, plans, and practical reason. Harvard University Press, Cambridge, MA (1987)

20. Bratman, M. E., Israel, D. J., Pollack, M. E.: Plans and resource-bounded practical reasoning. Computational Intelligence. 4, 349-355 (1988)

21. Rao, A. S., Georgeff, M. P.: Modeling rational agents within a BDI–architecture. In: Proceedings of the Second International Conference on Principles of Knowledge Representation and Reasoning. Morgan Kaufmann Publishers, San Mateo, CA, (1991)

22. Rodriguez-Ubeda, D., Flores, D.L., Palafox, L., Castanon-Pugaa, M., Gaxiola-Pacheco, C., Rosales, R.: Constructing beliefs from fuzzy perceptions in BDI agents, Unpublished work (2014)

23. World Health Organization: International Classification of Functioning, Disability and Health (ICF). Geneva: World Health Organization (2001)