Agent Communication for Believable Human-Like Interactions between Virtual Characters

(Extended Abstract)

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ABSTRACT

In this paper we present a model for realizing believable human-like interaction between virtual agents situated cognitively in a MAS on one side while embodied in a virtual environment within a game engine on the other side. A middleware approach is taken to facilitate such agents in communication, hereby making a tradeoff between efficiency and believability while taking into account the real-time requirements of games and simulations.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Intelligent Agents, Multiagent Systems* ; I.6.3 [**Simulation and Modeling**]: Applications

General Terms

Design, Human Factors

Keywords

Agent Communication, Intelligent Virtual Agents

1. INTRODUCTION

The use of agent technology in the form of multi-agent systems (MASs) seems a good fit to realize the cognitive and decision-making aspects of an Intelligent Virtual Agent (IVA). One of the problems one faces when applying a MAS to control the behavior of virtual characters is how to deal with agent communication in the MAS. Unlike in typical MASs where agents communicate using standard protocols (e.g. FIPA) and mediums (e.g. TCP/IP), agents now become embodied in a real-time virtual environment where they have to resort to the expression and perception of communicative behavior through their embodiment in order to interact in a human-like manner.

In current 3D video games or virtual worlds, human-like interaction between virtual characters has hardly been employed. When it is, it is often realized during so-called cut scenes or in specific situations that are known to occur by design. Since the dialog acts and the context in which the interaction takes place are fully known beforehand, realization can be crafted in detail at design time. Now when we turn to agent technology to design autonomous, goal-directed agents controlling virtual characters, the context in which they might communicate cannot be known beforehand. Hence, communication should be realized dynamically at runtime.

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2. CONCEPTUAL GAP

Using MAS technology to control human-like characters with communicative abilities, one has to bridge the inherent conceptual gap between typical agent communication in MASs and human-like communication realized in a virtual environment. This introduces several design issues:

- Agents become embodied and have to resort to the expression and perception of *multimodal* behaviors. The choice and interpretation of these behaviors may depend on a certain *context* (e.g. an agent's identity, its affective state or its beliefs about interlocutors and the social situation).

- Agents become situated in a real-time virtual environment and have to deal with the durative nature of the expression and perception of communicative intents (e.g. monitoring, ability to interrupt, and awareness and interpretation of perceived behavior). Additionally, believable perception should be enforced based on an agent's sensory capabilities and environment physics.

Besides these issues, additional aspects related to natural human-like communication should be considered. E.g. (1) other types of functions besides the common communicative acts typical in agent communication (e.g. meta-conversational, deictic or affective functions), (2) more flexible interaction protocols to simulate natural human-like conversations (e.g. [2]) and (3) the ability to perform listening behaviors and provide backchannel feedback.

3. A MIDDLEWARE APPROACH

We present a model for human-like communication to fill the conceptual gap between agent communication in a MAS on one side and its realization in a virtual environment on the other side, covering the mind-body interface between an agent and its embodiment. The model is illustrated in

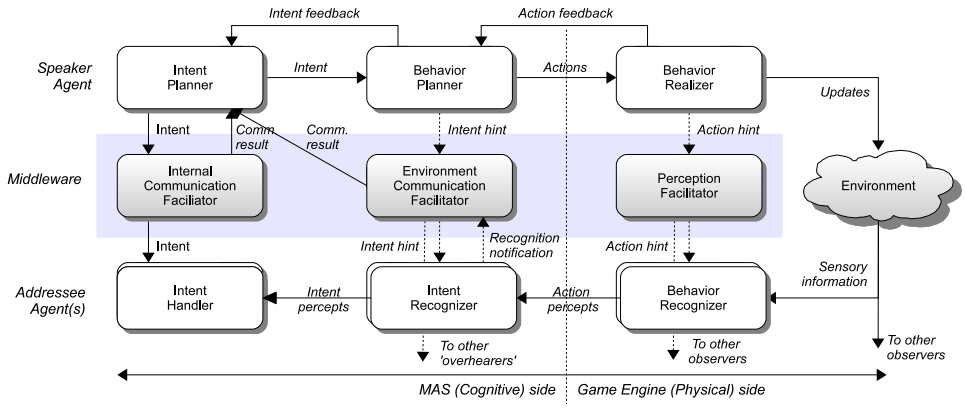


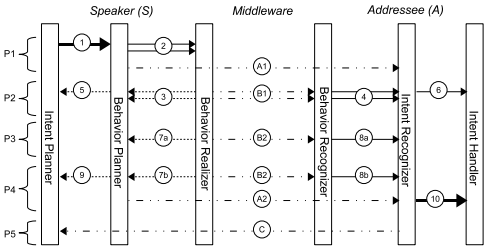
Figure 1: Virtual Agent Communication Model

figure 1 and is designed to tackle the issues described above in an efficient way without loosing believability.

First, the upper part of the model is responsible for realizing a communicative intent generated by a speaker agent using multimodal behavior expressions (similar to the SAIBA framework [1]). Second, the lower part of the model deals with the perception of communicative intents by addressee agents (or overhearers), based on the observation of multimodal behavior expressions. These perception stages can be computationally heavy processes and contribute to design complexity: *behavior recognition* would require observations over time to recognize communicative signals like speech (e.g. stream of sound waves) or gestures (e.g. motion of bones). *Intent recognition* could be seen as a pattern matching problem to match a set of communicative signals to an intent. Although resulting in a fully autonomous process for the perception of communicative intents, we believe this approach is not very practical to implement and is overly complex for use in real-time games.

As an alternative, we propose a design approach employing a middleware layer to facilitate communication between agents. It allows agents to (1) perceive communicative actions and intents without the need to interpret them from sensory information, (2) be notified about the successful recognition of an intent by a receiver agent and (3) perform internal MAS communication (eliminating behavior generation and perception states).

To clarify the communication process within our model, figure 2 illustrates the successful communication of a single communicative intent, realized using multimodal behavior consisting of two actions. To compare, a typical MAS communication using a direct transportation medium (e.g. FIPA) would be represented merely by line 1 and 10 in the example. Our model proposes an extension to cover the more complex medium that would be required for virtual agents, including (1) the cognitive abilities of agents to express and interpret intents, (2) their physical abilities to express and perceive communicative behavior and (3) a transportation medium represented by a virtual environment.



#	Agent	Activity	Message
1	S	schedule intent	*communicate(id=i1,content=inform_child_in_house)*
2	S	schedule action	*speech(id=a1,resource=child_in_house.mp3)*
3	S	receive action feedback	*action_feedback(action=a1,state=started)*
4	A	perceive action	*action_percept(action=a1,state=started)*
5	S	receive intent feedback	*intent_feedback(id=i1,state=started)*
6	A	perceive intent (no content)	*intent_percept(state=started)*
7	S	receive action feedback	*action_feedback(action=a1,state=finished)*
8	A	perceive action	*action_percept(action=a1,state=finished)*
9	S	receive intent feedback	*intent_percept(id=i1state=finished)*
10	A	perceive intent	*intent_percept(id=i1,state=ended)*

#	Middleware	Activity	Message
A1	Comm. Facilitator	send intent hint	*intent_hint(intent=i1, actions=a1,a2)(state=started)*
B1	Perception Facilitator	send action hint	*action_percept(action=a1,state=started)*
B2	Perception Facilitator	send action hint	*action_percept(action=a1,state=finished)*
A2	Comm. Facilitator	send intent hint	*intent_hint(intent=i1)(state=finished)*
C	Comm. Facilitator	send communication result	*communication_result(id=i1,observed_by=A)*

Figure 2: Example Communication

4. CONCLUSION

The proposed design approach for modeling agent communication allows virtual agents to communicate their intents efficiently on the MAS side and realize this in a human-like manner on the game engine side. Believable perception can be enforced through a virtual environment simulating a real-world medium. The primary contribution is the introduction of a middleware layer to simplify the perception stages for communicative actions and intents. We belief with this more practical approach a proper balance between efficiency and believability can be achieved for agent-based human-like communication, suitable for real-time games.

5. REFERENCES

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