

High Level Circuit Design

For Low Power Audio Signal Processing

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Our goal in the PRO-DASP project within the DFG priority program VIVA has been the development of a rapid-prototyping environment for functional verification and test of digital signal processing algorithms. We have realized a power-optimised technology independent macro-module library to support a fast and efficient design methodology. The library is embedded into a design-framework which supports an easy high-level data-flow oriented construction of signal processing algorithms using abstract function prototypes and allows an automatic optimisation and verification. The macros implement a variety of architectural and algorithmic transformations for DSP-functions as well as basic arithmetic components. Our approach differs from existing high-level low-power synthesis tools mainly in two points: Firstly, the framework embodies a psycho-acoustically motivated measurement of the output signal quality to ensure that the signal processing does not distort the signal beyond a limit while allowing transformations affecting the overall signal quality. Secondly, by defining hierarchy-levels for all modules, we can combine high level transformations for complex operations like filters with a set of basic arithmetic macros implementing various number representations and number systems like sign-magnitude, two's-complement or fixed- and floating point numbers and logarithmic and residue number systems.

The environment has been used among others for the implementation of a Gammatone filterbank for frequency analysis and synthesis. A prototyping system consisting of a Virtex-II device on a PCI-card and an appropriate generic software backend has been built. It meets real-time requirements by means of interleaving block-transfers to and from a large on-board memory and is dynamically reconfigurable. Furthermore, we have applied the framework to compare e. g. different FIR algorithms concerning their power consumption using two technologies (Mietec (0,35 μ , 3,3V) and UMC (0,18 μ , 1,8V)).

In the AVSy project we develop currently a link between the low power framework and Matlab. It will support bit accurate simulation of modules on system level. Signal statistics and appropriate heuristics will support an automated power optimized circuit design.