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Design and evaluation of a user-centered interface to model scenarios on driving simulators

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ABSTRACT

Modeling scenarios on driving simulators is a complex and difficult task for end-users because they do not have the skills necessary to program the scenarios. In this paper, we present a user-centered architecture in which we have split the scenario modeling interface into 3 sub-interfaces (Template Builder, Experiment Builder, Experiment Interface) based on the user skill. The concept is tested with a panel of end-users, with fair results in terms of performance and subjective judgment.

1. Introduction

Driving simulators are increasingly used to study driving behaviors, road safety features and to design and evaluate Advance Driving Assistance Systems (ADAS). In order to carry out an experiment, the end-user (e.g. behavioral researcher, psychologists, human factor experts) have to prepare an experimental protocol, which involves scenario authoring (e.g. modeling traffic situations and vehicle maneuvers). Such a preparation requires technical and programming skills for which behavior researchers do not have any formal training in most cases. As a result, they depend on technical persons or scenario developers in their respective organizations, which in most cases is a time-consuming and frustrating process, due to communication problems between people with different backgrounds. Moreover, this is also a time-consuming task for the technical team.

A scenario in virtual reality applications typically involves a sequence of actions or events. In the context of driving simulators, a scenario can be regarded as "everything that happens in the simulator", which include specifying and controlling the ambient traffic and its attributes, the ambient environment and the simulation conditions, the route of the participants and their position, the traffic situations and other vehicles maneuvers Papelis et al. (2003). Some authors include both the layout (road network, terrain, driving environment: city, motorway, etc.) and the activities during the experimental trials (critical situations, vehicle maneuvers, etc.) in the concept of "scenario". Some other use the term "scene" to specify the layout and the term "scenario" to specify the activities during the trials (Kearney and Timofey, 2011). In the following, scenario refers to the specification of all activities including critical events, vehicle maneuvers and environment changes.

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In order to develop scenarios, end-users take technical and programming help from the technical persons and the scenario developers. There is a communication gap between the end-users and technical persons, as there is no standardized language or communication method between researchers and technical persons, while their technical background is often very different (e.g. psychologist vs. computer scientist).

One of the reasons why programming is a difficult task for end-user is that programs are abstract (Cypher and Smith, 1995). It is difficult for end-users to think in an abstract manner to implement the specific task rather than thinking about the situation in the real-world.

Every driving simulator provides a scripting language and a scenario authoring tool to develop scenarios. These scripting languages are powerful enough to develop any kind of driving scenario but they do not take into account the skills of the end-users: they are at quite low-level, and they have not been designed by addressing the issues of Human–Computer Interaction (HCI) (Newell and Card, 1985). According to Pane et al. (2002), user interface is one of the factors which can make programming a difficult activity for the end-users. The End-User Development (EUD) systems should fulfill the goals of end-users by taking their skills and objectives into account. In driving simulators, scenario modeling is a challenging task for the end-user because of two additional factors Kearney and Timofey (2011). First, the driving behavior is complicated and not well-understood, so it is challenging to create a reproducible and realistic traffic. The second factor is the variability of the driving behavior.

Thus, there is a need to develop a standardized and user-centered scenario authoring environment that enable and empower the end-user to develop scenarios using the skills they have. In this paper, we present a detailed user-interface (UI) that we have developed using the User-Centered Design (UCD) approach. The remaining sections of the paper are organized as follows. In the next section, we present the related work, which is followed by the details of our method. Then we propose the new interface and its evaluation by a panel of end-users, which is followed by a conclusion.

2. Related work

Significant work has been done to develop usable programming and authoring systems for the end-users in the past, for example Agent sheet (Ioannidou, 2003), Alice (Conway et al., 2000), Programming by Example (Cypher, 1991), etc. Every driving simulation platform provides different user interfaces for scenario authoring which range from textual to graphical format. They also differ in the way critical events and the traffic is specified.

For instance, ARCHISIM (Espie et al., 1994), developed by IFSTTAR, uses textual statement described in a text editor (notepad-like) to specify scenario objects and critical events. They use if-else statements in textual format. The traffic and the critical events are specified in different text files. The SCANeR Software (Reymond et al., 2000) developed by OKTAL SA, uses a graphic way to model scenarios. Scenario objects (Vehicles, Traffic signals, etc.) are placed using the mouse, and scenarios are modeled using Condition-action pairs (If-else statements) in the authoring environment. A more recent example is STISIM (Park et al., 2011) developed by System International, which uses textual statements in their SDL (Scenario definition language). Scenario objects and critical events are described using SDL.

Wassink et al. (2005) proposed a movie set metaphor to generate scenarios dynamically based on Green Dino Virtual Realities' Dutch Driving Simulator. They have proposed the movie set as a driving simulator, where actors (vehicles, pedestrians, etc.) come at the scene and play certain set of roles, which are assigned to them in the script. They have also emphasized on the problem of end-users to model scenarios using a scripting language. A tile-based approach is also used to specify scene and scenario elements in the driving simulator. The world (scene) is divided in tiles, which are configured, assembled and then loaded into the driving simulator during the experimental trial. A "tile" is a section of the route which contains elements like roads, traffic signals, buildings, trees and scenario objects. They are grouped together and loaded using an interface or specifying the tile sequence. In some systems, tiles are static and may not be altered or moved during the experiment run (Papelis et al., 2003), while in other systems tiles as well as data about the tiles (scene objects, scenario objects) can be altered dynamically during the experiment run (Suresh and Mourant, 2005).

3. Method

We have used the User-Centered Design (UCD) approach to model scenarios. UCD methods claim to provide an end-product, which satisfies the users and enable them to achieve their goal while taking their profile into account. For this, we first conducted a user survey, to understand usability problems of existing driving simulator softwares. From this survey, a new approach was proposed and a prototype software has been built. Finally, the proposed prototype was evaluated with a new panel of end-users.

3.1. User survey

Nineteen driving simulator users were interviewed. They had an average of 2 years experience working with driving simulators, and 7 out of 19 had no programming experience at all. In their previous experience, these users always needed help (total or partial) from the scenario developers. For more detail about the survey see Bhatti et al. (2011).