The Parks-McClellan algorithm and Chebyshev-proxy rootfinding methods

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During the 1970s, James McClellan and Thomas Parks developed an iterative routine for designing finite impulse response filters. Their work is based on the theory of minimax polynomial approximation, and today, it is one of the most well-known filter design methods in digital signal processing. In this talk, I will give insight into some recent work that I have been a part of, to improve the practical behavior of this algorithm [1]. My main focus will be on numerically stable root finding routines that rely on determining the eigenvalues of appropriate structured matrices [2]. They appear in the context of polynomial interpolation using the basis of Chebyshev polynomials. Extrema/root finding is usually the most computationally intensive part of the Parks-McClellan algorithm. Through interval subdivision techniques, we were able to construct a very robust implementation of this filter design routine, one that is more scalable than other existing implementations, like those found in Matlab and Scipy.

References

[1] Filip, S. *A robust and scalable implementation of the Parks-McClellan algorithm for designing FIR filters*, submitted for publication, preliminary version available at https://hal.inria.fr/hal-01136005

[2] Boyd, J. *Finding the Zeros of a Univariate Equation: Proxy Rootfinders, Chebyshev Interpolation, and the Companion Matrix*. SIAM Review 55, 2 (2013), 375396