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► To cite this version:

Abdelwaheb Trabelsi, Houcine Ezzedine, Christophe Kolski. Evaluation of agent-based interactive systems, application to an information assistance system: first results. 28th European Annual Conference on Human Decision-Making and Manual Control, 2009, Reims, France. pp.45-50. hal-03474482

HAL Id: hal-03474482

<https://uphf.hal.science/hal-03474482>

Submitted on 14 Feb 2024

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Evaluation of agent-based interactive systems

Application to an Information Assistance System: First results

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Abstract

The evaluation of interactive systems is a wide and rich research domain. In this paper, we are focused on agent-based interactive systems. We propose an evaluation approach based on three complementary techniques: assistance evaluation tool, questionnaire, verbalization. The validation of our approach occurred within the framework of a project involving an industrial partner which is running the current urban transport network (tramway and bus) in the town of Valenciennes. The main results of the evaluation of an agent-based Information Assistance System (IAS) will be presented. This evaluation has been conducted in laboratory.

Keywords: evaluation, Human-Computer Interaction, Human-Machine Interface, Electronic informer, travellers information system, traffic regulation

1 Introduction

The evaluation of interactive system consists in ensuring that the users are able to carry out their task by using it; it must therefore meet their needs. The methods and tools currently available for evaluating interactive systems are numerous and various; we quote for instance: observations, eye tracking, interviews, electronic informers, questionnaires, user tests, inspection methods, knowledge based automated systems, and so on (Ivory and Hearst 2001; Jacko and Sears 2002; Nielsen 1993; Senach 1990). Each of them presents some advantages and drawbacks.

In this paper we are particularly interested in the evaluation of agent-based interactive systems. Indeed agent-based architectures of interactive systems have been proposed since the eighties in the literature. Such architectures lead to new needs concerning the evaluation of the interactive systems concerned (Kolski et al. 2009; Tran 2009).

Thus, we propose an evaluation approach based on several complementary techniques: assistance evaluation tool, questionnaire and verbalization. Urban transport networks, and in particular the system which provides information for the passengers (IAS: Information Assistance System (Ezzedine et al. 2008)), will be used as an example of the application of our approach.

We will present the main results obtained from the evaluation of the Information Assistance System (IAS). Indeed, the evaluation in the laboratory has initially enabled us to

technically test the proposed assistance evaluation system, and secondly to detect a prior representative set of utility and/or usability problems, inherent to the IAS exploitation.

2 Agent oriented specification and design of the Information Assistance System

Agent oriented architecture is used for the design of the IAS (Ezzedine et al. 2005, 2006). The application agents are intended to manage the passenger information in the vehicles and stations and to calculate the information to be displayed (delays, timetable and route modifications, etc.). According to the traffic context, each agent possesses rules enabling it to act correctly in its environment. Concerning the specification of the interface agents, we have identified six types of interface agent responsible for direct interaction with the human regulator. These agents are represented in the form of interactive windows. The regulator can interact with these agents via the various functions possible in the windows, for example: the buttons, the edition zones, the pictures, etc. These agents are:

- The *State of the traffic* interface agent: it gives a synthetic representation of all the delays concerning mobile units travelling on the network. Thus, with the help of the network support system, it ensures the real time surveillance of vehicle delays on the network supervised.
- The *State of the line* interface agent: the view of the *State of the line* interface agent is made up of graphic elements such as stations, route sections, vehicles, etc. (see figure 1a). A click on a vehicle directly displays the view (window) of the *Vehicle* agent which will deal with any further interaction with the regulator (see figure 1b). The principle is the same when the operator clicks on a station (see figure 1c).
- The *Station* and *Vehicle* interface agents: the view of these two interface agents is accessible by acting on their associated representations in the *State of the line* interface agent view (vehicle and station). It shows the regulator the information contained in the running plans in the form of a set of thumbnails depending on a direction which can be selected on a drop-down scroll list.
- The *Message* interface agent: the view of the *Message* interface agent enables the regulator to obtain a synthetic view of all the messages being sent to vehicles and stations.
- The *Overall View* interface agent: in order to make the task of supervising the traffic easier for the regulator, we created an *Overall View* interface agent. As its name implies, the view given by this agent provides the regulator with a global view of the traffic on the network. This view encompasses all the lines to be supervised and facilitates access to line, stations and vehicles.

A survey of the interfaces related to these agents is available in (Trabelsi 2006).

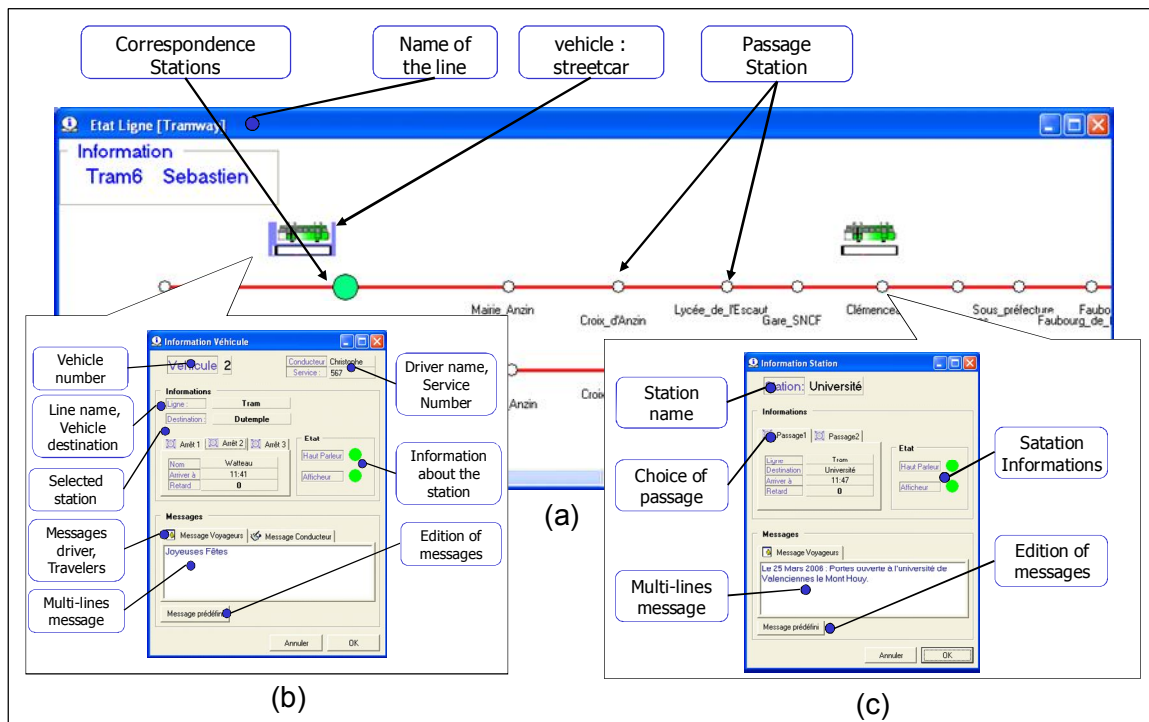


Figure 1: (a) view of the *State of the line* interface agent, (b) the view of a *Vehicle* interface agent, (c) view of a *Station* interface agent

3 Evaluation of the Information Assistance System (IAS)

3.1 Experimental device

The experimental device of the IAS evaluation consists of several techniques and tools: an assistance evaluation tool integrating an electronic informer called MESIA¹ (Trabelsi et al. 2006), questionnaire and verbalization. The use of each of them is presented hereafter.

3.1.1 Assistance evaluation system

The assistance evaluation system was conceived in order to help and assist evaluators of agent-based interactive systems. It is composed of three main modules (Trabelsi et al. 2006):

- **The *electronic informer module***: it ensures the collection of the actions/reactions of the user and the system. The collection of the data is ensured via a coupling between the IAS and the electronic informer. These collected data are very important insofar as the models of the tasks really carried out by the operator can be reconstituted and compared with the task models to be carried out.
- **The *generating Petri nets module***: this module uses the data given by the **electronic informer**, in order to generate Agent Petri nets (Ezzedine and Kolski 2008) representing the model of the performed task and the model of the task to be realized. Up to now, this module provides results in textual form.
- **The *Simulation/Confrontation/Specification of the Petri nets module***: This module offers the evaluators/designers the three following functionalities: the simulation of Agent Petri nets, the confrontation and the confrontation of these Petri nets.

¹ MESIA: Mouchard électronique dédié à l'Evaluation des Systèmes Interactifs orientés Agents; translated by: Electronic informer dedicated to the Evaluation of Agent-Based Interactive Systems.

Explanation about a specific tool ensuring the generation, the simulation and the confrontation of Petri nets can be found in (Tran et al. 2008a and 2008b; Tran 2009).

In addition to the verbalization, the use of the electronic informer as a tool for the evaluation of the IAS is enriched by subjective user answers to a questionnaire.

3.1.2 Questionnaire

The questionnaire prepared specifically for this evaluation is basically inspired from (Ravden and Johnson 1989). It is composed of three parts: the first presents questions about the interface general aspects (such as the response time); the second gathers specific questions about each IAS view (window); and the third part presents a total ergonomic evaluation of the interface. The complementary technique to the questionnaires is the verbalization.

3.1.3 Verbalization

The verbalization is an easy and direct means to collect information about the quality of the system and particularly the interface. Contrary to the questionnaire, the verbalization has the advantage of being more flexible insofar as it allows the orientation of the questions towards the information sought by the evaluator.

3.2 Population implied in the evaluation

According to (Nielsen and Landauer, 1993; Virzi, 1990), it is possible, with 4 or 5 participants, to detect nearly 80 to 85% of the utilisability problems which an interface could present. Hence, for this first evaluation of the IAS in laboratory, the population is made up of five subjects. They have an average age of 29 years. All the subjects are computer science PhD students. The fact that the subjects are experts in computer science can compensate, to some extent, their lack of experience in regulation. Indeed, the familiarity of PhD students with the computer software and the human-machine interfaces handling can put them draw sheet with the use of the IAS.

However, it is clear that the results obtained within the framework of this first evaluation will never be as consistent as those which could be obtained with professional users of the regulation.

3.3 Experimental protocol

Each experiment lasts approximately an hour and half and comprises four phases. During the first phase of the experiment, which lasts fifteen minutes, the IAS and its global functioning are explained to the subject. The participant to the experimentation is then familiarized with the various views of the IAS during approximately ten minutes before undergoing truly the experimental tests. The right handling proceeds in twenty minutes and relates to two scenarios. Ten minutes are devoted to each scenario. The last phase of the evaluation relates to the filling of the questionnaire and the verbalization; it lasts approximately forty-five minutes.

3.4 Tasks to be realized

3.4.1 Scenario 1

To make sure that the user (the subject) easily succeeds in interacting with the IAS by sending messages to the station(s) and the vehicle(s), we propose a first evaluation scenario made up of four tasks described in table I (b).

3.4.2 Scenario 2

In the second scenario, the subject has to perform four preset tasks. Contrary to the first scenario, the execution of the tasks is not sequential. Indeed, the beginning of each task is announced by an alarm or warning message. Therefore, the user (subject) can execute a task concerning the appearance of a message, and receive another at the same time.

Let us note that theoretical durations necessary to the realization of the tasks (see table 1 (c)) are approximate durations. They are determined by a supervision expert initiated with the SAI.

4 Results

The five subjects carry out the various tasks envisaged with the two scenarios. The experimental device used enables us to collect objective data by means of the electronic informer MESIA and of the subjective data via the verbalization and the fillings of the questionnaire. We present in what follows some relevant results.

The table I presents a summary of the real average duration of each task in the first scenario (d) as well as the success rate of its realization (e).

Table 1: The real average duration of each task and the success rate of its realization

(a)	(b)	(c)	(d)	(e)
Tasks to be realized	Task description	Theoretical duration of the task	real average duration of the task	Success rate of the task realization
T1	Send a message to the "SNCF railway station" of the tram line	45 seconds	41 seconds	100 %
T2	Send a message to the tram 6 driver	45 seconds	39 seconds	100 %
T3	Send a message to all the stations of line 16	60 seconds	67 seconds	(3 subjects out of 5)
T4	Send a message to all the vehicles	60 seconds	75 seconds	(3 subjects out of 5)

The results displayed in this table 1 indicate that all the subjects carried out well the first and the second task with an acceptable realization average time; whereas, for the third and fourth task, only three subjects out of five could complete them. We also notice that the real realization duration of these two tasks exceeds the average. Indeed, this can be explained by the fact that the subjects are not experts in regulation.

Other results are available in (Trabelsi, 2006). They lead to several improvements resumed below.

5 First IAS improvements

Regarding the results of the IAS evaluation obtained with the two suggested scenarios, the answers to the questionnaire and the verbalization, we propose improvements of the IAS mainly relating to the views of *State of the Traffic*, *State of the Line* and *Message* interface agents.

5.1 Improvement relating to the view of *State of the Traffic* interface agent

For a better usability, we propose to introduce (in top of the window) a specific zone to the alarm, anomaly and warning messages. In fact, when a message appears, the user takes note of it and validates it. Thus, instead of being lost, the message could be placed automatically in the message planned zone. In this way, the user would not need more to memorize messages or to note them on paper. This way of presenting the messages would make it possible the user to one by one treat them and to remove them once treated.

5.2 Improvement relating to the view of *State of the Line* interface agent

To solve the problem related to the message sent to the stations and the vehicles, we propose to introduce with the view of *State of the Line* interface agent a specific zone for the sending of message (see figure 2). This zone would make it possible the user to reach directly the *Message* view without having to pass by the view Station or the view Vehicle.

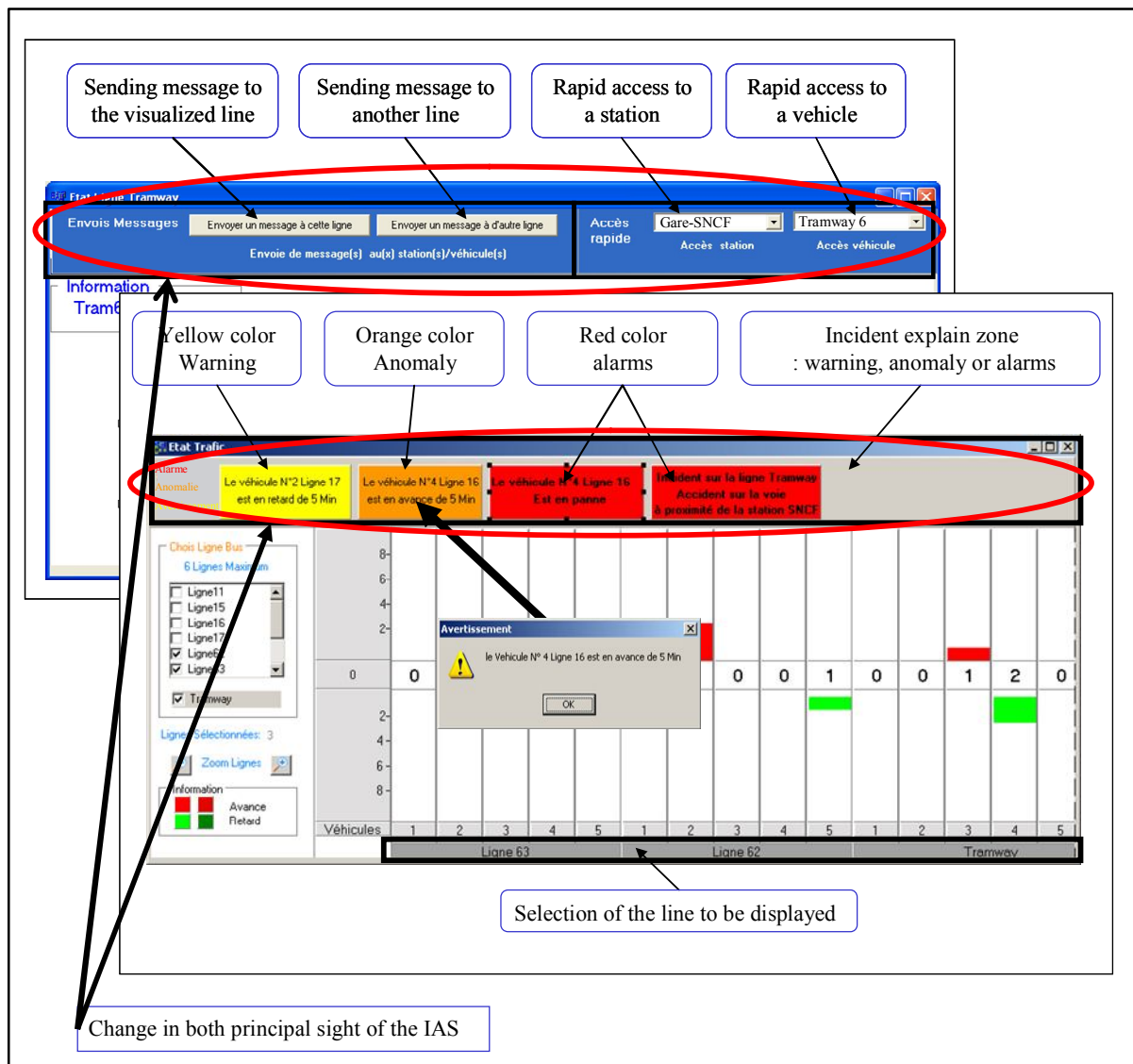


Figure 2: Improvement given to both interfaces: *State of the Traffic* and *State of the Line*

5.3 Improvement relating to the view of *Message* interface agent

After the changes carried out on the view of *State of the Traffic*, the view of *Message* interface agent should be also changed. Indeed, if the user wishes to send a message to the

whole of the stations of a specific line, it would be interesting to mask the information relative to the unconcerned lines.

5.4 Other possible improvements

In addition, we note, during the evaluation, that the messages edited by the user are not recorded by the IAS. Indeed, if the user wishes to send the same message twice, he or she has to reedit it.

6 Conclusion

We have presented in this paper the results of a first evaluation of an Information Assistance System. This system is based on an agent-based architecture. This evaluation has been performed in laboratory and provided us with interesting results. The evaluation dealt with two different scenarios. It was then possible to deduce from it first proposals for an improvement of the IAS.

Our further research aims, on the one hand, to the improvement of the Simulation modules/Confrontation/Specification and generation of Petri nets (see (Tran et al. 2008a and 2008b; Tran 2009)) and, on the other hand, a second evaluation on the ground which proves to be necessary for the detection of the problems of utility and/or usability not detected during the first evaluation.

Acknowledgements

The present research work has been supported by International Campus on Safety and Intermodality in Transportation, the Nord-Pas-de-Calais Region, the European Community (FEDER). The authors gratefully acknowledge the support of these institutions.

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