DOWNLOAD PDF SPECTRAL TECHNIQUES IN DIGITAL LOGIC

Chapter 1 : spectral logic and its applications for the design of digital devices | Download eBook PDF/EPUB

In digital logic design, spectral techniques have been used for more than 30 years. The bottleneck of spectral techniques has been the exponential resources required to calculate and store the spectral coefficients.

They have been used for Boolean function classification, disjoint decomposition, parallel and serial linear decomposition, spectral translation synthesis extraction of linear pre- and post-filters , multiplexer synthesis, prime implicant extraction by spectral summation, threshold logic synthesis, estimation of logic complexity, testing, and state assignment. This dissertation resolves many important issues concerning the efficient application of spectral methods used in the computer-aided design of digital circuits. The main obstacles in these applications were, up to now, memory requirements for computer systems and lack of the possibility of calculating spectra directly from Boolean equations. By using the algorithms presented here these obstacles have been overcome. Moreover, the methods presented in this dissertation can be regarded as representatives of a whole family of methods and the approach presented can be easily adapted to other orthogonal transforms used in digital logic design. Algorithms are shown for Adding, Arithmetic, and Reed-Muller transforms. However, the main focus of this dissertation is on the efficient computer calculation of Rademacher-Walsh spectra of Boolean functions, since this particular ordering of Walsh transforms is most frequently used in digital logic design. A theory has been developed to calculate the Rademacher-Walsh transform from a cube array specification of incompletely specified Boolean functions. The importance of representing Boolean functions as arrays of disjoint ON- and DC- cubes has been pointed out, and an efficient new algorithm to generate disjoint cubes from non-disjoint ones has been designed. The transform algorithm makes use of the properties of an array of disjoint cubes and allows the determination of the spectral coefficients in an independent way. By such an approach each spectral coefficient can be calculated separately or all the coefficients can be calculated in parallel. These advantages are absent in the existing methods. The possibility of calculating only some coefficients is very important since there are many spectral methods in digital logic design for which the values of only a few selected coefficients are needed. Most of the current methods used in the spectral domain deal only with completely specified Boolean functions. The links between spectral and classical methods used for designing digital circuits are described. The real meaning of spectral coefficients from Walsh and other orthogonal spectra in classical logic terms is shown. The relations presented here can be used for the calculation of different transforms. The methods are based on direct manipulations on Karnaugh maps. The conversion start with Karnaugh maps and generate the spectral coefficients. The spectral representation of multiple-valued input binary functions is proposed here for the first time. Such a representation is composed of a vector of Walsh transforms each vector is defined for one pair of the input variables of the function. The new representation has the advantage of being real-valued, thus having an easy interpretation. Since two types of codings of values of binary functions are used, two different spectra are introduced. The meaning of each spectral coefficient in classical logic terms is discussed. These relationships can be used to calculate the spectral coefficients directly from the graphical representations of binary functions. Similarly to the spectral methods in classical logic design, the new spectral representation of binary functions can find applications in many problems of analysis, synthesis, and testing of circuits described by such functions. Since the known fast algorithm that generates the GRME, based on the factorization of the Reed-Muller transform matrix, always starts from the truth table minterms of a Boolean function, then the described method has advantages due to a smaller required computer memory. Moreover, for Boolean functions, described by only a few disjoint cubes, the method is much more efficient than the fast algorithm. By investigating a family of elementary second order matrices, new transforms of real vectors are introduced. When used for Boolean function transformations, these transforms are one-to-one mappings in a binary or ternary vector space. The concept of different polarities of the Arithmetic and Adding transforms has been introduced. New operations on matrices: All previously known transforms, and those introduced in this dissertation can be characterized by two features: When a transform exists for all possible polarities then it is said to be "generalized". For all of the transforms discussed, procedures are given for generalizing and defining for different orderings. The meaning of each spectral coefficient for a given transform is also presented in terms of standard logic gates. There exist six commonly used orderings of Walsh transforms: By investigating the ways in which these known orderings are generated the author noticed that the same operations can be used to create some new orderings. The generation of two new Walsh transforms in Gray code orderings, from the straight binary code is shown. A recursive algorithm for the Gray code ordered Walsh transform is based on the new operator introduced in this presentation under the name of the "bi-symmetrical pseudo Kronecker product". The recursive algorithm is the basis for the flow diagram of a constant geometry fast Walsh transform in Gray code ordering.

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Tomasz S. Czajkowski, Stephen D. Brown, Functionally linear decomposition and synthesis of logic circuits for FPGAs, Proceedings of the 45th annual Design Automation Conference, June , , Anaheim, California.

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Chapter 4 : Stanley Leonard Hurst (Author of Spectral Techniques In Digital Logic)

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