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RESEARCH ARTICLE

Modeling believable agents using a descriptive approach

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Abstract
The concept of believable agents in game and simulator design has become increasingly important. This is because the improved realism offered by synthetic agents can lead to the increased popularity and prolonged life of electronic games. This paper offers a model for the development of believable agents. Specifically, this paper proposes the use of a descriptive approach to agent design. Using this approach, in-game agents are designed to learn human emotional responses from real world data. To achieve this, training data was collected and fed to the descriptive learning believable agent model. Further, we conducted a comparative study to determine whether agents designed using this approach were more believable than agents designed using more traditional approaches. The findings from this study revealed that the descriptive learning agent was perceived by study participants to be more believable than the agent that was programmed according to the specifications of two third-party agent developers.

Introduction

Over the past decade, there has been enormous growth corpus of data concerning the emotions, behaviors, and opinions of persons given certain real-world events and situations. This creates new opportunities for game and simulator designers to mine this data to unearth valuable information concerning human reactions to events.

We believe that enabling the interactions between this type of data and virtual environments presents an opportunity for modeling personality-rich characters for games and simulations.

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What are believable agents?

An agent can be described as anything which perceives and influences its environment (Russell & Norvig, 2010). Human agents perceive their environment through their senses, and influence it through their hands, legs and other body-parts. Robotic agents may achieve perception via the use of cameras, lasers, sonar and infrared range finders, while they may influence their surroundings through various motor and other mechanical appendages. Software agents perceive through keystrokes, the reading of file contents and other input mechanisms, and act on their environment by displaying on the screen, writing to files, etc. Believable agents are types of software agents that are designed to be perceived as realistic, in their (on-screen) appearance and behavior. They are personality-rich, autonomous (self-controlled) and inhabit the virtual worlds of video games, simulators, and interactive stories (Loyall, 1997).

Believable agents in industry

Enhancing the believability of agents is becoming increasingly important for the Computer Science industry, particularly the Electronic Gaming industry. This is because increasing the realism of autonomous game agents creates a more immersive experience for players and this leads to benefits such as better-selling games as a result of improved customer satisfaction; increased game title loyalty and; prolonged game life-cycles (Tozour, 2002; Vitale, Williams, Johnston, & Boccignone, 2014).

Fortunately, over the past decade there has been significant development in the fields of 3D Graphics, Artificial Intelligence (AI) and Machine Learning (ML). Accordingly, game developers have used these new techniques from these fields in video games and virtual world simulation. Indeed, game and simulation developers are increasingly using cutting-edge 3D Graphics, AI and ML techniques to design better agents to populate the virtual worlds they have created.

Believable agents in academia

Believable agent development is also an area of active research. This is because creating more realistic agents can lead to better models and simulations of human behavior. Creating better models of human behavior can aid in the prediction and analysis of this phenomenon. Results from this type of research have found applications in areas like Human Computer Interaction (HCI), User Interfaces (UI), Animation, and Human Resource Selection and Training.

Furthermore, some researchers expect that the study of believable agents will help achieve the ultimate goal of creating a ''strong AI" machine capable of passing the Turing Test. One reason for this view is because — according to Picard (1995) — in order to pass the Turing Test computers must be able to perceive and believably express behaviors based on emotions the way a human would expect.

Scope and contribution

Presented in this paper is a brief review of the believable agent literature; in addition, we propose a framework for the development of a descriptive believable agent named Bob. Bob along with his virtual environment, known as the Cricket Fan Game, was used to test the theory proposed in this paper. The descriptive believable agent named Bob has (artificial) intelligence, personality, emotions, physical appearance (not designed by us), sensors, actuators, and many more attributes. However, the scope and contribution of this paper will be limited to an analysis of the first three aspects of agent believability.

Outline of paper

The remainder of this paper is organized as follows. Secti on 'Background' gives an overview of the background literature that encompasses our study of believable agents. The architecture and design of the virtual environment and the descriptive believable agent are presented in Section 'System design'. In Section 'Enhancing believability' the current study is outlined. The results and findings of our study are presented in Section 'Results'. Conclusions and future work are presented in Section 'Conclusion and future work'.

Background

The use of emotion and personality models to influence agent behavior is well studied. Indeed, since Reynolds' (Reynolds, 1987) seminal paper on the use of a non-scripted behavioral approach to synthetic agent movement, there have been numerous works published on the use of behavior models to influence agent behavior (Loyall & Bates, 1997; Sellers, 2013).

In this section a brief review of the literature in Artificial Intelligence (AI) and Machine Behavior Models, and Personality and Emotion models is presented. Work in these areas has led to advancements in the development of autonomous synthetic agents. As a result, these fields set an overarching framework for our study in believable agents.

AI and machine behavior models

The term AI has been defined in various yet similar ways, and according to Russell and Norvig (2010), these definitions can fall into one of four categories. Firstly, those which are concerned with whether machines think like humans. Secondly, those which are concerned with whether machines think rationally. Thirdly, those which are concerned with whether machines act like humans (*descriptive* approaches). Finally, there are those definitions that are concerned with whether machines act rationally (*normative* approaches).

Accordingly, a machine that behaves rationally/logically can be described as a normatively rational machine. That is, one that utilizes a decision-making process that is based on making choices that maximize benefit or expected utility.