

Robot Vision in the Language of Geometric Algebras

Gerald Sommer, Cognitive Systems Group, University of Kiel, Germany

gs@ks.informatik.uni-kiel.de

For the design of robot vision systems two important problems have to be solved successfully. The first one is the design of a cognitive architecture. Inspired by biology we are following the approach of behavior based design. That is to bootstrap the system from a set of supervised trained perception-action cycles. The second one concerns a unique mathematical framework which enables both to overcome limitations in modelling based on commonly usual vector calculus and to bridge the gaps between diverse disciplines contributing to robot vision. Examples of these gaps are between image analysis and computer vision or between computer vision (immovable and stiff world) and robot vision (movable and nonrigid objects). The limitations of modelling based on vector algebra become visible in the following examples: analysis of multi-dimensional signals, learning of geometric transformation groups, kinematics of geometric entities other than points. The main problem in praxis is to end up in non-linearities.

Geometric Algebras are generalizations of vector algebra which turn out to have several striking advantages in modelling of robot vision. Some of these are:

- GAs represent a family of algebraic languages of modelling which can be adapted to the type of geometry of the problem at hand.
- With its rich subspace structure GAs enable algebraic representation of other geometric entities than points.
- Because each GA is associated with a Clifford group as orthogonal group, useful geometric transformation groups become linear ones. Also these operational entities are elements of the algebra.

Our group is using GA since more than a decade. In that context this also means to work out the representation structures of that rich language. After an introduction of the basic structure of GA I will present examples of its application in image analysis, computer vision and robot vision, and neural computing. Special emphasis is given the role of the homogeneous conformal GA, which turns out to be the best and most general algebraic framework for robot vision.