Clifford analysis techniques in image processing

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The course is intended to give an overview of applications of Clifford analytic methods to problems in signal and image processing. Since the principal fields of application are currently in the area of encoding of color image and edge detection we shall present examples of Clifford analytic methods for these problems. In the case of color imaging we will discuss the problem of sparse representation and applications of compressed sensing methods. For edge detection we introduce the monogenic signal and construct appropriate frames for it. Two principal examples of such frames will be given: Monogenic wavelets and monogenic curvelets. Since Clifford analysis techniques are strongly linked with geometric aspects of the underlying space we will show the limits of these approaches by discussing the problem of constructing monogenic shearlets. If there is time we intend to discuss also the natural question of the corresponding coorbit space theory. In any case we are going to show the practical problems arising in the implementation of these methods and give some examples in Matlab.

Tentative program:

0) *Monday, November 23, 14:30, Aula Seminari III piano*

Motivation: Image processing with quaternionic analysis/Clifford analysis

- Analytic signals/Link between gradient and Riesz transforms

- Representations of color images in Clifford algebras

1) *Tuesday, November 24, 14:30, Aula Seminari III piano*

Representation of color images:

- Sparse representations of bases

- Compressed sensing in Clifford Analysis

2) *Wednesday, November 25, 11:00, Aula Seminari III piano*

Quaternionic/Clifford Analysis and Edge detection

- Hypercomplex vs. Monogenic signal
- Frames and monogenic Hilbert transform
- Monogenic Wavelets
- Wavefront sets and edges
- Monogenic Curvelets
- Limits of monogenic approach: Shearlets

3) *Thursday, November 26, 11:00, Aula Seminari III piano*

Group representations and Coorbit theory

- Gabor frames
- Coorbit spaces

4) *Friday, November 27, 14:30, Aula Seminari III piano*

Implementation and practical considerations

- Fast transforms
- Discrete Picture and discrete monogenic Hilbert transform
- Acceleration techniques