Men Behaving Appropriately:
Integrating the Role Passing Technique into the ALOHA System

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Abstract

The Adaptive Level of Detail for Human Animation (ALOHA) system is a platform for animating virtual humans within a virtual environment using levels-of-detail for geometry, motion and conversational behaviour. Until now the behaviour of these humans has been determined using pre-defined scripts. This paper describes the integration of the intelligent agent based role-passing technique into the ALOHA system to allow for the creation of dynamic scenes.

1. Introduction

In the realm of Virtual Environment (VE) research, it is common for research projects to focus on one aspect of a problem, overlooking other important issues as they could distract from the core research being undertaken. Collaboration between research groups focusing on different aspects of the overall VE problem is one means of allowing groups to focus on their own particular research goals, and still pursue the goal of creating fully immersive VEs. In this paper we will discuss how two research projects, one based on level-of-detail (LOD) animation techniques and another based on Artificial Intelligence (AI) for computer games, are being combined to create dynamic virtual environments inhabited by intelligent virtual humans.

The first research effort, being undertaken by the Image Synthesis Group (ISG), is the Adaptive Level of Detail of Human Animation (ALOHA) system, the aim of which is to animate and render virtual-humans in real-time [8]. The system takes advantage of the limitations of the human visual system to use an LOD approach to compute less accurate models when loss of accuracy is unlikely to be noticed, and more accurate models when a model is likely to be the focus of a viewer's attention.

The second research initiative, part of a larger effort by the Artificial Intelligence Group (AIG) to apply sophisticated AI techniques to the realm of computer games [7], uses intelligent agent technologies to add depth to computer controlled Non Player Characters (NPCs) for adventure and role-playing games [11]. One of the techniques investigated in this research is *role-passing* which allows an agent in a particular situation to assume a role that then drives the agent's behaviour for that situation. This paper will describe the integration of the role-passing technique into the ALOHA system.

The synergy between these two projects brings significant benefits to both. Firstly, by using characters implemented using the role-passing technique, dynamic scenes can be created within the ALOHA system in which the behaviour of virtual humans is driven by their roles, rather than being scripted. Secondly, for the game AI project, the ALOHA system offers a graphically sophisticated test-bed for new agent technologies developed.

This paper will begin with an overview of the ALOHA system and its LOD approach. Following this the intelligent agent based work being carried out in the field of AI and computer games will be discussed. The role passing technique will then be introduced. A simulation example has been designed in order to test the system, and this will be described next. Finally, future and ongoing work being will be discussed.

2. ALOHA System Overview

The ALOHA system's aim is to animate and render virtual-humans in real-time based on a LOD approach. For example, if a user views a crowd from a distance, there is no need to have computationally expensive models and sophisticated animations, as the user will not perceive the difference. However if the user zooms up closer, the realism of the virtual human's model and its motion should be improved.

2.1 Level of Detail

This section describes the geometric, animation, gesture and conversational levels of detail implemented in ALOHA.

2.2.1 Geometric LOD

The different geometric levels of detail for the virtual human's skin layer are implemented using subdivision surfaces. Subdivision surfaces were used in the production of *Geri's Game* [5] and *A Bug's Life*. They are a mix between polygon meshes and patch surfaces, and provide some of the best attributes of each. Subdivision surfaces are constructed through recursive splitting and averaging. Because of this recursive nature, subdivision naturally accommodates level of detail control through adaptive subdivision.

2.2.2 Animation LOD

In order for the ALOHA system to be scalable, the LOD resolver has the ability to request different animation levels of detail. This allows the LOD resolver to decide how to resolve joint angles with inverse kinematics, to decide how many frames a movement should receive, and whether to use a simple kinematic interpolation technique or a dynamic technique to simulate a motion. This results in smooth realistic animations being applied to virtual humans rated with high importance, while lower level animation techniques are applied to virtual humans in the background, taking minimal perception degradation into account.

2.2.3 Gesture and Conversational LOD

The Gesture an Narrative Language (GNL) group from MIT Media Lab has developed the Behaviour Expression Animation Toolkit (BEAT) which allows an animator to input typed text to be spoken by an animated human figure and to obtain as output appropriate and synchronized nonverbal behaviours and synthesised speech in a form that can be sent to an animation system [3]. This toolkit automatically suggests appropriate gestures, communicative facial expressions, pauses, and intonational contours for an input text and also provides the synchronisation information required to animate behaviours in conjunction with a character's speech. Another collaborative project with this group aims to incorporate a simpler version of this toolkit in the ALOHA system.

This would allow the LOD resolver to provide realistic social interaction between characters that are rated with high importance, while a lower level of detail would be applied to characters socialising in the background.

Animations in the ALOHA system are static as a result of using pre-defined scripts (as shown in Figure 1), and for this reason the intelligent agent based role-passing system developed by the AIG is being added to it. This will provide a means to automatically drive the behaviour of virtual humans within the ALOHA system, thus creating dynamic scenes. The improved design for ALOHA incorporating role-passing is shown in Figure 2. The following sections will describe the research from which this system arose, and the system itself.

Figure 1: Scripted bar scene

3. Proactive Persistent Agents using Level of Detail AI

In adventure and role-playing games there is a trend for computer controlled NPCs to be very simplistic in their behaviour. Usually, no modelling of NPCs is performed until the player reaches the location in which an NPC is based. When the player arrives at this location, NPCs typically wait to be involved in some interaction, or play through a pre-defined script. This leads to very predictable, and often jarring behaviour. For example, a player might enter a room and meet an NPC who would play through a pre-defined script. If the player were to leave that room and re-enter, the NPC would again play through the same script. In order to overcome these limitations, an agent architecture for use in computer games has been proposed [11]. Agents implementing this architecture are referred to as Proactive Persistent Agents (PPAs).

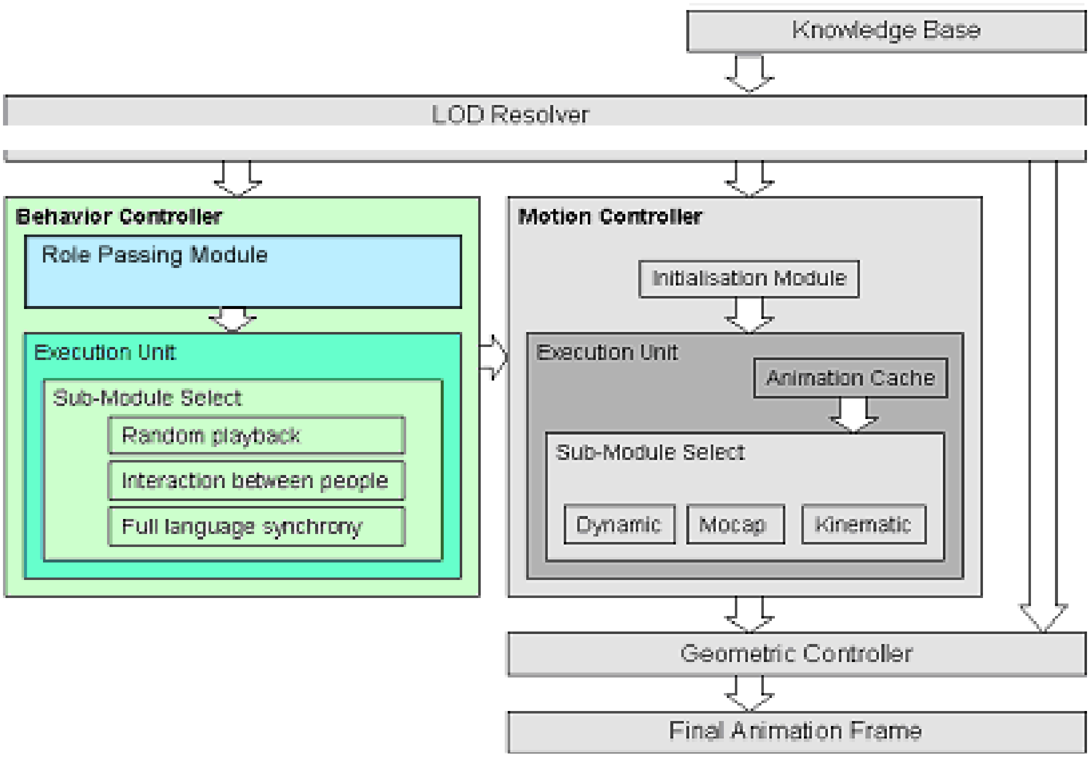

Figure 2: Original ALOHA framework extended to incorporate role-passing into the Behaviour Controller

These agents are proactive in the sense that they can take the initiative and follow their own goals, irrespective of the actions of the player. In line with [14] this is one of the key attributes distinguishing intelligent agents from other software paradigms. However, this proactiveness has been overlooked in agents for computer games. Persistence refers to the fact that at all times, all NPCs in a virtual world are modelled *at least to some extent*, regardless of their location relative to that of the player.

As part of the PPA research effort the technique of level of detail AI (LODAI) is also being investigated. LODAI arises from similar work in the field of computer graphics and simulation [2,6] where it has been used to great effect. LODAI involves controlling characters to higher or lower levels of sophistication based on their position, with respect to the player, in a virtual world.

The technique of role-passing has also emerged from the work on PPAs and complements the use of LODAI. The following section will explain the role-passing technique in some detail.

4. Role Passing

When intelligent agents are used in virtual environments, for example games or simulations, it is often required that they behave believably in a range of different situations. For example, it might be required that within the same simulation an agent is found at work in an office, and then later on enjoying a drink in a bar. The kind of behaviour required of the agent, and the motivations that should drive this behaviour, are quite different in both of these situations – at least they should be! Inspired by [10], the technique of role-passing allows intelligent agents to take on different roles depending on the situation in which they are found[1]. This section will explore the technique of role-passing, examining its advantages and how it complements level of detail techniques.

Role-passing operates by layering a *role* on top of a very basic agent. The basic agent is capable of simple behaviours such as moving through a virtual world, using objects and interacting with other characters. The agent may, or may not, have a collection of motivations that drives its behaviour. Finally, the agent should have a number of attributes describing personality traits.

When a particular role is layered upon this basic agent, it instructs the agent on how to behave in a certain situation. The first key component of a role is a set of motivations that drives the agent. Activation levels for these motivations are extrapolated from the attributes defining the basic agent. Secondly, a role contains rules for the agent's interaction with other agents. For example, the role might specify when it is appropriate for the agent to stop and interact with another character. Finally, a role contains a set of bindings to objects important to the current role. Figure 3 shows an illustration of the role passing process. As can be seen, at various times within a simulation, an agent can assume one of a collection of roles.

Arising from the integration with the ALOHA system, a role also contains the animations required to render the character in that role.

To illustrate the make-up of a role, consider the definition for the role of a doorman. The motivations associated with the doorman role will cause the agent to either patrol around the door, open the door for characters known to the doorman, or question strangers approaching the door. The specific door to be guarded by the doorman is associated with the role as an object of particular importance. Also associated with the doorman role would be a number of animations specific to that role. For example, the animation used when the doorman opens a door, or salutes a well known character are linked to this role.

The main advantage of role-passing is the simplicity it lends to populating a virtual world with agents. Placing agents within a novel situation involves simply defining a new role. This eases some of the complications involved in attempting to design very general agents capable of behaving realistically in many situations and avoids having to write completely separate agents for different roles within a single scene.

Another advantage of the role-passing technique is that it moves some way towards creating agents capable of being transferred between different applications. Through role-passing the same basic agent is able to behave believably in very different situations. This is a major research area in intelligent agent technology [1].

Finally, role passing complements LODAI. By assuming and discarding roles as required, motivations unrelated to the current situation encountered by an agent are never considered. The result of this is that motivation levels surplus to the current situation need not be stored, and decisions not related to the current situation, are never even considered.

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[1] Note that what we refer to as role-passing operates at a coarser level of granularity than that discussed in [1].

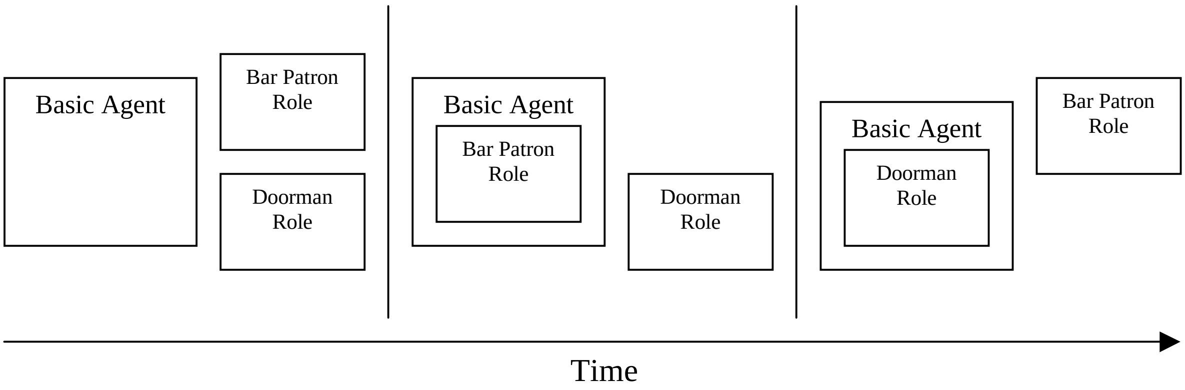


Figure 3: A diagram demonstrating the use of the role passing technique.

5. Simulation Example

As a means to test the role-passing technique, a test scenario has been designed. In the test scenario, a bar scene has been created, in which a number of characters have been located. Figure 4 shows a screenshot of the graphically simple version of the bar scenario.

At this point, two distinctive roles are in use. The first is that of a bar patron. This entails sitting at tables, chatting with other characters and getting drinks when the character becomes thirsty. The second role is that of the barman. This role entails a special relationship with the bar objects located in the scene. The barman watches the bar objects and if he sees a customer waiting at any of them he serves them a drink. At present the agents are implemented as simple behaviour based agents (following the scheme given in [15]), not exploiting the full PPA architecture. Figure 5 shows motivation networks (again following [15]) illustrating the various motivations driving an agent's behaviours.

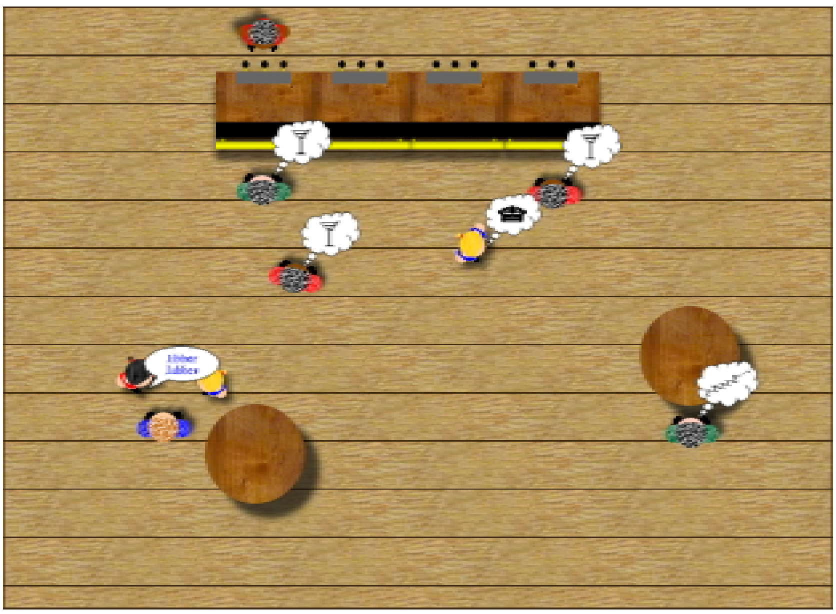
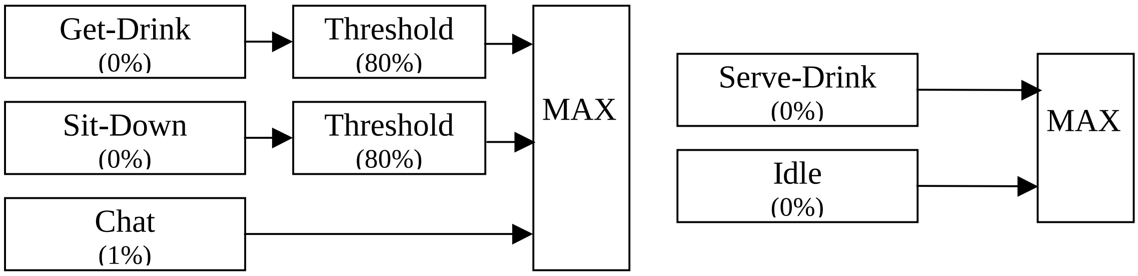


Figure 4: A screenshot of the graphically simple version of the bar scenario. Notice the icons showing the current behaviour of the various agents.



(A) **(B)**

Figure 5: The motivation networks that controls the behaviour of **(A)** the bar-patron role and **(B)** the barman role. Over time the motivations increase and the behaviour with the highest motivation is selected as the current behaviour.

The aim of this simulation is to amalgamate this role-passing technique with the ALOHA system. Currently in the ALOHA system, all virtual human animations are scripted which results in the virtual humans behaving in a cyclical manner, which is very unrealistic. Implementing this role-passing technique in the ALOHA system, allows the association of different motions with different roles as well as with different objects. This will result in a realistic VE where all the virtual humans will behave in an autonomous manner, and will also take advantage of the LOD approach reducing the computational cost of simulating the virtual humans.

Conclusion

This paper has discussed the amalgamation of two separate research areas in order to create a realistic virtual environment in which virtual humans may socially interact with each other. This collaboration allows both groups to focus on their core area of research.

With regards to the ALOHA system, further research needs to be done not only in blending different animations at the same level of detail, but also in smoothly switching between similar motions that are using different levels of detail. In the case of the role-passing system, more advanced roles and behaviours, plus more sophisticated character interaction will be added.

One final issue, which must be mentioned, is that of the evaluation of virtual worlds. Evaluation of such systems is notoriously difficult as the simulation of virtual humans is a complex task. However, a number of techniques, for example that described by Thalmann [13]**,** have been developed and will be used to determine the success of this project. In addition, psychological evaluation techniques such as those described in [9,12] will also be used.

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