UFC-CRAb: A group on Computer graphics, virtual Reality and Animation

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Abstract—This paper describes the history, mission, objectives, research lines and ongoing projects of UFC-CRAb, a research group on computer graphics, virtual reality and animation at the Federal University of Ceará (UFC).

Keywords: computer graphics; virtual reality; animation

I. INTRODUCTION

UFC-CRAb (http://crab.dc.ufc.br/joomla) is a research group on Computer graphics, virtual Reality and Animation, associated with the Masters and Doctorate Program in Computer Science (MDCC) of the Department of Computing (DC) at the Federal University of Ceará (UFC), Brazil (www.mdcc.ufc.br, www.dc.ufc.br, www.ufc.br).

UFC-CRAb is an interdepartmental research group, active in the areas of Computer graphics, Virtual reality and Animation, and involving researchers from two departments (Computing and Mathematics). The group was created in the year 2000, and incorporated the former Computer Graphics Laboratory of the department of Computing. Its mission is to contribute to the advancement of the areas of Computer Graphics, Virtual Reality and Animation, and to the formation of skilled researchers in the field. It also aims at applying computer graphics technology to solving problems demanded by society.

The group develops relevant projects in many areas related to Computer graphics (Meshing and Rendering), Virtual reality (Virtual Environments and Artificial Life) and Animation (Direct Dynamics and Controller Simulation). As examples of research topics in these areas, the group has been working on: adaptive meshing for applications in virtual reality and engineering; biologically-inspired generation of virtual characters and applications; realistic rendering methods and applications; collaborative virtual environments; sculpting; animation of virtual characters and clothing; development of efficient and adaptable graphics engines; and behavior of autonomous virtual characters.

UFC-CRAb offers an excellent infrastructure for graduate research at Masters and Ph.D. levels, and a friendly atmosphere that fosters teamwork and leadership. Since the beginning of the masters program in 1995 and the doctorate in 2005, the group has formed 23 masters, and, in 2011, it will form the first two doctors. Today, the group houses nine master students and eleven doctorate students, and take part in several inter-institutional cooperation and research projects. UFC-CRAb has maintained cooperation with Tecgraf of PUC-Rio in many areas related to Computer graphics, with the Cornell Fracture Group of Cornell University in the areas related to Meshing, and with the Animation Group of the University of California at Riverside in the areas related to Dynamic Simulation.

II. RESEARCH TOPICS

In this section, we present the ongoing research topics listed in Section 1. All the topics are either embedded in a larger project, or receive direct financial support from the Brazilian funding agencies CAPES, CNPq and FUNCAP.

A. Adaptive mesh generation for applications in virtual reality and engineering

This research aims at developing adaptive meshing algorithms for arbitrary 2D and 3D domains, as well as for parametric surfaces [23, 24] (Figure 1).

We have developed efficient algorithms for sequential and parallel processing of 2D domains with and without cracks, based on the Advancing Front Technique [6]. We also developed an optimized pattern-based adaptive mesh refinement technique using GPU [11]. A mesh generation technique controlled by curvature was developed for 3D parametric surfaces [23].

Currently, we are extending the sequential and parallel techniques: to generate meshes of convex quadrilateral elements for arbitrary 2D domains and surfaces; to generate meshes of tetrahedral and hexahedral elements for arbitrary 3D domains; to generate surface meshes for non-manifold problems.

Figure 1. Mesh generation of a parametric model of a tire.
B. Biologically-inspired generation of virtual characters and applications

This research line uses the biological concept of diploidy, and simulates the gamete generation process of meiosis. After fecundation, a simulated chromosomal data structure is used to construct the virtual characters [30]. That idea has been applied to generate diversity [31, 32], and to transmit traits from ancestors to descendants [33, 34, 35, 36, 37]. Recently, it is being applied in a research for solving the missing persons problem [3] (Figure 2).

The next steps in our research are: the extension to full-body representation; the inclusion of growth model to represent body and facial changes from childhood to adulthood; and inclusion of an aging model.

C. Collaborative virtual environments

The focus of this research is on mapping requirements specified in the area of CSCW (Computer Supported Cooperative Work) to networked virtual environments. We have developed networked virtual environments for education and training [1, 2, 10, 22, 25-29].

Currently, we are interested in making collaborative virtual environment a practical and effective tool in education and training. In this area, the challenges are immense, and there is much room for collaboration with other groups.

D. Sculpting

This is a very recent initiative of the group. The focus is on developing intuitive manipulation tools for sculpting and clever data structures and topological operations to support local model adaptations.

We are working on an adaptive refinement technique for virtually sculpting small details in triangular meshes; and on multiresolution sculpting techniques.

E. Development of efficient and adaptable graphics engines

This research is focused on developing graphics engines for game applications [12-14].

Currently, we are evolving our CRaBGE graphical engine to make it useful in developing multiplatform games.

F. Behavior of autonomous virtual characters

The goal of this research is the representation of natural and realistic behaviors of autonomous virtual characters through the use of Enactive Artificial Intelligence [15-16].

At the moment, we are working on a model that will make the emergence of behavior possible. We are looking at ways of making virtual characters sense the stimuli of the virtual environment and develop coherent behavior.

G. Realistic rendering methods and applications

The focus of this research is on rendering point clouds and splats, and on methods of global illumination with special treatment of the equation of light transport [7-9] (Figure 3).

H. Crowd simulation

This research focuses on the comprehension of crowd behavior and on developing algorithms to simulate crowd movements under different situations [5] (Figure 4). Recently we are investigating evacuation of crowded spaces in emergency situations.

In our current work, we are testing a hybrid method for simulating crowds with varied behaviors in real time. The proposed model use multiple grids (potential fields), with different levels of discretization, to reduce the cost of computing potential fields, with cells of varied sizes according to environmental needs or modeled behavior.
Figure 4. Crowd simulation.

I. Animation of virtual characters and clothing

In animation of virtual characters, we exploit the natural vibration modes of a physically based character in order to provide a palette of animation basis modes that animators can use to assemble desired motions (Figure 5) [4, 17-21].

In clothing animation, we concentrate on realistic modeling and simulation, using mass-damp-spring systems. Efforts for using the finite element method are under way.

Figure 5. Animation of virtual characters using controllers.

III. COLLABORATION

Currently our group maintains collaboration with other groups in Brazil and abroad in the areas of mesh generation and animation. We are open to collaboration in all the research topics described in Section II. We also seek highly motivated students with strong interest in computer graphics, virtual reality or animation. Strong background in mathematics and computer graphics is desirable.

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REFERENCES


