An Interface Agent for Attention Manipulation (Extended Abstract)

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ABSTRACT
This paper describes the idea of an interface agent that is able to manipulate the visual attention of a human, in order to support naval crew in a tactical picture compilation task. The agent will consist of four submodels, including a model to reason about a subject's attention. In a study (not presented here) a practical case study was formally analysed, and the results were verified using automated checking tools. These results show how a human subject's attention is manipulated by adjusting luminance, based on comparative assessment involving a descriptive and a prescriptive model of the subject's attention.

Categories and Subject Descriptors
H.1.2 [**Models and Principles**]: User/Machine Systems - *Human factors.*
I.2.11 [**Artificial Intelligence**]: Distributed AI- *Intelligent agents.*

General Terms
Experimentation, Human Factors, Verification.

Keywords
Description level: Applications.
Inspiration source: Artificial Intelligence.
Focus: Agent-Human Interaction, Ambient Intelligence, Attention.

1. INTRODUCTION
In the domain of naval warfare, it is crucial for the crew of the vessels involved to be aware of the situation in the field (e.g., own vessels, hostile vessels). One of the crew members is usually assigned the task to identify and classify all entities in the environment (e.g., [4]). This task determines the type and intent of a multiplicity of contacts on a radar screen. Attention is typically directed to one bit of information at a time [11], [12], [14]. Because the dynamic nature of the task makes it impossible for a single human to monitor everything in parallel, support from an intelligent agent system may be useful. An interface agent may alert the human about a contact if it is ignored. To this end the agent has to maintain a model of the cognitive state of the human: the human's distribution of attention. Existing cognitive models on attention show that it is possible to predict a person's attention based on a saliency map, calculated from features of a stimulus, like luminance, colour and orientation [6], [10].

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Furthermore, such an intelligent support agent should have the capability to attribute attentional (e.g., [5], [6], [7]) states to the human, and to reason about them. In this study, an interface agent is employed to adjust behaviour of the human: distribution of attention is manipulated by changing features of stimuli. Attention can be elicited by the contrast with stimuli at other locations [6], [8], [9] and the abrupt change of a feature, like luminance [13], [15] or form [15].

2. ARCHITECTURE OF THE AGENT
The interface agent described in this abstract uses four models. The first is a dynamical model of human attention, for estimation of the location of a person's attention, based on information about objects and the person's gaze. The model uses input from features of objects on the screen and the human's gaze to provide an estimation of the current attention distribution at a time point: an assignment of attention values to a set of attention spaces at that time. This attention distribution is assumed to have a certain persistency, so that also attention for objects that have been observed some seconds ago is modeled. The second model is a reasoning model which the agent uses to reason through the first model, to generate beliefs on attentional states at any point in time. With a third model, the agent compares the output of the second model (a descriptive model) with a model for the desired attention distribution (a prescriptive model), in order to determine whether there is a discrepancy. Finally, the agent uses a fourth model to provide support: in case the third model assesses that there is a discrepancy with respect to a certain object on the screen, it directs the person's attention to that object. Initial versions of the first two models were adopted from earlier work [3].

The interface agent has been implemented in a case study where participants perform a simplified version of a tactical picture compilation task. Within this case study, two experiments were conducted to validate the agent's manipulation. Results show that the participants are confident that the agent's manipulation indeed is helpful. Also with respect to the users' performance, the agent seems to be useful.

3. CONCLUSION
An important task in the domain of naval warfare is the Tactical Picture Compilation Task, where persons have to deal with a lot of complex and dynamic information at the same time. To obtain an optimal performance, an intelligent agent can provide aid in such a task. This paper presented an initial version of a supporting

software agent, which serves as a model-based intelligent interface agent, as described in [1]. Within this type of agent an explicitly represented model of human functioning plays an important role, for the case considered here the model of the human's attention. Such a model forms a basis for the application of dedicated model-based reasoning methods.

To obtain a software agent for these purposes, four models have been designed that are aimed at manipulating a persons attention at a specific location: 1) a dynamical system model for attention, 2) a reasoning model to generate beliefs about attentional states using the attention model for forward simulation, 3) a discrepancy assessment model, and 4) a decision reasoning model, again using the attention model, this time for backward desire propagation. The first two models were adopted from earlier work [3].

The interface agent has been implemented in a case study where participants perform a simplified version of the tactical picture compilation task. Within this case study, two experiments were conducted to validate the agent's manipulation. Although the participants reported to be confident that the agent's manipulation indeed was helpful, the results of these validation studies with respect to performance improvement have been only partly positive. The found order effect makes it hard to validate the agent in an N=1 design. This suggests more research with more participants. It is also expected that future improvements of the agent's submodels, based on the gained knowledge from automated verification will also contribute to the success of such validation experiments.

Nevertheless, more detailed analysis and verification of the behaviour of the agent provided positive results. Traces of the two experiments were checked (cf. [2]) to see whether the agent was able to adapt the features of objects in such a way that they attracted human attention. Results show that when there was a discrepancy between the prescriptive and the descriptive model of attention, the agent indeed adapted the feature luminance in a correct manner, and as a consequence attention could be manipulated. The analysis also showed that the feature adaptation worked better in the second (improved) experiment than in the first.

Concerning further future work, an important challenge would be to perform a more elaborated validation of the supportive system. This can be done in several steps. First, to obtain more data, the experiment introduced in this paper will be performed with a larger number of participants. The resulting data can then be used to check (using automated analysis tools) whether the supporting agent is successful in various situations. Different strategies will be tested like adapting the shape or orientation of an object in addition to luminance. Also, different parameter settings will be tested. Finally, in addition to manipulation of bottom-up attention, the effect of manipulating top-down attention will be investigated.

4. ACKNOWLEDGMENTS

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