Cognitive Aspects of Traffic Simulations in Virtual Environments

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Introduction

Traffic simulations for virtual environments are concerned with the behavior of individual traffic participants. The complexity of behavior in these simulations is often rather simple to abide by the constraints of processing resources. In sophisticated traffic simulations, the behavior of individual traffic participants is also modeled, but the focus lies on the overall behavior of the entire system, e.g. to identify possible bottle necks of traffic flow [8].

One objective of the FIVIS project [3][4] is to create a realistic bicycle simulator to be used for road safety training of children. For that the traffic agents need to be persistent and react realistically to changing environmental conditions in real-time. However, within the context of virtual environments, traffic simulations need to be realistic only within the viewing frustum of the visualization setup. If simulated content is not directly visible, there is no need to spend major computing resources on its calculation.

Training simulators are widely used to increase safety in almost all areas of modern transportation (car, train, plane, etc.). With their help trainees are taught how to behave in dangerous situations without the risk of causing physical harm. The FIVIS project attempts to apply this advantage to bicycles, as there seem to be no such simulators commonly available today. So far dangerous traffic situations are realized in general by scripted events, defined for each car or any other traffic agent. This process is tedious, inflexible and might require trainees to follow a specific route.

Thus, for the simulation of traffic agents in virtual environments, a cognitive traffic modeling approach is proposed that combines techniques from the field of traffic research and cognitive architecture research to address the stated challenges within a project called AVeSi ("Agentenbasierte Verkehrssimulation mit psychologischen Persönlichkeitsprofilen" – Engl. "Agent-based traffic simulation with psychological personality profiles").

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Modeling of Traffic Agents

The AVeSi project aims at developing an autonomous traffic simulation as an extension to the FIVIS bicycle simulator that achieves the aforementioned criteria of persistence and realistic behavior. The concept developed to fulfill this objective is based on previous research by Kutz et al. [5], who planned to utilize psychological personality profiles for traffic agents in virtual environments. The new concept extends these ideas and is summarized below.

Persistent Traffic Agents

An obvious way to save computation resources in traffic simulations for virtual environments is to remove traffic agents from the simulation once they leave the user’s field of view. This can lead to situations which are irritating to a user, but simulating all agents at all times would be too costly. Thus, the idea is to combine a microscopic simulation within the user’s vicinity with an additional macroscopic simulation, simulating traffic agents with less detail. Since traffic can be described by density and flow on a macroscopic level, fluid dynamics can be used to simulate it. Applying smoothed particle hydrodynamics (SPH) to approximate common numerical solutions is proposed to decrease processing time; similar to the approach presented by Rosswog and Wagner [6][7]. Simultaneously, this approach should establish a link between the macro and micro level, since the approach is based on individual particles. Rosswog and Wagner only briefly mention the macro-micro link as possible benefit of their method in [6], but do not provide any details.

Cognitive Traffic Agents

To achieve a realistic traffic simulation, agents need to show misbehavior like their human counterparts, but they must do so only in situations where it makes sense to an observer. Therefore, the authors believe that it is not enough to deviate from “normal” behavior by introducing fuzzy logic or random events, which is done frequently (e.g. [2]). Instead an agent must consider its current perceivable situation when determining its actions. For this purpose
the relevant cognitive processes should be modeled to induce realistic human behavior in traffic (e.g. perception, anticipation, decision making, etc.). Particularly modeling the influence of risk propensity on action selection will be a central aspect of the project. Other factors which affect the behavior as well (e.g. mood, age, gender, time of day, weather, etc.) might also be considered. The application of ideas from cognitive architecture research to the domain of microscopic traffic simulation is anticipated to achieve these objectives.

In conclusion, modeling persistent traffic agents whose behavior is inspired by human cognitive processes might improve road safety training applications, since they reflect real world traffic conditions more realistically. Implementing the current ideas might be challenging, but if successful, other driving/traffic simulators and in particular traffic simulations in digital games will benefit from this research as well.

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