A Perception Framework for Intelligent Characters in Serious Games

(Extended Abstract)

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1. INTRODUCTION

The use of BDI-agents seems a good fit to realize intelligent behavior for virtual humans. One of the problems of the BDI-paradigm when an agent becomes embodied in a virtual environment is the lack of control over perception [3]. While performing a task, humans tend to direct their attention to selected information from the environment which can support them in achieving the task. As attention is considered to be a limited resource, one cannot attend to all aspects in the environment which currently fall into sensory range. The same can be said for BDI-agents. Without any form of goal-directed perception, an agent can become flooded with sensory information from the virtual environment, which may result in reasoning over too much irrelevant information. Besides the risk of performance loss this is also unrealistic when we look at the physiology of human perception [1]. A balance must be found between stimulus-driven and goal-based control over perception.

In this paper we present a perception framework which provides sensing abilities and perceptual attention for BDI agents embodied in a virtual environment. The framework handles *covert attention*, the mental focus on possible sensory stimuli which doesn't involve any motor actions [2]. Different perception stages are identified together with the information communicated between the stages. We show the advantages of using ontological data representations for this information to form an agreement between a BDI-agent in a multi-agent system and its embodiment in a game engine. To illustrate its use in the perception framework, we present an approach for implementing goal-directed perception for BDI-agents.

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2. PERCEPTION FRAMEWORK

Figure 1 illustrates the perception framework used to connect a BDI agent with its embodiment in a virtual environment. The framework employs ontological information models representing an agent's perceptive view on the environment based on semantic concepts. With these models we not only abstract from any specific virtual environment implementation, but also from the technologies used to create virtual environments and BDI-agents. Having sensory information formatted in accordance with an ontology enables us to employ a data-driven approach to implement different perception processes within the framework.

The sensing phase concerns the *Sensory Processor* whose task it is to collect all information from the environment which can be observed by an agent through its sensors within the *Embodiment Interface*. The sensory information is represented as a collection of *signs* that correspond to object or event concept classes from the *Environment Object Model*. The perceiving phase has the task to create percepts applicable for agent reasoning. First, it acts as a filter for sensory information, discarding irrelevant information and making the agent *aware* of important information as determined by an agent's current activity or mental state. Also, *non-anticipated* information is passed allowing an agent to shift his physical or cognitive attention by performing reactive behavior or adopting new goals. These filters are represented by the *Goal-Directed Attention* and *Stimulus-Driven Attention* components respectively. Next, the *Sign Interpreter* converts the filtered flow of *signs* to a flow of *percepts*. It represents a non-cognitive process where sensory information is interpreted by converting one or more signs to a (possibly higher-level) representation suitable for reasoning. The resulting percepts are represented in accordance with the *Perception Object Model* encompassing the possible percepts as input for a BDI-agent.

3. GOAL-DIRECTED ATTENTION

In the perception framework, goal-directed attention is a top-down control over perception that extracts selected information from an incoming flow of sensory information

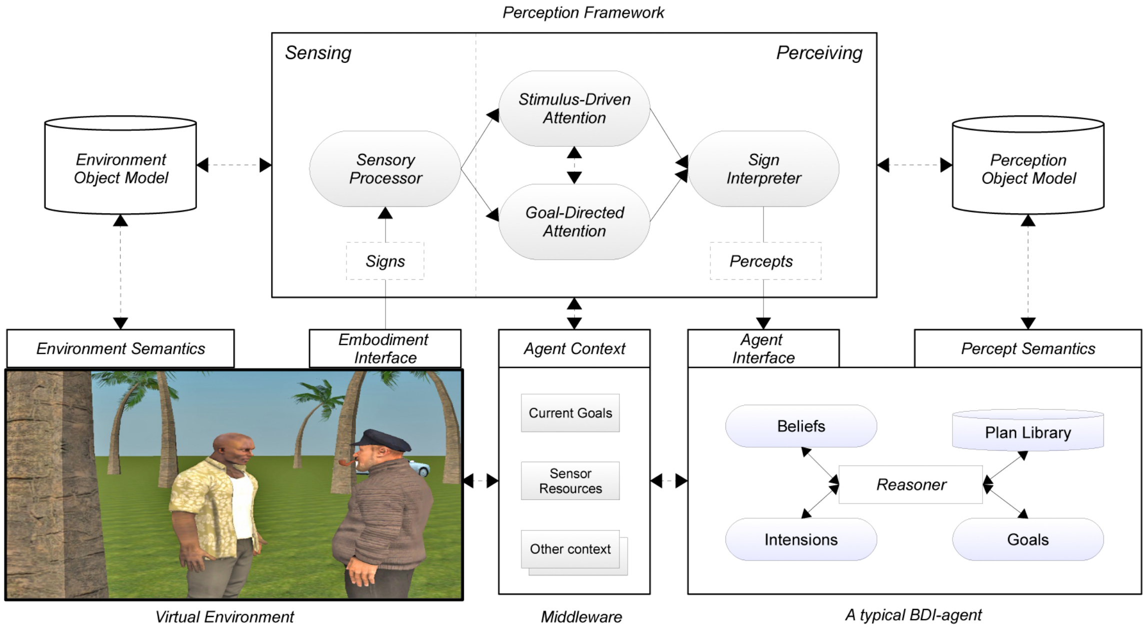

Figure 1: Perception Framework

relevant to an agent's current desires or goal.

We propose a data-driven method to filter sensory information using a subscription mechanism. As an agent adopts a goal, he can automatically subscribe to a set of *interests* which represent the agent's perceptual needs required to achieve the goal. Consequently, when the goal is achieved or dropped, the agent can unsubscribe from the corresponding *interests*.

Since the sensory information is formatted in accordance with an ontology model, we can employ this model to provide specifications for an agent's interests towards its environment. The hierarchical nature of object and events in the model is taken into account. For example, an agent having an interest in physical objects indirectly has an interest in all object classes defined as a subclass of a physical object.

3.1 Interest Specification

Several different *features* can be employed to specify an interest. First of all, one can specify the nature of the information in the form of object properties or event classes. Second, one can specify conditional values for certain object properties or event parameters to specify more concrete interests. Third, one can specify a specific source object from the environment from which information is desired. Last, the intensity with which an agent is interested towards specific information can be specified, enabling an agent to dynamically adapt his cognitive focus.

The use of the described features for interest specification provides a powerful mechanism to filter and extract selected information from sensory input. The possible specification of interests is limited by the richness of semantics in the environment as defined in the *Environment Object Model*.

3.2 Tasks and Perceptual Needs

An agent's perceptual needs are related to his current tasks or goals. We identify several categories of agent tasks whose realizations can benefit from the proposed goal directed attention mechanism:

Perceptive tasks include for example a *visual search* for specific objects or *monitoring* objects by retrieving periodic updates of their state. Interests can be specified to support such tasks by identifying the target objects and the intensity of the perceptive focus.

Role tasks are performed by an agent in the context of the role he takes on (E.g. a fire fighter leading a team or a police officer directing traffic). Having proper situation awareness (SA) is essential in performing such tasks. Interests can be specified to account for object and events related to a task.

Communicative tasks involves the perception of both verbal and nonverbal communicative behavior and is essential for properly recognizing the communicative intents of the speaker. Interests can be specified to actively attend to the (non)verbal cues of an interlocutor.

Social tasks include tasks or behaviors where an agent is required to be aware of his social environment, being able to recognize people, groups, relationships and social or conversational settings. Interests can be specified to account for the factors required for social perception.

The perception framework has been implemented as part of a middleware for connecting multi-agent systems to game engines. Experiments are currently being conducted to evaluate the framework.

4. REFERENCES

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