Multi-agent research in Transportation Domain

DIM DEPARTMENT (DECISION, INTERACTION AND MOBILITY)
LAMIH UMR CNRS 8201, UNIV. DE VALENCIENNES, FRANCE

I. CONTEXT

The LAMIH[1] laboratory, at the University of Valenciennes is organized into different departments (essentially, Automation, Mechanics, and Computer Science). The Computer Science department, named *Decision, Interaction and Mobility* (DIM), has two teams: operational research and distributed and embedded systems (OptiMob), and interactions and agents (InterA). InterA studies Human-Machine interaction and Distributed Artificial Intelligence / Multi-Agent Systems, (DAI / MAS).

Transportation, and more precisely road traffic simulation, is considered as one of the complex applications where MAS models open new research perspectives. Agent-centered, aka. microscopic, approaches are thus introduced to compete against previous macroscopic approaches. MAS tools take into account a larger variety of behaviors and richer environments, such as geographical databases and ontologies.

InterA investigated in the early 2000s application domains bound to the urban contexts: bus regulation and road traffic simulation. The animation of virtual pedestrians in an urban context contributed to the modeling of realistic environments for traffic simulations in towns.

II. DESCRIPTION

A. Bus traffic regulation

InterA aims to improve the quality of bus transportation by supplying a decision support system (DSS). Buses are modeled with a multi-agent approach. To respect precisely the theoretical schedules announced to the customers / users, it is necessary for the designer to propose a real time regulation. To take into account the incidents (which cause delays), the DSS allows for evaluating alternatives based on different possibles actions (e.g., modifying arrival times). These actions are often realized by a human operator because the process of regulation is not formalized. To meet the needs of the regulator and the satisfaction of the users, InterA designed a tool where agents (buses) change their actions (e.g., respecting the possibility for users to take another bus at a bus stop, in spite of the delays).

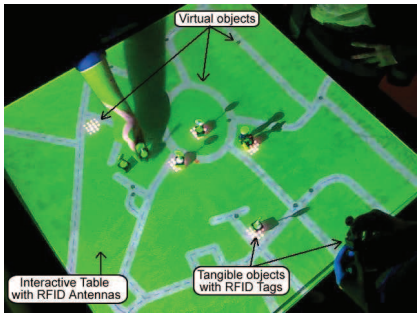
B. Behavioral animation of virtual pedestrians

A model of actions based on a vote mechanisms was applied for virtual agents (pedestrians). An educational simulator was designed for allowing the placing of a child-player in situations produced by interactions between pedestrians and vehicles. InterA contributed to the design and behavioral animation of virtual pedestrians. The actions modeled by these agents correspond to possible movements. A hybrid architecture was proposed, embedding cognitive and reactive properties. The cognitive reasoning searches a path following the adoption of a new goal. The reactive reasoning is happens during simulation. It enables reacting in a appropriate way at every step of the simulation, in a complex environment. The proposed model was also adapted to model the behavior of drivers.

C. Platform based on information spreading in a road traffic

A tool for road traffic simulation was developed to study the implementation of services within the mobility and intermodality contexts. This is part of the *Platform of simulation dedicated to the mobility services* project (PLAiiMOB) of the International Campus on Safety and Intermodality in Transportation (CISIT). Data exchanged between agents may help reacting to unexpected events (e.g., accidents) by reproducing a global behavior.

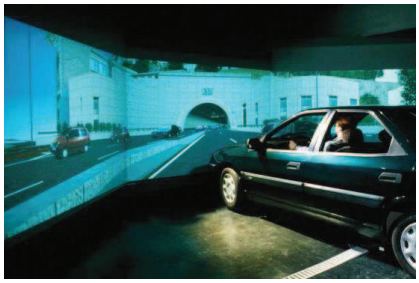
To facilitate supporting cartographic data from OpenStreetMap[2], an extension was implemented for an interactive table with tangible objects (TangiSense) based on RFID. Support was added for interactions between human users [4].



D. Road traffic simulation

InterA worked with Renault on the platform Scaner II for insertion problems on a road. A collaboration with IFSTTAR[3] on the ArchiSim simulation platform addresses traffic in urban contexts.

[1] french acronym for *Laboratoire d'Automatique, de Mécanique et d'Informatique, industrielles et Humaines*
[2] http://www.openstreetmap.org/
[3] french acronym for "Institut franais des sciences et technologies des transport, de l'amnagement et des rseaux".



In this context, a human agent is located into an environment simulating interactions with software agents and other humans. Models for critical situations (e.g., crossroads) were compared with measures of real traffic. Two studies addressed crossroads:

(i) The first one concerns the interactions between vehicles (agents) based on game matrices [5]. Each agent player chooses and selects its actions according to its potential payoff and the gain of other players.

(ii) The second study concerns the environment perceived by each agent as a set of constraints (CSPs) [1], [2]. Every agent tries to anticipate the behavior of the other agents and to detect situations of blocking by detection of incoherence of the network of constraints. This work highlighted the importance of the notion of non-normative agents in a global traffic. In this context, agents will not necessarily respect the traffic rules, considered until now a *inviolable* norm.

Motorbikes or emergency vehicles build virtual lanes (different physical lanes), and their actions based on their reasoning model are not easily described. Our model is based on the notion of *affordance*. The approach considers the properties of objects of the environment, the different possible actions, and also individual agent characteristics [3].

The process of perception of its environment by the driver is a preliminary process in decision-making. Inter-A's model takes into account the perceptive and attentional constraints of the driver. The model includes a double activity for the perception (passive and active), coupled with a quantitative limitation of percepts (due to court-term memorization).

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Contact Information:

Prof. René Mandiau &
Prof. Sylvain Piechowiak

E-mail:
rene.mandiau@univ-valenciennes.fr
sylvain.piechowiak@univ-valenciennes.fr

Phone:
+ 33 3 27 51 14 38
Address:
LAMIH UMR CNRS 8201
Univ. of Valenciennes, France
Website:
http://univ-valenciennes.fr/LAMIH