



## Plano de Trabalho de Dissertação

Ano Letivo 2020/2021

Universidade do Minho  
Escola de Engenharia

<b>Nome Estudante</b>	Paulo Alexandre Ferreira Barbosa
<b>Título da Dissertação</b> (em Português)	Hidrodinâmica de partículas suavizadas - SPH
<b>Título da Dissertação</b> (em Inglês)	Smoothed-particle hydrodynamics - SPH

### Enquadramento e Motivação (150 - 200 palavras)

When it first was created the SPH algorithm had in mind astrophysical problems. As more and more people became aware of this algorithm, they saw other problems that could be solved by it, this includes: ballistics, volcanology, and oceanography.

Since this method was not created with the sole purpose to simulate fluids for computer graphics it is only normal that it has some limitations like the computation time it takes to run. As the years passed some researchers made some changes to the algorithm making it more stable and faster. Some of the SPH variants are:

- In 2009, B. Solenthaler developed the Predictive-corrective incompressible SPH (PCISPH)[3]
- In 2010, M. Ihmsen introduced adaptive time-stepping for PCISPH [2]
- In 2013, N. Akinci introduced a versatile surface tension and Adhesion for SPH fluids[1]

Apart from all the work on the algorithm it is also needed to find some way to process all the information in a fast way. That is where fast data structures come into play. Given that this area of work could be a project by itself further research will be made and papers like the Multi-Level Memory Structures for Simulating and Rendering Smoothed Particle Hydrodynamics[4] will be used as guidance to develop a fast data structure.

**Objetivos e Resultados Esperados** (150 - 200 palavras)

The present work will focus on the SPH algorithm and the variations listed above. It is intended to follow some of the evolution of the algorithm, starting with the base model and implementing some of the improvements made along the years.

The main goal is to have a fast and realistic fluid simulation and explore possible mutations or merges between methods to provide either a more robust or faster method. It is also intended to have a good control over the simulation by changing the value of multiple variables making it possible to simulate a vast number of fluids.

The aim is to have a final version running as much as possible on the GPU, which implies not only the SPH base algorithm but also coding efficient data structures.

NVIDIA's GVDB Voxels[5] will be evaluated to see if it makes sense to use it in the context of this work.

On a final note, this work will be only focused on the simulation and not the rendering of the fluid.

**Calendarização**

Year	2019			2020						
Month	10	11	12	01	02	03	04	05	06	07
Research and understanding of the fundamentals of Smoothed-particle hydrodynamics										
Research and implementation of new variations of SPH										
Explore possible mutations or merges between methods to provide either a more robust or faster method										
Writing of dissertation										

**Referências Bibliográficas** (5 - 10 referências)

- [1] N. Akinci, G. Akinci, and M. Teschner. Versatile surface tension and adhesion for sph fluids. ACM Transactions on Graphics, 32, 11 2013.
- [2] Markus Ihmsen, Nadir Akinci, Marc Gissler, and Matthias Teschner. Boundary handling and adaptive time-stepping for pcisph. pages 79–88, 01 2010.
- [3] Barbara Solenthaler. Predictive-corrective incompressible sph. ACM Trans. Graph., 28, 09 2009.
- [4] R. Winchenbach and A. Kolb. Multi-level memory structures for simulating and rendering smoothed particle hydrodynamics. Computer Graphics Forum, 39(6):527–541, 2020.
- [5] Kui Wu, Nghia Truong, Cem Yuksel, and Rama Hoetzlein. Fast fluid simulations with sparse volumes on the gpu. Computer Graphics Forum (Proceedings of EUROGRAPHICS 2018), 37(2):157–167, 2018.



## Assinaturas

Estudante

Paulo Barbosa

Orientado

Diretor do Ciclo de Estudos

Coorientador (se aplicável)

Assinatura digital qualificada com Cartão de Cidadão ou Chave Móvel Digital. Para os estudantes, nos casos em que tal não seja possível, os mesmos deverão imprimir este plano, assinar manualmente e, após digitalização, os restantes intervenientes usam a assinatura digital qualificada.