Knowledge-Based Systems 34 (2012) 97–113

Contents lists available at SciVerse ScienceDirect

Knowledge-Based Systems

journal homepage: www.elsevier.com/locate/knosys

Improving game bot behaviours through timed emotional intelligence

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ARTICLE INFO

Article history:
Available online 21 April 2012

Keywords:
Games
Computational intelligence
Emotions
Fuzzy control
Fuzzy markup language
Timed automata

ABSTRACT

The video game industry is a very active economic sector focusing on the design and development of entertainment applications. In this sector, different enterprises compete to design innovative video games that exploit physical and emotional capabilities of video gamers in order to achieve high levels of realism. From this point of view, video games research should be enhanced by introducing: (1) novel methodologies for modeling emotions that depict the behaviour of different characters populating a virtual environment, and (2) some abstraction technologies useful to "move" this emotional intelligence on different game platforms without additional efforts. In this paper, innovative computational intelligence techniques, like the Timed Automata based Fuzzy Controllers, have been hybridized with emotional representation methodologies in order to provide game bots with human-like capabilities and, as a consequence, improve the realism of game under design. In order to allow different competitors to exploit our "emotional engine" on different hardware platforms, the Fuzzy Markup Language (FML) has been chosen to be the main technology for designing and implementing the bots behaviour. As shown in a case study based on Unreal Tournament 2004, the game bots exploiting our approach provide a more human-likeness behaviour if compared with simple finite state automaton based bots.

1. Introduction

The entertainment industry started its golden age in 1978 with the release of *Space Invaders*, a killer-app that inspired dozens of manufacturers to enter the video games market. In particular, this game stimulated several software houses to design and develop hundreds of video games compatible with different popular consoles and computers made by pioneers of home entertainment such as Atari, Apple, Commodore, Sinclair, ColecoVision, and Mattel. These games were mainly based on elementary interactions among video gamers and a collection of simple virtual entities, being characterized by the absence of emotions and personality. The first attempt to provide these entities with unsophisticated personalities was made by *Pac-Man* programmers that designed each ghost enemy with its own distinct behaviour in order to keep the game from becoming impossibly difficult or boring to play; the real personality of all enemies has been described in more detail only at the 2011 Game Developers Conference where Pac-Man programmers stated that the red ghost would chase Pac-Man, the pink and blue ghosts would try to position themselves in front of Pac-Man's mouth,[1] whereas the orange enemy's behaviour was randomly selected.

Since golden age era, the entertainment enterprises have been trying to enhance cognitive aspects of video games and, in particular, competing for developing innovative and realistic video games that exploit both emotional and physical characteristics of video gamers. This challenge has resulted in the development of creative systems able to strongly involve video gamers inside virtual environments and, as a consequence, make video games more attractive than entertainment applications that do not take care with physical and emotional status of human players. From this point of view, video games control systems such as Nintendo Wii™, Sony EyeToy™ and Microsoft Xbox Kinect™, enhance gamers' capabilities by introducing meaningful whole body gestures and, as a consequence, accommodating a plethora of physical inputs that are strongly related to the emotional status of human player.

Nevertheless, in order to further improve the emotional features of next generation video games, some formal and efficient methodologies should be introduced so as to provide video game characters (and not only human players) with additional properties such as *personality*, *likes* and *dislikes*, *emotions*, *moods* aimed at improving their *human likeness* and *believability* [1]. However, as stated by different psychology studies, a full understanding of emotions and emotion characteristics could only be reached when their dynamic nature is taken into account. Indeed, emotions unfold over time and, depending on external as well as internal events, their intensity level may continuously change so as to generate high variability in a human behaviour [2]. As a consequence, human emotions and moods can be artificially imitated only if

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[1] http://www.cnbc.com/id/41888021.

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http://dx.doi.org/10.1016/j.knosys.2012.04.012

their dynamical characteristics are opportunely analyzed. This choice will put players more deeply into the game story, make them feel alive and, consequently, create entertainment scenarios characterized by high level of realism.

In order to achieve this goal, this paper proposes a novel cross-platform architecture (whose preliminary version is presented in [3]) meant to model Non-Player Characters (NPCs) behaviour by taking into account different features such as emotions, personality and dynamic selection of actions, and strongly improving NPCs' human-likeness. This result has been mainly achieved by merging some theories from psychology area, OCC [4] and OCEAN [5], together with an innovative computational intelligence technique named Timed Automata based Fuzzy Controllers (TAFCs) [6,7] that, unlike conventional fuzzy systems, models inference engine whose performance is strongly depending upon temporal concepts. OCC and OCEAN are simultaneously used to model the personality and the collection of emotions that characterize the behaviour of a given NPC, whereas, TAFCs are used as a decision making system able to analyze the video game virtual environment and the NPCs' emotional state in order to select the most suitable actions improving NPCs human likeness at a given time. Our proposal represents the first attempt to put together relevant concepts, such as time, emotions and personalities, which strongly influence the human being's behaviour, in order to define a so-called *timed emotional intelligence* useful to enhance video game bots from a human likeness point of view. This hybrid approach has been developed by using the Fuzzy Markup Language (FML) [8], a computer language useful for implementing fuzzy systems in a hardware-independent way. This choice will allow different competitors to implement the proposed approach for modeling bot behaviours on different game platforms (such as Sony PS3, Microsoft Xbox 360, and Nintendo Wii) in a simple and direct way.

Our approach for cross-platform timed emotional intelligence has been tested by interfacing it with a collection of tools, such as UnrealEngine, GameBots 2004 and Pogamut, that are usually used for the design of video games bots. In particular, a framework capable of generating a network of NPCs and monitoring and evaluating their matches has been developed. In order to estimate the human likeness obtained by the proposed approach, a Turing test has been performed, since, even if it was not intended to, Turing's test is considered as a reference for believability evaluation [9].

2. Related works

In the last years, several efforts have been led in order to model video game bots with a human-like behaviours and to achieve a greater enjoyment in playing video games. In particular, in [10], in order to design interesting opponents, the authors propose to teach a computer opponent to play like a human using machine learning techniques. Similarly, in [11], the authors introduced *Dynamic Scripting*, an online learning technique based on the use of reinforcement learning to adjust a mechanism for selection to choose between various scripted behaviours. The stochastic selection mechanism and the online learning provided the play with a degree of unpredictability so to make it more human-likeness. In addition, in [12], the authors studied a Bayesian-based approach to the derivation and imitation of human strategic behaviour and motion patterns in commercial computer games. They demonstrated the effectiveness of their approach in producing convincingly human-like game agents in conjunction with the believability-testing system. Finally, in [13], the authors propose a method for generating natural-looking behaviours for virtual characters using a data-driven method called behaviour capture. In details, they describe the techniques for capturing trainer-generated traces, generalizing these traces and using the traces to generate behaviours during game-play. The work presents several trace generalization mechanisms, including a technique that learns a Hidden-Markov Model (HMM).

However, all these works do not deal with emotions, which are an essential component of the believability of embodied characters interacting with humans [14–16]. Therefore, in order to provide bots with a more believability and induce a player to participate in the game story more deeply so to transform a game into an "intense emotional journey" [17], the last researches have been studying computational models to include emotions and personality in the bot behaviours. In particular, in [18], the authors describe the design and implementation of a module of emotions and personality for synthetic actors. In details, the designed model is implemented using fuzzy logic, Finite State Machines (FSMs), and probability theory. The functionalities of the module were shown using a demo version implemented by the videogame engine Unreal®2 Runtime. Another example is provided in [19], where the authors propose a kind of robotics inspired behavioural AI techniques to simulate characters' personalities in a commercial video game.

Although the above said works improve the state of the art related to the modeling of NPCs, they still suffer from a lack of temporal concepts management which strongly influences the emotional state of an intelligent entity. Indeed, let us consider a human being under stress and let T be a timer that counts the number of minutes during which this human being works under stress; it is clear that the human beings actions will change when T and stress intensity grow. This example shows how intelligent entity's actions depend on a combination of emotions and time.

Therefore, in order to overcome this temporal weakness, our idea is to exploit dynamic fuzzy engines, named TAFCs, capable of modelling NPCs behaviour in a fuzzy and time-dependent way by analyzing emotions and personality of the intelligent entity under design.

3. Background knowledge: OCC/OCEAN approaches, TAFCs and FML

The goal of this paper is to propose a novel cross-platform architecture enhancing the modeling of Non-Player Characters (NPCs) behaviour by taking into account different features such as emotions, personality, and dynamic selection of actions. This aim is achieved by merging some theories from psychology, like OCC and OCEAN, together with an innovative computational intelligence technique named Timed Automata based Fuzzy Controllers (TAFCs). Moreover, our proposal has been developed in a hardware-independent way through the exploitation of an XML-based computer language, called Fuzzy Markup Language (FML).

Therefore, in this section, before presenting our approach in a detailed way, a description of the OCC/OCEAN approaches, TAFCs and FML is given.

3.1. OCC/OCEAN approaches

There are several emotion models available in literature [22,23]. However, the so-called OCC model developed by Ortony, Clore and Collins has established itself as a standard model for the emotion synthesis [16]. This model considers emotions as valenced reactions to three kinds of stimuli: *consequences of events*, *actions of agents*, and *aspects of objects*. These stimuli are appraised according to individual's goals, standards and attitudes. Specifically, an individual judges the following [24]:

- the desirability of an event, i.e., the congruence of its consequences with individual's goals (an event is *pleasant* if it helps the individual to reach his/her goal, and *unpleasant* if it prevents him/her from reaching his goal);