OPTIMIZATION FRAMEWORK FOR 2D COMPLEX FILTERS: The optimization framework consists of 3 steps:

1) Generate the Energy-Performance-Accuracy space of 2D complex filter realizations, by varying hardware parameters and frequency of operation.

2) Multi-objective Pareto Optimization of the EPA space: The EPA space is represented by a set of hardware realizations along with their EPA values. We find the optimal realizations in the Pareto (multi-objective) sense.

3) Dynamic management based on real-time EPA constraints: Once the Pareto front has been extracted, we can cast optimization problems based on PPA constraints. Example:

\[
\begin{align*}
\text{max} & \quad \text{Energy}(R_t) \\
\text{subject to:} & \quad \text{Accuracy}(R_t) \geq 50\text{dB} \\
& \quad \text{Performance}(R_t) \geq 30\text{fps}
\end{align*}
\]

Feasible set: golden points. Circled point: realization from the feasible set that minimizes energy consumption.

Pareto optimal point: Hardware realization that becomes active in the FPGA via DPR and/or Dynamic Frequency Control. It is represented by:

**bitstreams, freq. of operation**

EXPERIMENTAL SETUP

A complex image is processed through a Gabor separable filter (complex coefficients). The table shows: parameter and frequency combinations for the generation of the EPA space. N (# of coefficients), NH (coefficient bit-width), L (LUT size), OB (output bit-width). Ideal filter: 31x31 double precision coefficients. Test image: analyticallena (8-bit, CIF resolution)

RESULTS

Multiobjective optimization of the EPA space: The Pareto front lied entirely at the 100 MHz frequency. Thus, we carried out optimization for the EPA space at 100 MHz.

There are 20 Pareto-optimal points, that requires 20 MB of memory (40 bitstreams).

Dynamic EPA Management: Time-varying constraints applied to a video sequence. The circled points meet the constraints.