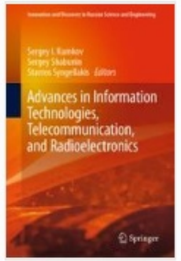

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Hypercomplex Algebras as Unified Language for Image Processing and Pattern Recognition Part 1. Cliffordean Models of Multichannel Images

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Chapter

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Abstract

In this work, we assume that a brain in the visual cortex (VC) operates with Clifford numbers

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In this work, we assume that a brain in the visual cortex (VC) operates with Clifford numbers when it calculates hypercomplex-valued invariants of an image as it recognizes it. Clifford algebras generalize the algebras of complex numbers, quaternions and octonions. Of course, the algebraic nature of hypercomplex numbers must correspond to the spaces with respect to geometrically perceivable properties. For recognition of 2-D (bichromatic), 3-D (color), and n-D (multi-channel) images, we turn the perceptual spaces into corresponding Clifford algebras (and call them the VC-*perceptual algebras*). This approach gives full representation of how algebraic structures can possess image features and how algebraic structures can be used in different visual systems. It is our aim to show that the use of Clifford algebras fits more naturally to the tasks of recognition of multicolor patterns than does the use of color vector spaces. One can argue that nature has, through evolution, also learned to utilize properties of Cliffordean numbers.

Keywords

Clifford algebra | Image processing | Invariant pattern recognition

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Notes

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References

1. V.G. Labunets, Clifford algebra as unified language for image processing and pattern recognition, in *Topics in Computational Noncommutative Algebra and Applications*, ed. by J. Byrnes, G. Ostheimer (Kluwer Academic Publishers, Dordrect, Boston, London, 2003), pp. 197–225

for Future Digital Systems (2000), pp. 231–261
Google Scholar

3. V.G. Labunets, E.V. Kokh, E. Ostheimer, Algebraic models and methods of image computer processing. Part 1. Multiplet models of multichannel images. Comput. Opt. **42**(1), 84–95 (2018)
CrossRef Google Scholar

4. V.G. Labunets, E.V. Rundblad-Ostheimer, Spatial-color Clifford algebras for invariant image recognition, in *Topics in Geometric Computing with Clifford Algebras*, ed. by G. Sommer (Springer, Berlin, New York, 2001), pp. 155–185
CrossRef Google Scholar

5. E. Labunets-Rundblad, I. Nikitin, V.G. Labunets, Unified approach to Fourier-Clifford-Prometheus sequences, transforms and filter banks, in *Topics in Computational Noncommutative Algebra and Applications*, ed. by J. Byrnes, G. Ostheimer (Kluwer Academic Publishers, Dordrect, Boston, London, 2003), pp. 389–400
zbMATH Google Scholar

6. V.G. Labunets, E.V. Rundblad, J. Astola, Is the brain a "Clifford algebra quantum computer?", in *Topics in Applied Geometrical Algebras in Computer Science and Engineering*, ed. by L. Dorst, C. Doran, J. Lasenby (Birkhauser, 2003), pp. 486–495 (2002)
Google Scholar

7. E.V. Labunets-Rundblad, V.G. Labunets, J. Astola, Is the visual cortex a "fast Clifford algebra quantum computer"?, in *Topics in Clifford Analysis and Its Applications, II.* Mathematics, Physics and Chemistry, NATO Science Series, vol. 25 (2001), pp. 173–183
CrossRef Google Scholar

8. V.G. Labunets, A. Maidan, E.V. Rundblad-Labunets, J. Astola, Color triplet-valued wavelets and splines, in *Proceedings of the International Conference on Image and Signal Processing and Analysis (ISPA'01)* (2001), pp. 535–541
Google Scholar

9. V.G. Labunets, A. Maidan, E.V. Rundblad-Labunets, J. Astola, Color triplet-valued wavelets, splines and median filters, in *Proceedings of the International Conference on Spectral Methods and Multirate Signal Processing (SMMSP'2001)* (2001), pp. 61–70
Google Scholar

10. E.V. Labunets-Rundblad, *Fast Fourier-Clifford Transforms Design and Application in Invariant Recognition.* Ph.D. thesis (Tampere University Technology, Tampere, Finland), 262 pp.
Google Scholar

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