The Complexity of Testing a Motivational Model of Action Selection for Virtual Humans

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Abstract

After implementing a motivational model of action selection applied to autonomous virtual humans inspired by models of animals' decision-making, the problem consists of testing it in good conditions for validation. Indeed this model has to respect the six criteria that we define according to Tyrell's requirements for designing a mechanism of action selection. So we use the real-time framework VHD++ for advanced virtual human simulation and we define a simulated environment with many conflicting motivations. Finally a video shows the first results where the virtual human's decision-making follows the six criteria and so validates our model in the simulated environment.

Keywords. Behavioral Animation, Virtual Humans, Action selection and Motivations.

1. Introduction

Designing autonomous agents has been one of the major concerns in several fields of research, especially in computer graphics. To produce complex animations with minimal input from the animator, each autonomous agent must repeatedly solve the problem of action selection.

The action selection problem is still discussed in ethology, and more widely in cognitive sciences, because of his multi-disciplinary approach. Indeed, among mutually conflicting actions, an animal can only perform one at a time. The difficulty resides in knowing how to choose "at each moment in time, the most appropriate action, out of a repertoire of possible actions", and "how to apportion one's available time so as to simultaneously satisfy several needs" [1].

To solve the problem of action selection, an action selection mechanism needs to be implemented and tested in good conditions for its validation. Therefore we implemented a motivational model of action selection [2] applied to virtual humans in which many hierarchical classifier systems (HCS) [3] are working in parallel (one for each motivation and their number is not limited). The activity is propagated throughout the hierarchical classifier system and selection of the most activated node is not carried out at each layer, as in classical hierarchy, but only at the end, as in a free flow hierarchy [4] (the action layer). In the end, the action chosen is the most activated according to the motivations and information environment.

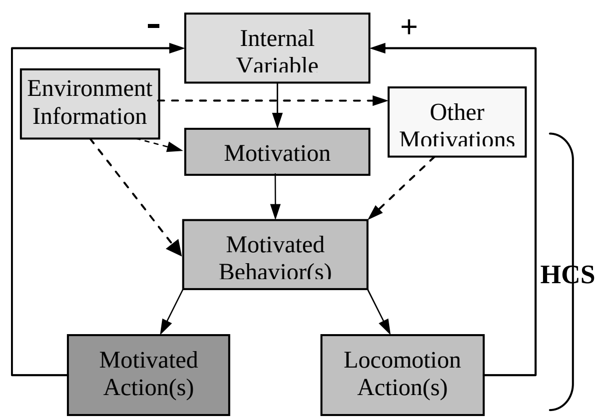

Figure 1: a hierarchical decision graph of our model for one motivation

Since then the model has been much improved to validate it in a simulated environment with the aim of respecting the six criteria [2] that we defined respecting Tyrrell's requirements [5] for designing a mechanism of action selection inspired by models of animals' decision-making.

In this article, we define what should be included in simulated environments in order to test all the capabilities of this model, which should follow the six criteria. Using the real-time development framework VHD++ [6] for advanced virtual human simulation, we define a simulated environment with ten conflicting motivations. A video shows the first results validating the model in the simulated environment.

2. Defining a simulated environment

A simulated environment is created to test whether the motivational model of action selection respects the six criteria with the aim of validating it.

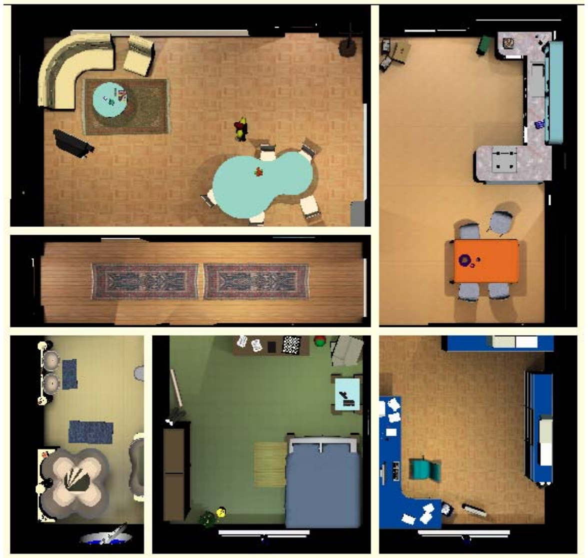

Figure 2: Top view of the apartment

We choose to simulate a virtual human in a complex environment: an apartment where he can "live" autonomously by perceiving his environment and satisfying several motivations at specific locations.

We arbitrarily define ten conflicting (the number of motivations is not limited) that a human can have in this environment with their specific locations and the associated motivated action, described in the table 1.

motivations	locations	action
hunger	table	eat
thirst	sink, table	drink
toilet	toilet	satisfy
resting	sofa	rest
sleeping	bed	sleep
washing	bath	wash
reading	bookshelf	read
playing	computer	play
watering	plant	water
Watching (default)	sofa	watch TV

Table 1: All available actions with their associated locations

Different types of motivations are represented: basic motivations (hunger, thirst, rest and toilet need), important motivations (sleeping or washing) and finally optional motivations (reading, playing with the computer or watering the plants). For the time being, they all have the same importance for the virtual human.

At any time, the virtual human has to choose the most appropriate action to satisfy the highest motivation between conflicting ones, according environmental information. Then he goes to the specific place in the apartment where he can satisfy this motivation and finally perform the associated motivated action. Moreover, one compromise behavior is possible at the table where the virtual human can drink or eat. The virtual human also has a perception system to permit opportunist behaviors. He can also perform two different actions in the same place but not at the same time: rest and watch TV when he is sitting in the sofa. The default action is watching television in the living room, like for many of us. In other words, if all the motivations are satisfied, the virtual human sits to the sofa and watches TV.

3. Test simulation in VHD++

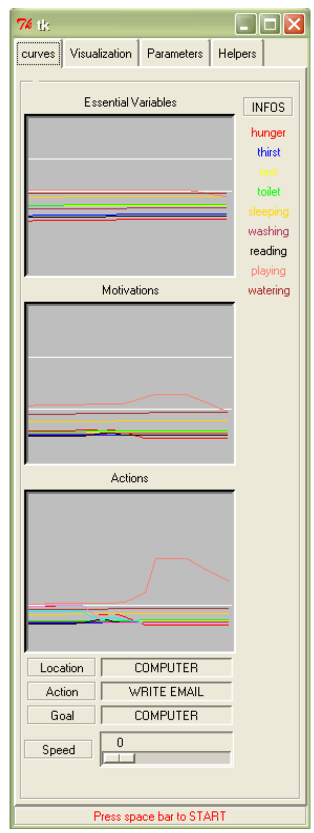

Figure 3: Implemented interface for monitoring our model

The test of our motivational model of action selection applied to virtual human can be done by implementing the model in Python [7] thanks to the Python module of the real time framework VHD++ [6] for advanced virtual human simulations.

As depicted in the figure 3, an interface has been designed for monitoring, and changing if necessary, the evolution of the virtual human's internal variables, motivations and actions in real-time. The path-planning module [8] is applied for obstacle avoidance when the virtual human walks to a specific location using the walk engine [9]. Finally its 3D viewer shows, in real-time, what the virtual human decides to do at each moment and can play keyframes for motivated actions.

4. First Results

A video shows the first results of the virtual human in the apartment, making decisions using the motivational model of action selection, according to the motivations and the environment information.

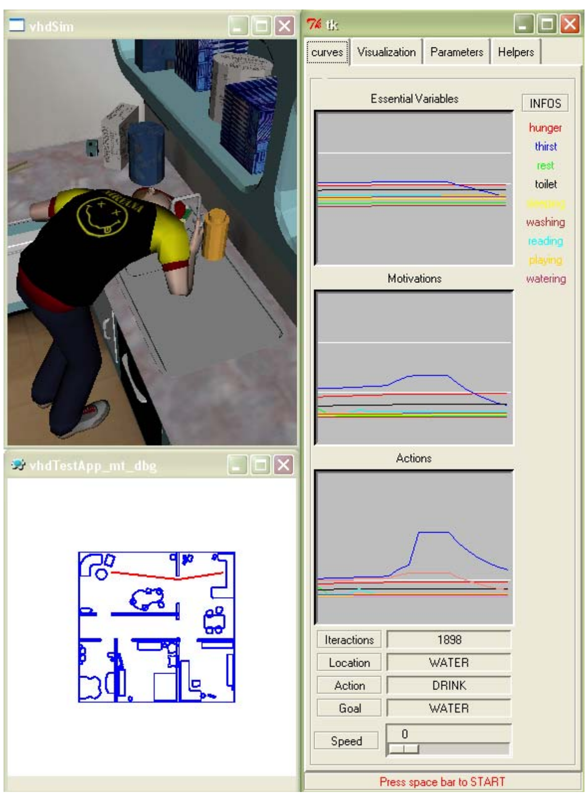

Figure 4: Overview of the VHD++ modules during the simulation

As a whole the virtual human doesn't oscillate between several motivations and chooses the most appropriate action at each moment in time. The motivational model of action selection manages the ten conflicting motivations and respects the six criteria. The virtual human "lives" autonomously and adaptively in his apartment.

5. Validation with the six criteria

Tyrrell [5] tested performances (genetic fitness) of many action selection mechanisms in complex simulated environments with many motivations. He defined some requirements for validating action selection mechanism inspired by models of animals' decision-making. We summarize these requirements in six criteria, which our model respects:

1) *Taking motivations into account.*

During the simulation, the virtual human satisfies all his motivations over the allotted time, thanks to the "subjective" evaluation of the motivation [2] from the essential variables, which can be assimilated with levels of attention that help the action selection mechanism to choose the most appropriate behavior at any time. The persistence of associated motivated actions allows to decrease the motivations sufficiently and to avoid oscillations.

2) *Taking environment information into account.*

The virtual human avoids obstacles when reaching the place where he can satisfy his motivations, thanks to the path-planning module. Moreover, opportunist behaviors occur, via the virtual human's perception system. For example, when the he goes to the desk and passes near food, hunger increases proportionally to the distance to the food location, and if it is already high, the virtual human eats before going to the desk.

3) *Preferring to perform motivated actions (eat, drink…) over locomotion actions (go East, South...).*

Each time when the virtual human detects that he can perform a motivated action which satisfies the current motivation, it is chosen by the action selection mechanism, because the motivated actions weigh twice as much as locomotion ones and because it permits to directly decrease the motivation.

4) *Carrying out the current sequence of actions to its end in order to satisfy the current motivation.*

To satisfy the current motivation, a sequence of locomotion actions is generated, thanks to the hierarchical classifier system and the path-planning module, in order for the virtual human to reach the specific location where the motivated action can be done and so the current motivation decreased.

5) *Interrupting the current sequence of actions if another motivation becomes higher or if opportunist behaviors occur.*

Interruptions may occur during the current behavior, e.g. to perform opportunist behaviors, due to differences in the evolution of motivations parameters or to the perception system. In this case, the current behavior is interrupted and a new sequence of locomotion actions is generated, because the action selection mechanism always chooses the most activated action, using free flow hierarchy.

6) Preferring compromise behaviors, i.e. where the chosen action satisfies the greatest number of motivations.

When thirst is the highest motivation, the virtual human can choose the sink or the table for drinking. Most of the time, the decision depends on the distance to both water sources. However when hunger is high too, a compromise behaviors occurs: the action selection mechanism chooses to go to the table because the virtual human can both eat and drink, therefore decreasing both motivations at the same place instead of going to two different locations.

6. Conclusions

The respect of the six criteria validate our motivational model of action selection according to Tyrrell's requirements [5] for designing action selections mechanisms inspired by models of animals' decision-making. Moreover, the virtual environment is adequate for testing all the functionalities of the model, which chooses always the most appropriate action at each moment according the motivations and environment information.

But are the six criteria enough to validate our model in a simulated environment? The principal problem encountered during the testing of the motivational model of action selection is the tuning of the parameters. For the time being, we have to adjust all forty-five parameters for each motivation by hand. The length of some motivated actions poses another problem. How to define the time parameters for these actions? Should we base on a twenty-four-hour day? For the time being, we estimate time according to real life.

Nevertheless, the results encourage us to continue to test the motivational model of action selection in our simulated environment with more motivations. It seems to be a good basis for designing a more complex model, integrating hierarchy between motivations, for a better adaptation of the virtual human to his environment. The ultimate goal is to try to approach the complexity of human decision.

7. Acknowledgments

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