We would like to thank Gizem Kayar for discussions and suggestions in the development of the project. This project is supported by Yasar University Computer Engineering Department.

KEYWORDS

Term	Description
Cell	Axis aligned bounding box is divided into small identical cubes.
Colour field quantity	It is a function that calculates how each particle is affected by all the other particles.
Gradient	The directional derivative of a scalar field gives a vector field directed towards where the increment is most, and its magnitude is equal to the greatest value of the change.
Grid	Series of vertical and horizontal lines that are used to subdivide AABB vertically and horizontally into cells in three-dimensional space.
Iso-surface	An isosurface is a 3D surface representation of points with equal values in a 3D data distribution which is the 3D equivalent of a contour line.
Marching Cubes	Marching cubes is a computer graphics algorithm, published in 1987 for extracting a polygonal mesh of an isosurface from a three-dimensional discrete scalar field.
NVIDIA Flex	NVIDIA Flex is a particle-based simulation technique for real-time visual effects created by NVIDIA company.
Polygonal Mesh	A polygon mesh is the collection of vertices, edges, and faces that make up a 3D object.
Unity 3D	Unity is a cross-platform game engine developed by Unity Technologies. Unity is used for developing video games and simulations for consoles and mobile devices.
Spatial Hashing	Spatial hashing is a technique in which objects in a 2D or 3D domain space are projected into a 1D hash table allowing for very fast queries on objects in the domain space.

Table 1: Keywords

ABSTRACT

POF system aims at providing more optimized and faster surface identification and visualization on particle-based fluid simulations.

This project is research-based. It is possible for the small parts of the structures can change during the project. We research possible solutions for the problem and examined a lot of research papers for the algorithms. We discussed the pros and cons of various methods and decided to use specific algorithms for the mentioned reasons.

The POF system divided into a structure that has various algorithms. A control panel (controller or handler) administers these algorithms that placed as substructures in the POF system.

We can list these substructures as Hash System, Surface Particle Recognizer and Visualization parts. Hash System is an imaginary structure and serves to search for data easily. Surface particle recognizer distinguishes the surface particles. Visualization part draws the surface particles vertices which is an implementation of the Marching Cubes algorithm [4].

ÖZET

POF sistemi, partikül bazlı sıvı simülasyonlarında daha optimize ve daha hızlı yüzey tanımlama ve görüntüleme sağlamayı amaçlamaktadır.

Bu proje araştırmaya dayalıdır. Proje sırasında yapıların küçük bölümlerinin değişmesi mümkündür. Sorun için olası çözümleri araştırdık ve algoritmalar için birçok araştırma makalesini inceledik. Çeşitli yöntemlerin artılarını ve eksilerini tartıştık ve belirtilen nedenlerden dolayı spesifik algoritmalar kullanmaya karar verdik.

POF sistemi, çeşitli algoritmalara sahip bir yapıya ayrılmıştır. Sistemin arayüzü olan bir kontrol paneli, (denetleyici veya işleyici) POF sistemindeki alt bileşenleri yönetir.

Bu alt yapıları karma sistemi (hash system), yüzey partikül tanıyıcı ve görselleştirme parçaları olarak listeleyebiliriz. Karma (hash) sistemi hayali bir yapıdır ve verileri kolayca aramaya yarar. Yüzey partikül tanıyıcı yüzey partiküllerini ayırt etmemize yarar. Görselleştirme bölümü, Yürüyen Küpler algoritmasının [4] bir uygulaması olan yüzey parçacıklarının köşelerini çizmemizi sağlar.

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LIST OF ACRONYMS/ABBREVIATIONS

AABB	Axis Aligned Bounding Box. Bounding volume for a set of objects is a closed volume that completely contains the union of the objects in the set.
API	Application Programming Interface.
CPU	Central Processing Unit.
CUDA	Compute Unified Device Architecture. CUDA is a parallel computing platform and application programming interface (API) model created by NVIDIA.
D3D11	Direct3D 11. Is to create 3-D graphics for games and scientific and desktop applications.
GPU	Graphic Processing Unit.
MVC	Stands for Model View Controller. MVC is an application design model comprised of three interconnected parts (Model, View, Controller).
NVIDIA	NVIDIA corporation is a company designs GPUs.
OPENGL	Open Graphics Library is a cross-language, cross-platform application programming interface for rendering 2D and 3D vector graphics.
POF	Performance Optimized Fluid.
SSF	Screen Space Fluids Pro.

Table 3: List of acronyms/abbreviations

WARNING!

Important Note: POF project has hardware-based requirements. Your GPU must have CUDA 8.0.44 or better version and D3D11 support. If you do not have the required components, POF will not work.

We were using the Yaşar university computer lab in the first semester. Since Yaşar University is closed because of the COVID-19, we cannot access the computer laboratory. Therefore, we cannot make any progress in visualization.

The %75 of the project is finished. Implementation of the Marching Cubes algorithm which is the last step about the visualization part of our project could not be completed (We have a working marching cubes code as a prototype. However, we did not implement to the POF system.). For this reason, we have restated our project requirements and goals which will be clarified detailed in the Final Report and Requirements Specifications Document. In brief, the implementation and testing of the surface recognition system is the new goal of our project and some of the requirements are discarded such as Marching Cubes.

1. INTRODUCTION

This section explained in three main titles: problem description, project goal and project output.

1.1. Description of the Problem

The main problem of the particle-based fluid simulation system is excessive numbers of the particles. A particle is a rigid body sphere.

There are millions of particles in a small number of liquids. Simulation control particles by physics-based calculations to obtain fluid behaviours. Simulation having difficulties in calculations dependent on a surplus of particles and time and memory complexity increases indirectly. Visualizing millions of particles on a scene are a tedious job.

1.2. Project Goal

During the POF project, we were researching ways of enhancing the performance and efficiency of particle-based fluid simulation. Creating a suitable and stable platform for executing a particle-based fluid simulation is one of our primary project goals. This platform is Unity for our project. Constructing a more user-friendly platform for testing and comparing various algorithms for scientific research is another project goal.

We aim to achieve these goals by reaching particles faster by constructing a spatial hash sub-system. To detect surface particles, we must implement surface recognition sub-system.

Our project has no predetermined method because POF is a research and development based. We can research and implement new methods during the project.

1.3. Project Output

- Better performance.
- Better memory efficiency.
- Fluid-like appearance and behaviour.
- Different algorithms testing for performance and efficiency.
- Surface particles detection.