

# Guide to Geometric Algebra in Practice

Andreas Aristidou and Joan Lasenby

## Abstract

This paper describes a novel iterative Inverse Kinematics (IK) solver, FABRIK, that is implemented using Conformal Geometric Algebra (CGA). FABRIK uses a forward and backward iterative approach, finding each joint position via locating a point on a line. We use the IK of a human hand as an example of implementation where a constrained version of FABRIK was employed for pose tracking. The hand is modelled using CGA, taking advantage of CGA's compact and geometrically intuitive framework and that basic entities in CGA, such as spheres, lines, planes and circles, are simply represented by algebraic objects. This approach can be used in a wide range of computer animation applications and is not limited to the specific problem discussed here. The proposed hand pose tracker is real-time implementable and exploits the advantages of CGA for applications in computer vision, graphics and robotics.

## 3.1 Introduction

This paper describes a fast iterative Inverse Kinematics (IK) solver which is implemented using Conformal Geometric Algebra (CGA). Geometric Algebra (GA) [1] provides a convenient mathematical notation for representing orientations and rotations of objects in three dimensions. The conformal model of GA extends the usefulness of the 3D GA by expanding the class of rotors to include translations, dilations and inversions, as well as being able to express lines, planes, circles and spheres as elements of the algebra. Rotors are more numerically stable and more

A. Aristidou (✉) · J. Lasenby  
Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ,  
UK  
e-mail: aa462@cam.ac.uk  
J. Lasenby  
e-mail: jl221@cam.ac.uk

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