



## "Measuring Particle Flow by Voronoï Diagrams"

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### ABSTRACT

A Particle-Trajectory Velocity (PTV) of moving particles can be analyzed by a digital imaging method based on the Voronoï diagram, which is the dual of the Delaunay triangulation. While this technique has been already applied in various fields, such as homogeneous fluidization, uniform debris flow, this paper adapts and applies this technique to the area of very small moving particles, such as in spermocytogram, as follows: 1) A high-resolution microscope acquires a video sequence of the moving particles; 2) Image segmentation is achieved by detecting discrete particles in each image based on the position of their center; 3) A Voronoï diagram determines the influence zones of each particle at time  $t$  and  $t+dt$  4) A correspondence is established between the two images at time  $t$  and  $t+dt$  5) The velocity is calculated on this basis.

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# Measuring Particle Flow by Voronoï Diagrams

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**Abstract:** A Particle-Trajectory Velocity (PTV) of moving particles can be analyzed by a digital imaging method based on the Voronoï diagram, which is the dual of the Delaunay triangulation. While this technique has been already applied in various fields, such as homogeneous fluidization, uniform debris flow, this paper adapts and applies this technique to the area of very small moving particles, such as in spermocytogram, as follows:

- 1) A high-resolution microscope acquires a video sequence of the moving particles;
- 2) Image segmentation is achieved by detecting discrete particles in each image based on the position of their center;
- 3) A Voronoï diagram determines the influence zones of each particle at time  $t$  and  $t+dt$
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**Key Words:** gesture tracking, motion capture, motion tracking, particle tracking, Voronoï diagram.

## 1. INTRODUCTION

The present paper summarizes the output of the VITALITY (Voronoi Imaging Techniques for the Analysis of sperm motiLITY) research project, funded by DGO6, Région Wallonne, under Convention n°0516079.

## REFERENCES

- [1] R. Aleixo, S. Soares-Frazão, Y. Zech, Velocity-field measurements in a dam-break flow using a PTV Voronoï imaging technique, *Experiments in fluids*, vol. **50**, no. 6, 2011, pp. 1633-1649.
- [2] A. Beirekdar, J. Vanderdonckt, M. Noirhomme-Fraiture, A Framework and a Language for Usability Automatic Evaluation of Web Sites by Static Analysis of HTML Source Code, in *Proc. of Computer-Aided Design of User Interfaces III*, Springer Science+Business Media, Dordrecht, 2002, pp 337-348. [https://doi.org/10.1007/978-94-010-0421-3\\_29](https://doi.org/10.1007/978-94-010-0421-3_29)
- [2] H. Capart, D.L. Young, Y. Zech, Voronoï imaging methods for the measurements of granular flows, *Experiments in Fluids*, vol. **32**, 2002, pp. 121-135.

- [3] A. Coyette, S. Schimke, J. Vanderdonckt, C. Vielhauer, Trainable Sketch Recognizer for Graphical User Interface Design, in *Proc. of 11<sup>th</sup> IFIP TC 13 Int. Conf. on Human-Computer Interaction INTERACT'2007*, Rio de Janeiro, Brazil, September 10-14, Lecture Notes in Computer Science, vol. 4662, Springer Verlag, Berlin, 2007, pp. 124-135.
- [3] I. Fent, Y. Zech, S. Soares-Frazão, Dam-break flow experiments over mobile bed: velocity profile, *Journal of Hydraulic Research*, vol. **57**, no. 1, 2019, pp. 131-138.
- [4] Q. Limbourg, J. Vanderdonckt, B. Michotte, USIXML: A User Interface Description Language Supporting Multiple Levels of Independence, *Proc. of ICWE'2004 Workshop*.
- [?] J. Melchior, J. Vanderdonckt, P. Van Roy, A Model-based Approach for Distributed User Interfaces, in *Proc. of the 3rd ACM Symposium on Engineering interactive computing systems EICS '11*, Pisa, Italy, June 13-16, 2011, ACM Press, New York, 2011, pp. 11-20. <https://doi.org/10.1145/1996461.1996488>
- [1] B. Spinewine, H. Capart, M. Larcher, Y. Zech, Three-dimensional Voronoï imaging methods for the measurement of near-wall particulate flows, *Experiments in Fluids*, vol. **34**, no. 2, pp. 227-241, 2003.

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