Chapter 34
An Artificial Intelligence–Based Vehicular System Simulator

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ABSTRACT

This paper presents a vehicular system simulator, which enables the human player to race a car against three system-controlled cars in a three-dimensional road system. The objective of the vehicular system simulator is not to support defeating the opponent in a car race, but to provide the player with a challenging and enjoyable racing experience. Therefore, it is important that the system simulates human driving behavior and adopts cognitive computing. The paper discusses development of the vehicular system simulator using the artificial intelligence (AI) techniques that are supported in the game engine of Unity. The design and implementation of the vehicular system simulator are presented. The discussion includes some possible extensions of the current version of the system so that it can be adapted to be a simulation system for education purposes

1. INTRODUCTION

A vehicular system simulator provides a popular game environment. In a traditional game like chess, a situation is presented where "players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" Salen & Zimmerman (2004). Such artificial conflicts are often represented as a puzzle or a challenge, and having the puzzle solved or the challenge resolved provides a real-world purpose to the game players (Liu et al., 2011). These games are sometimes referred to as "serious" games (Wood & Reiners, 2012), but they have been increasingly replaced by electronic games, especially for the "game generation" (Prensky, 2001) of "digital natives". This younger generation of game players typically grew up playing games and, in contrast to the "digital immigrants" (Prensky, 2001) of the older

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generation, they are adapt in "dealing with large amounts of information quickly even at the early ages, using alternative ways to get information, and finding solutions to their own problems through new communication paths" (Akilli, 2007).

The Artificial Intelligence (AI) field has witnessed a similar transition from the "classical AI games" such as Samuel's Checker Player (Samuel, 1967) and Waterman's Poker Player (Waterman, 1970) to the contemporary AI techniques adopted in electronic games. The goal of the game is no longer a quantifiable outcome of winning over the opponent as in the case of a checker or poker game. Instead, a contemporary game contains changing environments, multiple objectives, and dynamic aspects of the game that are revealed to the player as the game unfolds. The objective is to offer to the human player an enjoyable experience through his or her interaction with the game, and this does not involve any specific quantifiable outcome.

The vehicular system simulator has been developed as a racing game, called Racer, with the goal of offering to the player a challenging and enjoyable experience in a car race against a system-controlled car. Although the player's goal within the game is to win the race against the system-controlled car, the AI techniques adopted in the game are primarily designed to give the player an enjoyable time racing his or her car. In other words, the objective of winning by either side is not given the highest priority.

This paper proceeds as follows. Section 2 provides some background literature relevant to the work. Section 3 presents some components of the vehicular system simulator. Section 4 presents implementation of the vehicular system; Section 5 discusses some AI techniques adopted in the vehicular system simulator, their effects on system performance, and some exploration on feasibility of extending the current system into an educational software system useful for teaching transportation engineering concepts. Section 6 includes the conclusion and some ideas on future directions of the work.

2. BACKGROUND LITERATURE

Some research studies on cognitive vehicular systems are briefly summarized as follows. Xie & Xu (2015) provided an overview of the algorithms and technologies useful for extracting static properties of vehicles from videos so as to support criminal and traffic violations. With the rapid growth of the video surveillance technology, a large database of video and images has been created. The database can become an important resource for police in performing traffic events analysis: crucial information such as speed and license plate of vehicles can be extracted and examined. Yoshizawa & Iwasaki (2015) examined a type of driving behavior, called "aimless driving", which is responsible for a large number of fatal traffic accidents in Japan. The study investigates this "aimless driving" behavior by giving subjects non-visual secondary tasks of four difficulty levels while they watch pedestrians and their responses to objects in the road on which they travel are measured. The results indicated that even non-visual tasks influence eye movement and the subjects were not able to react well to objects on the road. Xu et al. (2014) studied the use of semantic technologies for annotating videos so as to enhance comprehensibility of the videos. Their work proposed a video annotation platform, which supports users by providing a search interface of annotated video resources. Some preliminary results indicated that applying semantic technologies for annotation of videos can enhance reusability, scalability, and extensibility of the video resource and support increased adoption of this resource for traffic events analysis.

Much research work that focuses on developing AI-controlled components of game systems called "bots" can be found. These "bots" approximate or emulate human game playing styles. Development of the "bots" often has been motivated by the belief that a human player's enjoyment in the gaming