An Algebraic Approach to Signal Processing: Algorithms and Applications

C. Guerrini[*] D. Lazzaro[†] L.B. Montefusco[‡]

Unitá operativa di Bologna

It has recently been shown that the algebraic-combinatorial notion of recursive matrices can fruitfully be used to represent and easily handle the basic properties of filter theory, such as the *perfect reconstruction* and *alias cancellation* properties. Moreover, in this algebraic context, it is easy to extend the lifting scheme to the building of M-band perfect reconstruction filter banks, and to factorize every biorthogonal filters into simple lifting steps, with consequent reduction of the computational cost.

On the other hand, the algebraic reinterpretation of the wavelet packet analysis by means of recursive matrices enables the alias free detection of transients in non-stationary signals, giving the possibility to dynamically follow in the time the behaviour of well defined frequency bands. In this work we present an application where this capability is exploited for the study of typical non-stationary phenomena such as electrocardiograms (ECG) or Heart Rate Variability (HRV) signals.

References

[1] M. Barnabei and L.B. Montefusco, *Recursive Properties of Toeplitz and Hurwitz Matrices*, Linear Algebra and Applications **274**, pp. 367–388 (1998).

[2] M. Barnabei, C. Guerrini, and L.B. Montefusco, *Some Algebraic Aspects of Signal Processing*, Linear Algebra and its Applications **284**, n. 1–3, pp. 3–17 (1998).

[3] D. Lazzaro, *Biorthogonal M-band Filter Construction Using the Lifting Scheme*, Numerical Algorithm **22**, pp. 53–72 (1999).

[*] Dipartimento di Matematica, Universitá di Bologna, `guerrini@dm.unibo.it`.

[†] Dipartimento di Matematica, Universitá di Bologna, `lazzaro@csr.unibo.it`.

[‡] Dipartimento di Matematica, Universitá di Bologna, `montelau@dm.unibo.it` .