Geometric algebra for applications in signal and image processing, computer vision, graphics engineering, robotics and machine learning.
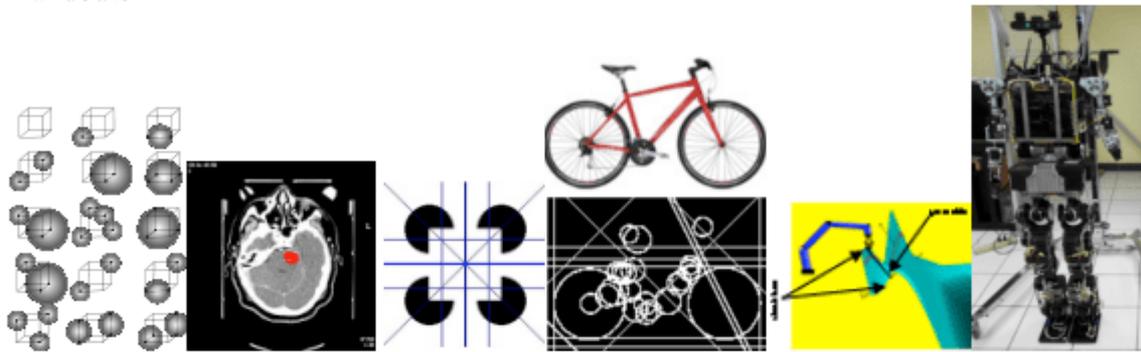
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Course of 8 to 10 lectures on Wednesdays 15:00-17:00
Begins in October
Handouts

Resume

In this course we present the framework of geometric algebra for applications in signal and image processing, computer vision, graphics engineering, robotics and machine learning. We will show that this mathematical system keeps our intuitions and insight of the geometry of the problem at hand and it helps us to reduce considerably the computational burden of the problems. We believe that the framework of geometric algebra can be in general of great advantage for applications in signal and image processing, filtering, estimation and interpolation, neural networks and machine learning, PCA and big data, graphics engineering, stereo vision, range data, laser, stereo-omnidirectional and odometry based robotic systems, kinematics, dynamics and nonlinear control of robot mechanisms, robot manipulators, mobile robots   and humanoids.

Content

1. Introduction to Geometric Algebra

   1.1 Introduction to Associative Algebras
   1.2 History of Geometric Algebra
   1.3 Introduction to Geometric Algebra
   1.4 Algebra of the 2D and 3D Spaces
   1.5 Motor Algebra
   1.6 Projective Geometry , Algebra of Incidence and Invariant Theory
   1.7 Conformal Geometric Algebra
   1.8 Computer Programming Issues

2. Secial Topics in Geometric Algebra

   2.1 Kinematics of the 2D and 3D Spaces
   2.2 Lie Algebras
   2.3 Differential Kinematics and Dynamics
   2.4 Quaternion, Clifford Fourier Transform and Quaternion Wavelet Transform
   2.5 The Geometric Algebra of Computer Vision
   2.6 Fuzzy Logic and Geometric algebra
   2.7 Geometric Neural Networks
   2.8 Tracking Spinors with Extended Motor Kalman Filter

3. Practical Applications

Computer Vision
   3.1 Motion Estimation Using Points, Lines, Planes and Spheres
   3.2 Body-Eye (sensors) Calibration
   3.3 The spherical retina
   3.4 Mobile Robot Navigation

Robotics
   3,5 Kinematics of Robot Devices
   3.6 Dynamics of Robot Manipulators
   3.7 Grasping
   3.8 Geometric Control

Image Processing
   3.9 Image Processing using the QFT and the QWT
   3.10 Rigid Motion Estimation using Harmonic Analysis on the Sphere
   3,11 2D and 3D Segmentation
   3.12 Geometric Methods for Neurosurgery

Machine learning and Neuralcomputing
   3.13 Geometric Neuron
   3.14 Clifford MLP
   3.15 Clifford SVM
   3.16 Geometric RBF
   3.17 Geometric Spike Neurons