

Bringing Hollywood to the Driving School: Dynamic Scenario Generation in Simulations and Games

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Abstract. In this paper we discuss a framework for simulation software called the movie metaphor. It is applied to the **Dutch Driving Simulator for dynamic control of traffic scenarios**. This framework resolves software complexity by the use of agent protocols inspired by the way of working on a movie set. It defines clear responsibilities for the agents so that the system is extensible, maintainable and easy to understand. The framework is a software pattern for multi-agent systems especially suitable for simulation software and games.

1 Introduction

Games and simulation software are very complex systems. To deal with this complexity, technologies like “multi-agent-systems” are introduced. Herein every virtual living entity is represented as a software agent. Every agent is acting autonomously in its virtual world to reach its goal [7]. Agents can also share a higher level goal. **This is especially the case in simulation software where agents are like scenario players who play their role to generate a successful scenario.**

Green Dino Virtual Realities is one of the leading companies in Driving Simulation technologies. They have developed the Dutch Driving Simulator (DDS) which is used at driving schools to teach students how to drive a car. The DDS contains a Virtual Driving Instructor (VDI) to give feedback to the student and ambient traffic. Ambient traffic entities are represented by software agents that drive freely through the environment. The problem of the current software is that there is no control on the ambient traffic entities. The VDI can only hope that a useful scenario will occur when the student passes a certain place. The occurrence of a scenario is fully dependent of coincidence, since the ambient traffic drives freely through the environment.

To improve the effectiveness of the driving lessons with the DDS it is desirable that the scenarios can be controlled. This paper describes a framework that combines the powerful agent technology with the use of agent protocols inspired by the way of working on a movie set. This combination of agent technology and the movie metaphor helps to develop software that is extensible, maintainable and easy to understand. With the framework a prototype of a new version of the DDS has been built that dynamically creates and plays traffic scenarios. But the framework is applicable to other simulation software and to games as well.

2 The Dutch Driving Simulator

The problem of the current software of the DDS is that scenarios could not be generated explicitly, because agents are driving freely through the environment. To solve this problem two things have to be done:

1. One should be able to describe scenarios
2. The system should be able to steer the agents in the environment

Traffic scenarios should be described in an easy manner. The scenarios should be described by a script language so that it is possible to create new scenarios after compile time. There are other driving simulators that use a scenario description language [2], [3]. These simulators have a centralized traffic director. The intelligence is put into this director. A serious disadvantage of this approach is that it is difficult to create new traffic entities. Furthermore, the scenarios could be played only at fixed positions in the environment.

In our approach, scenarios are described text-based script like in [5], [1]. The problem of these languages is that they define static locations in the environment. It is not possible to define locations in an abstract manner like “on a cross”. The intelligence is put in the environment to lead the entities through the environment. When new dynamic elements with their own set of actions are inserted, the whole environment should be modified to support the new action set. We developed a version of the DDS where the intelligence is put into the dynamic entities, which makes it possible to insert new entities without modifying the environment. In our solution we use a movie metaphor. From now on when we mention the DDS we refer to this new version of the DDS.

3 On the Movie Set

Why have we chosen to look at the movie set? The movie set is a clear and structured area. Many people work together, all with their own responsibilities, to create a movie. On the movie set, there are just the actors. They are the only ones that will be visible on screen. Behind the set, there are many other people working together to establish the whole thing. This gives a clear separation of what is visible to the viewers and what is done behind the scene.

To describe what should happen on the set, there is a scenario script [4], [6]. A scenario script contains the answers to the W-questions: Where does the scene play, Who are playing the roles, When are they playing, What should they do.

This information is distributed over three separated parts [1]:

1. Information about the required location (the set).
2. Information about the required actors (the cast).
3. Information about the roles to be played.

This decomposition makes it easier for the persons on and behind the movie set to collect the information they need. The traffic scenario can be described in the same structure as a scenario in a movie. It contains information about the traffic location, about the traffic entities which will be in the scenario (like car drivers or even traffic lights), and it contains information about the role descriptions.

The whole setup of the DDS is that it should play a set of scenarios during one driving lesson. The set of scenarios to be played is stored in the scenario pool. This could be seen as the whole script of a movie. The only difference is that scenarios are not directly related to each other in the DDS [6]. Next, we will discuss the people on the movie set and the agents with similar tasks in the DDS.

The *location scout* [4], [6] is the person who searches for suitable scenario locations. He checks which location matches the location description of the scenario. In the DDS, the location scout always tries to find useful locations in the neighbourhood of the student, because the student is always the leading star in the traffic scenarios. The locations it recognizes are road elements and intersections.

The *assistant director* [4], [6] is the person who schedules the scenarios, determining which scenario is the best one to be executed. To do this, he takes into account the required cast, the current location and the time. He tries to schedule the scenarios as efficient as possible, by reducing travelling, cast reallocation and the required time. In the DDS, the assistant director continually looks which scenario is applicable. It makes its decision using the set of scenarios in the scenario pool, the available locations and the student's driving skill. Of course the set of available locations is managed by the Location scout.

The *casting director* [4], [6] is the one who does role casting. This means, he reads the required roles in the scenario script and searches for the actors to play the roles. In the DDS the only thing the casting director knows of roles is the kind of actors that could execute them. But sometimes it is desirable that an actor is in a certain state, for example it might be required the actor is near a certain location. So when the actor type matches, the casting director asks the actor whether or not it could execute the role. This has the advantage that it is easier to introduce new actor types. An actor is the only one who has to know whether it can play some role at a certain moment or not.

The leading person behind the set is the *director* [4], [6]. For every scenario, he gives the start command and the stop command. In the movie world, these commands are called respectively "action" and "cut". When the director has given the action command, he continually observes the role execution of the actors. When the roles are not executed conform the scenario script or when the scenario is completed, the director commands a "cut". This means that the scenario playing should be stopped.

In the DDS, the director directly communicates with the assistant director for requesting a suitable scenario with a corresponding location. When a scenario is available, he asks the casting director for the required cast. When all these preparations are done, the director gives the action command for starting the scenario. When a scenario is played unsuccessfully, the director puts the scenario back into the scenario pool, to mark it as "not played".

The *actors* [5], [6] are the only entities that are on the set and who can play the roles. They know how to interpret the roles that are defined in the scenario script. In software, actors have equal responsibilities. They accept roles they can play and try to play them.

The actors are divided into three groups

1. The leading stars, these are the persons central in the scenario. In the DDS, the student is the leading star, since he is the one who should learn car driving

2. The supporting stars, they are on the set for interacting with the leading stars to make the scenario possible.
3. Extra roles, these people are on the set for filling up the environment. They have no specific role, but without them, the environment seems unrealistic.

Of course on the movie set every actor has several characteristics, for example sex, which limits the kinds of roles he/she can play. In the DDS the actor types currently available are the student and other car drivers.

The director sends directives to the actors of how much time is left to reach a certain shot. Then the actors could re-improvise their plan to reach the next shot. If an actor knows that it is not possible anymore to reach the next shot within the given amount of time, he will notify the director about this.

The system contains a director for each actor type, so that only that director has to know about the capabilities of the actor. The directors are ordered hierarchically. This means that the director for car drivers is an assistant of the director for road users, since every car driver is a road user.

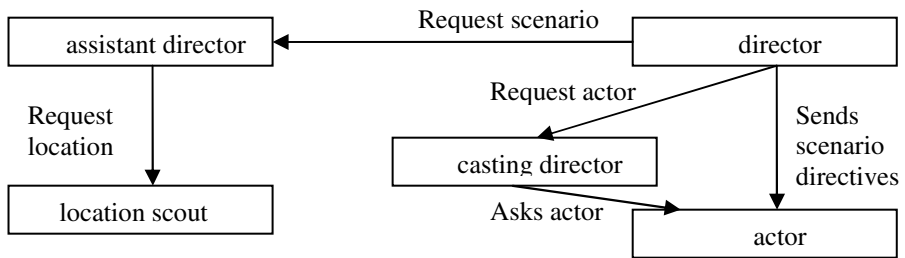


Fig. 1. Structure of the agents

In Figure 1, one can see which agents are communicating with each other. This figure is based on the description above. One can see that every actor and crew member has his own set of responsibilities and tasks. This makes the movie metaphor a clear structured approach.

4 Conclusion

This paper describes a new point of view for creating traffic scenarios, where the whole virtual world is structured like on a movie set. Scenarios are selected based on the current environment properties and what is instructive to the student. The living entities in the DDS, like ambient traffic, are seen as the actors on the movie set. The advantage of this metaphor is that scenario description is separated from scenario playing. The agents read their required information from the script and perform their actions based on that information. Because every agent has its own responsibilities, debugging is easier and it is easier to introduce new elements, such as locations, actors and roles.

The movie set metaphor is not only restricted to driving simulators. It could also be applied to games. In games, every living element, like the enemy, could be implemented as an actor. The location scout could recognize the location for playing a game scenario. Based on this and based on the player's game experience, the assistant director could select a scenario. The director can distribute the roles over the actors, which could be the enemies. The actors then behave corresponding to their role. Interesting in this setup is that the game play can be modified at runtime. A game will be different every time it is played and the level of the game can be changed at runtime.

One can see that the movie set metaphor is not just a design for a specific application. It is more like a concept that can be used for simulation and games. This makes the movie metaphor a reusable design framework.

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