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学 位 論 文 題 目	Enhanced Environments：Real－time Eco Systems in Virtual Reality （高次複合環境：バーチャルリアリテイにおけるリアルタイム生態系）
学 位 論 文 審 査 委 員	（主査） 教 授 小 鹿 丈 夫 （副査） 教 授 後 藤 宗 弘 教 授 藤 田 廣 志

論 文 内 容 の 要 旨

Abstract: This Dissertation research proposes a new method for using real-time information to eventually support large-scale, climatic virtual environments that foster virtual life and natural eco-behavioral conditions. The purpose of this research is to create an enhanced environment where the hydrological conditions and the real user are integrated into an immersive, real-time eco system. For this research experiment, we customized available GIS satellite, terrain, and photography data to construct a highly accurate, large-scale virtual environment. Next a web-based climatic collection system was developed to persistently collect real time weather information for the physical area being modeled. Finally an Enhanced Environment Module was created to support a 'living' virtual eco-system supporting real-time climatic conditions. This type of enhanced environment lays the groundwork for creating dynamic environments that integrate the behavioral patterns of climate, artificial life, user interactions and their complex interrelationships within a dynamic virtual world.

The questions being explored in this dissertation are:

1. Can we use real-time streaming data in dynamic virtual environments?
2. Does it have Utility, or, is streaming data useful in controlling various functions within dynamic virtual environments?

3. Can data integrity be maintained and still be meaningful to the user?

Rapid advances within the GIS/ Visualization Simulation industry have developed complex and rich real-time environments or modeling and simulation of large-scale virtual environments. In parallel, there is deep exploration within the artificial life community to develop virtual life and worlds that exhibit simulated living traits. From the Computer graphics industries, high resolution, highly accurate work is being done to create stunningly beautiful virtual environments with realistic rendering. The Gaming industry has also been developing high computing performance, realistic world building, artificial life behavior, massive multi-user networks and high-action immersive role-play. Unfortunately, little cross-integration has been done between these strands as the technical hardware/software requirements, computational overheads demanded by each, and the wide application focus has promoted separate development paths. Yet recently there have been hybrid development styles emerging that promote this integration. This new type of 'hybrid integration' across previously separate disciplines brings new questions, solutions and problems.

Mainly the focus of this new hybrid technology usage is the "Electronic Battlefield", or synthetic environments that simulate a wartime battlefield situation. SEDRIS (Synthetic Environment Data Representation and Interchange Specification) environments tend to be large scale, low resolution with an expensive overhead in hardware and software. Its complexity and depth has grown quite quickly since 1994 in the areas of GIS, terrain simulation, hydrology, modeling, distributed database and massive multi-user environments. Other solutions do exist to support this style of synthetic environments and Large Scale Visualization Industry, yet the research is primarily focused upon simulation and visualization representation of specific environmental conditions, with little or no emphasis upon a persistent, complex evolvement of an eco-system style virtual environment.

The Questions this research addresses are whether integrating these technologies together can in fact, yield a highly immersive, realistic virtual environment that is complex and dynamic, exhibiting living behavior conditions and ultimately generating the emergent properties required to create and sustain virtual 'life' on a PC-based computer and still retain an acceptable performance ratio. The focus of this research is not to offer another solution to the already saturated vis/sim, artificial life, and computer graphics or gaming industries. Rather, the focus is upon using these existing technologies in a hybrid style of integration to support highly accurate, large-scale, climatic eco-systems that can be used to support realistic behaving environments. This Dissertation will present research performed on this topic, provide the approaches used, and conclude with an analysis of the results.

論 文 審 査 結 果 の 要 旨

This research proposed a unique method for using real-time information to support large-scale, climatic virtual environments exhibiting natural eco-behavioral conditions. The purpose of this research was to create an 'enhanced virtual environment' where the hydrological conditions and the real user are integrated into an immersive, real-time eco system. For this research experiment, we customized available GIS satellite, terrain, and photography data to construct a highly accurate, large-scale virtual environment. Next a web-based climatic collection system was developed to persistently collect real time weather information for the physical area being modeled. Finally an Enhanced Environment Module was created and added to an existing game engine to support a 'living' virtual eco-system with real-time climatic conditions.

The results of this research indicated the following key points;

1)   It is feasible to use real-time information to control a virtual environment, and that real-time data in fact could have utility or meaning in controlling weather conditions within the virtual environment.

2)   Data integrity could be preserved throughout the conversion from one format to another, despite the substantial errors created in resampling across different platforms and technologies.

3)   Inexpensive hardware and software systems are now advanced enough to process complex virtual environments and begin developing rich, meaningful virtual environments.

This research also addressed the challenging problems of a hybrid system where many of the current formats being used in one discipline are not readily acceptable in another. It addressed the problem of technology accessibility, where a highly accurate,

visually stunning enhanced environment could be built and distributed over the Internet by almost anyone on fairly inexpensive computers. And finally, it probed into the realms of complexity to set an initial foundation for developing a new style of more naturalistic virtual environments, or "Enhanced Environments" where natural real-time data streams are used instead of artificial algorithmic simulation.

In future works, this research provides a strong foundation for creating more compelling virtual environments and establishes a structure for building artificial life and other evolvable characteristics of life within a virtual environment.
Several new research directions have been created from this research in the areas of intelligent GIS virtual environments and location aware computing systems. These systems will utilize the ever growing amount of available, ubiquitous real time information, to provide users with next generation enhanced environments.

最 終 試 験 結 果 の 要 旨

公聴会後に学位論文に関する口頭質問を行い、これを最終試験に代え、合格と判定した。

以上