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Bio-edutainment: Learning life science through X gaming

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Abstract

Learning through gaming is one of the natural ways for knowledge and skill acquisition. This paper presents our work on bio-edutainment. Playing X games not only allows low age students to learn bio-molecular structure but also enables better understand complicated structure of bio-molecules. Immersive and interactive games may potentially motivate students to develop their interest to explore the wonder of life science. Based on our core Virtual Reality technology, the bio-edutainment system developed consists of mainly three components of visualization, modeling and interaction. Enabling technology includes also GPU technology, Networking, sensor technology and so on. The system was exhibited in Singapore Science Center.

Keywords: Edutainment; VR; Computer gaming; Biology; Protein structure

1. Introduction

Learning, a synonym of acquisition and eruditeness is the cognitive process of acquiring skill or knowledge according to Webster's Dictionary. In psychology, learning is defined as the processing of information, motivated by experience, leading to relatively permanent changes in behavior, increases in knowledge and improvements in abilities [1–3]. In animal world, it is crucial for young animals to develop their hunting skills through play. Playing is obviously a natural way of learning to human, especially kids [4,5–7]. Having fewer ways in communication, kids make use of play as their major technique for self-expression and social behavior. Human play is a fun-filled yet voluntary activity. Through playing, players engage in behaviors that mimic reality [8,9].

Even though it is a very old and traditional approach, learning through playing in education is yet to be fully and systematically exploited. This is partially due to factors such as the lack of effective technological support and insufficient attention from educators [10]. With the latest advancement in computer science and technology, edutainment is being increasingly recognized as a technology for fundamental learning. Today, computer games have become part of children's culture [11]. With game-based fun learning software, traditionally dull syllabus of education can be possibly implemented in a more vivid and fun fashion [12–14]. MIT and Microsoft are jointly developing the *Games-to-Teach Project* aiming to conceptually prototype the next generation of interactive educational entertainment for mathematics, science, engineering, humanities and social sciences [15].

A good game design comes with good content, graphics, color, animation, and sound. They provide the sensory of the game, which is creating realism to the user. Computer simulation technology [16–18] plays a

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vital role in game design and development for innovative learning in various applications from business to surgery [19–21]. As an emerging technology, Virtual Reality (VR) has found many applications [22–25] in design, engineering, surgical planning and treatment, military training, flight simulation, and so on. VR is a computer-integrated system enabling users to create, visualize and interact with the virtual world. It also allows users to feel immersed in a VR environment through stereographic and haptic interfacing.

In this paper, we will discuss our VR enhanced immersive games for fun learning of molecular biology. The rest of the paper is organized as follows. Section 2 discusses the fundamentals of bio-molecule learning with emphasis on protein structure. Section 3 describes our core VR-enhanced game technology for modeling, visualizing and interacting protein structure. Section 4 further details the X game design in terms of contents and prototypes. Section 5 concludes this research.

2. Protein structure learning

The Human Genome Project (HGP) was launched in the USA in October 1990. Its objective is to discover the secrets of human genome [26]. A milestone announcement was made, in July 2000, for the breakthrough advancement with the HGP [27]. The advent of completely sequenced genomes is the first stage towards a good understanding of human beings: biological structure, functions and eventually treatment of various diseases. From the view of molecular biology, genes are the DNA molecular segments carrying certain information of biological inheritance that performs a certain biological function at a specific condition. While the sequence information base is exponentially growing today, adequate structure and function of individual genes and proteins are far beyond the identification.

Education of structural biology will play a crucial role in the post-genome era. As bio-molecules are complicated biological systems, to understand the 3D structure and the function relationships are increasingly important to modern molecular biology. The overall folding of the structure and the information at the active sites, have shown evolutionary relationships with its 3D structure [28]. Traditionally, biological education relies upon classroom teaching and wet lab experiment as two major components. In routine classroom teaching, physical models in an enlarged size made of wooden, metallic or plastic material are often used to show students bio-molecular structures. Unfortunately, this is constrained by the limited number of bio-molecule models physically produced. Besides, the number of known proteins being discovered is increasing in an

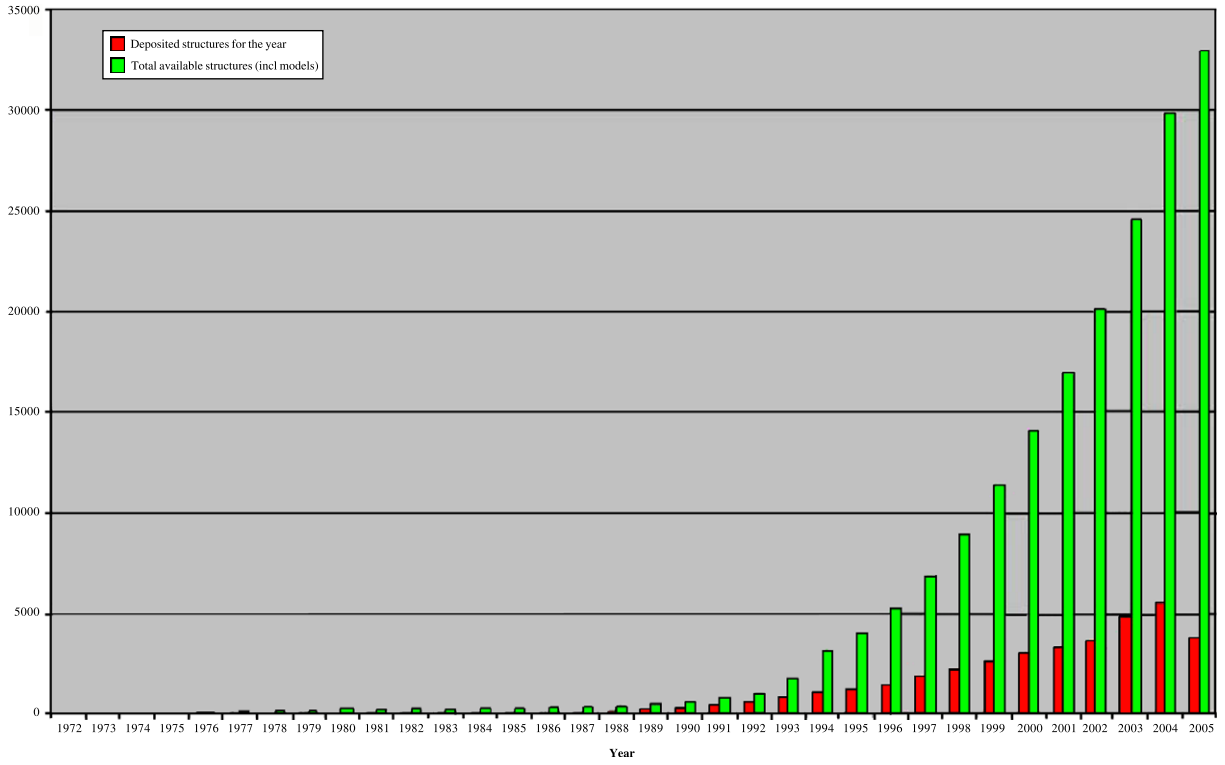

Fig. 1. Proteins deposited in PDB.