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Conformal Geometric Algebra

Summary

This session will introduce the framework of *Conformal Geometric Algebra* (CGA), which is a 5-D representation of 3-D space. In its current form, CGA was discussed briefly by Hestenes in 1984 [1], but became the subject of renewed interest within the GA community in 1999 with the Hestenes paper presented at the first AGACSE conference [2].

We will show how CGA can provide an elegant approach to geometry and give us a language in which objects such as spheres, circles, lines and planes are simply elements of the algebra and can be transformed and intersected with ease. We also show that rotations, translations, dilations and inversions are all performed via *rotors* in our 5-D space. This allows us to provide very simple proofs of complicated constructions. We will give specific examples of the use of this system, with particular emphasis placed on its use in computer graphics, as well as discussing the advantages and disadvantages of CGA as a numerical framework in which to program. Finally, we indicate how the language of CGA can be extended to deal with other geometries, giving examples of the non-Euclidean cases of spherical and hyperbolic geometry.

[1] HESTENES, D., AND SOBCZYK, G. *Clifford Algebra to Geometric Calculus: A unified language for mathematics and physics*. D. Reidel, Dordrecht, 1984.

[2] HESTENES, D. *Old wine in new bottles: a new algebraic framework for computational geometry*. In Geometric Algebra with Applications in Science and Engineering (Boston, 2001), E. Bayro-Corrochano and G. Sobcyzk, Eds., Birkhauser, pp. 116.