An Extensible Game Engine to Develop Animated Facial Avatars in 3D Virtual Environment

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ABSTRACT

Avatar facial expression and animation in 3D Collaborative Virtual Environment (CVE) systems are reconstructed through a complex manipulation of all details that compose it like muscles, bones and wrinkles in 3D space. The need for a fast and easy reconstruction approach has emerged out in the recent years due to its application in various domains; 3D disaster management and military training etc. These details simulation must be as realistic as possible to convey different emotions according to the constantly changing situations in CVE during the runtime. For example, in 3D disaster management, it is important to use dynamic avatar emotions; firefighters should be frightened when dealing with a fire disaster and smiling when treating injures and evacuating habitants. However, the solution of facial animation remains a challenge that restricts the rapid and ease development of facial animation systems. In this work, the author presents extensible game engine architecture to easily produce real-time facial animations using a script atomic action without having to deal with control structures and 3D programing language. The proposed architecture defines various controllers, object behaviors, tactical and graphics rendering, and collision effects to quickly design 3D virtual environment. Firstly, the author gives the concept of atomic expression, and the method to build a parametrized script file according to the atomic expression. Then the author shows the validity of the generated expressions based on the MPEG-4 facial animation framework. Finally, the feasibility of the proposed architecture is tested via a firefighter scenario. The author’s approach has the advantages over previous techniques of fitting directly an easy and faster technology with a high degree of programming independence. The author also minimizes the interaction with the game engine during the runtime by injecting dynamically the XML file into the game engine without stopping or restarting the engine.

KEYWORDS
Atomic Story, Avatar Facial Animation, Faces Expression, Game Engine, Networked Virtual Environment, Virtual Reality, XML

1. INTRODUCTION

3D facial animation reconstruction approach has been an active area of research in 3D Collaborative Virtual Environment (CVE). The need for new approaches that handle CVE runtime extensibility requirements without a complex 3D data manipulation and engine restarting has emerged out in the recent past few years due to its application in realistic facial animation for 3D disaster management. Such a requirement is vital for very large critical virtual environmental applications like military training, emergency preparedness scenarios, and E-shopping. Every year, Saudi Arabia receives about three million people to perform Al-Hajj in Makkah. Two incidents (Hajj Incidents, 2016) occurred in
2004 and 2006 during the stoning ritual in Mina (ramy al-jamart) where more than 500 were killed and about 500 injured. Rescuers went to the scene, and security officials attempted to control the crowds to prevent further crushing. Due to the absence of information and technologies in-place, no clear picture has been given of what caused accidents. It is important to have a believable virtual environment to prepare a backup rescue scenario with an acceptable response time whenever there is a need.

The integration of the avatars’ face animation as an on the fly feature remains a challenge and require an important amount of work for qualified artists with a strong knowledge in facial anatomy. Each player in the CVE is represented by a 3D body called an avatar (Hasgand, 1996), which allows the players to see, interact, and hear each other. The ability to change and extend a 3D collaborative virtual environment (CVE) without having to stop it is an important non-functional requirement especially when used for critical applications such as military training, and disaster management systems. Application services should be available around the clock without interruption. In related approach most widely used in CVE, changes in the requirements are followed by changes in the game engine and are time consuming. Broadly, 3D objects and avatars’ faces may change in various ways to give the users a visual display about the actions that are being applied to the objects or embed animation modeling into an avatar according to the constantly changing situation in the game portfolios. Traditionally, any modifications in the virtual environment system require collaborative efforts from graphic designers and 3D programmers to generate a new game scenario, then stop the engine to inject the new scenario, and finally restart the engine to reflect the new modification in the 3D space. Several research studies on 3D disaster management have been proposed to model human behavior and offer true-to-life VE. However, there is still a lack of studies that can adequately present avatar animation in emergent situations as shown in (Bourkerche et al. 2005; Information Technology, 2000; VRML Online; 2016) in real time without stopping the engine. Its representation structure is complex to parse and visualize, so that it requires professionals, and time with additional cost to develop playable game description.

We proposed to develop a modular game engine architecture based on atomic simulation concepts in order to facilitate the generation of new game scenario on the fly when avatar behavior requires changes. The engine hides the low level details needed in CVE, thus allowing users to focus on the higher-level functionalities of the application and guarantee continuity during runtime. The game engine is designed to separate the language used to implement the game from the game scenario and offer flexibility and simplicity to the user when modification is required. We integrate a scripting story interpreter component in the game engine to control and manage avatar face animation changes. We found that using a game description language called eXtensible Virtual Environment Markup Language (XVEML) as a general-purpose of event-based state machine language can make the development easier and faster during the runtime and discharge designers and professionals’ programmers. The envisioned criteria of XVEML are: the language should be easy to parse and visualize, human readable, and unambiguous. Its terminology should be highly expressive and extensible to adapt any type of CVE application. A fire disaster management application would appreciate such changes as fire propagation and weather patterns, a car racing game would be more concerned with collision and road friction.

The XVEML provides hierarchical structure content for simulation description, objects behaviors, and avatar facial animation to facilitate automatically generated new game scenarios, in such a way to enable playable game description. We choose MPEG-4 Facial Animation Parameters (FAP) for avatar facial animation (Noh & Neumann, 1998; Pandzic &Forchheimer, 2002) to validate and recognize the accuracy of the generated avatar facial animations. The purpose of the validation approach is to help the 3D graphic designer to build the required facial deformation structures more clearly and with
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