CERIES 東北大学 電気情報系 グローバルCOEプログラム
Center of Education and Research for Information Electronics Systems

グローバルＣＯＥセミナー開催案内

講師にGeorgi Stoyanov 先生（ソフィア工科大学, ブルガリア）をお迎えし、
DESIGN AND INVESTIGATION OF FRACTIONAL DELAY IIR DIGITAL FILTERS
についてご講演をしていただきます。

開催日時：平成２０年７月１７日（木）１６：００－１７：００
開催場所：電子情報システム・応物系２号館５階５１５号室

主　　催：東北大学グローバルＣＯＥ「情報エレクトロニクスシステム教育研究拠点」

講　　師：Georgi Stoyanov (Technical University of Sofia, Bulgaria)

講演題目：DESIGN AND INVESTIGATION OF FRACTIONAL DELAY IIR DIGITAL FILTERS

講演概要：

All conventional linear digital circuits are providing delay time response that is equal to an integer number of sampling intervals and additional design and approximation procedures have to be applied in order to obtain a fractional delay (FD). FD filters are very useful in telecommunications for time delay estimation, timing adjustment in digital modems, precise jitter elimination, frequency synchronization in wireless telecommunications and also in the speech processing, in different multirate applications, in modeling of musical instruments and in many other DSP applications. Recently, the FD digital filters (fixed and variable) are subjects of an ever growing interest. And while the design and the realization of FIR FD filters could be considered as a well developed and even completed and mature field, a lot remains to be done and investigated in the case of the IIR FD filters. They are based usually on all pass structures, providing a unity gain for all frequencies and permitting thus to concentrate only on the phase delay approximation. The IIR FD realizations are often more preferable because of their lower complexity (less multipliers and delays) and of their lower overall delay (because of the lower

transfer function (TF) order). The design of such type of digital filters however is much more complicated because of the problems like possible instability, higher level of the round-off noises and worst behavior in a limited wordlength environment due to their higher sensitivities.

In this lecture first a critical review of the known methods of design of FD IIR filters will be given and the existing problems will be identified. Then our recent results in developing new design procedures based on Thiran's maximally flat delay-time approximation and cascade realization of all pass FD filters including a sensitivity minimization of the individual all pass sections, implementing each couple of TF poles, will be summarized. It will be shown how unusual are the pole loci of the FD filters, requiring thus a development of new all pass sections, having low phase sensitivities for pole positions that are rarely met in the conventional filter TFs. One new second-order all pass section will be described and compared to the other known realizations and then a low-sensitivity design procedure for FD IIR filter of an arbitrary order will be introduced.

Next the known methods for realization of variable FD IIR filters will be compared and a new method of design and implementation of variable FD all pass digital filters will be proposed. It is based on Thiran approximation and makes use of truncated Taylor series expansion of the filter coefficients. It will be shown that truncation of the series after the linear term is applicable only for phase delay adjustments in a quite limited range of values of FD. The second-order Taylor approximation of the coefficients is providing possibilities of tuning in much wider range of values, exceeding these, achieved in other known publications. The implementation of the method is simple and permits a real time tuning.

Finally, the overall sensitivity and the parasitic effects due to the coefficient quantization will be studied and it will be shown how to obtain effective multiplierless implementations of FD IIR filters.

At the end, the possible directions of further investigations will be discussed.

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