Real-Time Rendering of Molten Glass with Raymarching Technique on Point Clouds

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Résumé

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1 Introduction

Glassblowing is an art form with deep cultural and historical roots, especially in France, where it represents centuries of craftsmanship and tradition. However, preserving this heritage poses modern challenges, such as the environmental impact of energy-intensive training methods and the need to adapt these artisanal techniques to new technologies.

The overarching goal of the LORIA (Laboratoire Lorrain de Recherche Informatique et ses applications) project is to design a fully immersive augmented reality experience that allows users to blow and shape their own molten glass to create various forms, such as vases or sculptures. This project aims to strike a delicate balance between the realism of the interactions and the technical performance, paving the way for new possibilities in digital creation and virtual craftsmanship.

Beyond its technical innovations, this project aims to contribute to the preservation of glassblowing as a craft while addressing sustainability. By providing a virtual training tool, it could reduce the reliance on furnaces for practice, significantly lowering the ecological footprint of the learning process.

This project focuses on creating a real-time simulation of molten glass using raymarching techniques on 3D point clouds. Raymarching, a rendering method that calculates light interaction by progressing along rays to detect surfaces, offers a highly flexible way to represent complex physical deformations. In our case, it allows us to dynamically model the surface of molten glass.

The originality of this work lies in its departure from traditional mesh-based rendering. Instead, we leverage implicit surfaces and raymarching to bridge the gap between dynamic physical simulation and advanced visualization techniques. Despite the complexity of molten glass, which behaves as both a fluid and a solid depending on temperature and movement, our approach offers a promising solution for realistic real-time rendering.

2 La méthodologie

3 Les résultats, la discussion

4 Les conclusions, future perspectives

5 Les références bibliographiques

Collision Detection for Raymarch Objects by Floney Yang [1], which helped us understand collision techniques, though it does not address deformable materials like glass.

GitHub repositories like UnityRaymarchingCollision [2] and Raymarch Engine [3], which offer practical raymarching examples but lack real-time physical simulation.

Adrian Biagioli's blog [4] Raymarching : Step Into the Light and Nabil N. Mansour's article Raymarching in Three.js [5], both of which provide excellent foundations but do not cover dynamic systems like ours.

The paper "Modelling of the Glass Melting Process for Real-Time Implementation" [6] focuses on using Finite Element Method (FEM) models to optimize the control of glass manufacturing processes, such as bottle production. It addresses real-time control challenges, aiming to improve energy efficiency and product quality through advanced supervisory control systems.

However, this study does not provide a solution to our problem. It primarily targets industrial control rather than real-time graphical visualization. The FEM models discussed are computationally intensive and unsuitable for interactive simulations. Additionally, the paper does not explore techniques like raymarching or implicit surfaces, which are crucial to our project's goal of simulating molten glass dynamically and realistically.

Références

[1] Floney Yang. Raymarching collision, November 2024.

[2] Hecomi. Raymarching collision project (github), November 2024.

[3] Sakri Koskimies. Raymarching engine (github), November 2024.

[4] Adrian Biagioli. Raymarching presentation, November 2024.

[5] Nabil Mansour. SDF raymarching, November 2024.

[6] AGH University of Science and Technology in Krakow, 30-059 Krakow, Mickiewicza Av. 30, Poland, Wojciech Grega, Adam Pilat, and Andrzej Tutaj. Modelling of the Glass Melting Process for Real-Time Implementation. *International Journal of Modeling and Optimization*, 5(6) :366–373, 2015. Number : 6.