



Preface

Sebastià Xambó-Descamps* and Josep M. Parra-Serra

The 6th Conference on Applied Geometric Algebras in Computer Science and Engineering (AGACSE 2015)¹ was dedicated to David Hestenes in recognition of his sustained leadership, particularly at the interface of mathematics and physics. The dedication was celebrated with the launch of a second edition of his *Space-Time Algebra* (Birkhäuser 2015, Gordon and Breach 1966). In addition, the David Hestenes Prize was established for the best work submitted to the AGACSE Conference by a young researcher. The winner of the First David Hestenes Prize was Lei Huang for *Elements of line geometry with geometric algebra*. Pierre-Philippe Dechant and Silvia Franchini were finalists with the works *The E_8 geometry from a Clifford perspective* and *A family of embedded coprocessors with native geometric algebra support*, respectively. The conference was preceded by a 2-day Summer School attended by two thirds of the conference participants. It was also decided that the next AGACSE will be held at the University of Campinas, Brazil, in 2018.

At the Conference it was decided that the Proceedings' editors would be Sebastià Xambó-Descamps (Guest Editor in Chief), Josep M. Parra-Serra and Ramon González Calvet.² Shortly after the Conference, a call was sent to all participants inviting them to submit a paper for the Proceedings. The announcement included a statement that accepted papers would be published as a special issue of *Advances in Applied Clifford Algebras* (AACA) and that they would be subjected to the standard refereeing procedures of the journal.

The Proceedings consists of twenty-six contributions accepted from among thirty-nine submissions. The editors of this special volume publicly acknowledge the effort and care of all the contributors, who have been sub-

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Josep M. Parra-Serra: Retired from Universitat de Barcelona.

¹27–31 July, Barcelona, Spain: <http://www-ma2.upc.edu/agacse2015/>.

²Unfortunately, R. González Calvet resigned his editorial responsibilities early March 2016. This was the more regretful as he had played a key role in bringing the Conference to Barcelona and provided substantial help in the organization and development of the event. The two remaining editors are thankful for all his work devoted to AGACSE 2015.

jected, without exceptions, to strict editorial criteria and refereeing aimed at guaranteeing the quality and impact of the published articles. Thanks are also due to the many referees for all their work.

The first paper, *Fifty years with Geometric Algebra: a retrospective*, corresponds to David Hestenes' keynote lecture. It is a historical survey of the evolution of Geometric Algebra and in particular of the significance of the author's contributions. The last paper, *A Survey of Geometric Algebra and Geometric Calculus*, corresponds to Alan Macdonald's lectures at the AGACSE 2015 Summer School.

The remaining papers have been grouped into three categories: Mathematics (9 papers), Engineering, including Software (10 papers) and Physics (5 papers). In each group, the first listed paper corresponds to a plenary lecture. In the case of the Mathematics and Engineering groups, the second listed papers correspond to works that were finalists for the First Hestenes Prize.³ The remaining papers are arranged alphabetically according to the last name of the first author.

Index

David HESTENES: *Fifty years with Geometric Algebra—a personal retrospective.*

Mathematics

Eckhard HITZER: *General two-sided quaternion Fourier transform, convolution and Mustard convolution.*

Pierre-Philippe DECHANT: *The E_8 geometry from a Clifford perspective.*

Timo ALHO: *Coordinate free integrals in Geometric Calculus.*

Rafael ALVES, Carlile LAVOR: *Geometric Algebra to model uncertainties in the discretizable molecular distance geometry problem.*

Pablo COLAPINTO: *Composing surfaces with conformal rotors.*

Lei DONG, Lei Huang, Changpeng Shao, Yong Wen: *Matrices of $SL(4, \mathbb{R})$ that are the product of two skew-symmetric matrices.*

Rimvydas KRASAUSKAS: *Unifying theory of Pythagorean-normal surfaces based on Geometric Algebra.*

Peter LEWINTAN: *Geometric Calculus of the Gauss map.*

Alba PÉREZ-GRACIA, Federico Thomas: *On Cayley's factorization of 4D rotations and applications.*

³Unfortunately, the paper that was awarded the First Hestenes Prize was not submitted to the Proceedings.

Engineering, including Software

Stephen J. SANGWINE, Eckhard Hitzer: *Clifford multivector toolbox for Matlab*.

Silvia FRANCHINI, Antonio Gentile, Filippo Sorbello, Giorgio Vassallo and Salvatore Vitabile: *Embedded coprocessors for native execution of Geometric Algebra operations*.

Leobardo CAMPOS-MACÍAS, Óscar Carbajal-Espinosa, Alexander Loukianov, Eduardo Bayro-Corrochano: *Inverse kinematics for a 6-DOF walking humanoid robot leg*.

Dietmar HILDENBRAND, Justin Albert, Patrick Charrier and Christian Steinmetz: *Geometric Algebra computing for heterogeneous systems*.

Jaroslav HRDINA, Aleš Návrat, Petr Vašík, Radek Matoušek: *CGA-based robotic snake control*.

Jaroslav HRDINA, Aleš Návrat, Petr Vašík, Radek Matoušek: *Geometric control of the trident snake robot based on CGA*.

Gehová LÓPEZ-GONZÁLEZ, Nancy Arana-Daniel, Eduardo Bayro-Corrochano: *Parallel Clifford support vector machines using the Gaussian kernel*.

Dimiter PRODANOV, Viktor Toth: *Sparse representations of Clifford and tensor algebras in MAXIMA*.

Gerardo SORIA-GARCÍA, Gerardo Altamirano-Gómez, Susana Ortega-Cisneros, Eduardo Bayro-Corrochano: *FPGA implementation of a geometric voting scheme for the extraction of geometric entities from images*.

Lars TINGELSTAD, Olav Egeland: *Automatic multivector differentiation and optimization*.

Physics

Anthony LASENBY: *Geometric Algebra as a unifying language for Physics and Engineering and its use in the study of gravity*.

Gene E. MCCLELLAN: *Application of Geometric Algebra to the electroweak sector of the Standard Model of Particle Physics*.

Waldyr A. RODRIGUES, Samuel A. Wainer: *Equations of motion and energy-momentum 1-forms for the coupled gravitational, Maxwell and Dirac fields*.

Terje G. VOLD: *Computational electromagnetism by the method of least action*.

Vaclav ZATLOUKAL: *Hamiltonian constraint formulation of classical field theories*.

Acknowledgements

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We are most grateful to the Editors of AACA who have assisted us all along with this project. In particular, Ms. Saranya Karunakaran, JEO Assistant from Journals Editorial Office (JEO), and two successive Editors in Chief, Waldyr A. Rodrigues, Jr., at the very beginning, and Rafał Abłamowicz thereafter.

Let us also recall that the Barcelona meeting paid homage to Jaime Keller Torres from Mexico. He was the founder and lifetime editor of *Advances in Applied Clifford Algebras* and one of the most active and prominent builders of the new area of Geometric Algebra until his untimely death. He was an extraordinary open-minded scientist and a true humanist, and Barcelona, Wien and Toulouse (where he was awarded the Golden Medal of the Université Paul Sabatier) were loved and cherished cities in which he worked in and promoted Clifford Algebra research. We are also sure that the late Roy Chisholm, Artibano Micali and especially Pertti Lounesto would most likely have been very happy to participate in this first meeting about Clifford Geometric Algebra in Barcelona (and Spain).

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