

WP 2.1 Summary

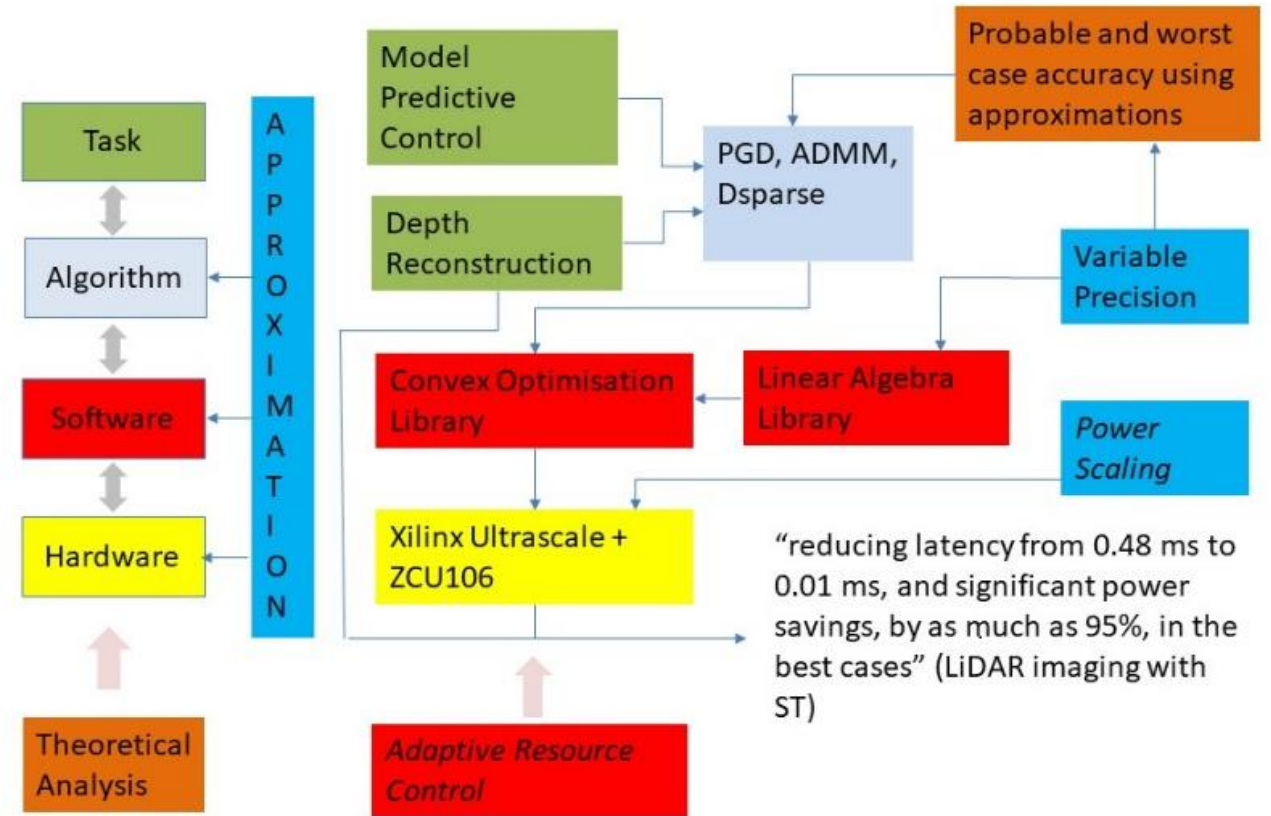
Context and Goal

Full computational stack

from task/algorithm to hardware

Resource-constrained platforms

Limited battery, power, or space

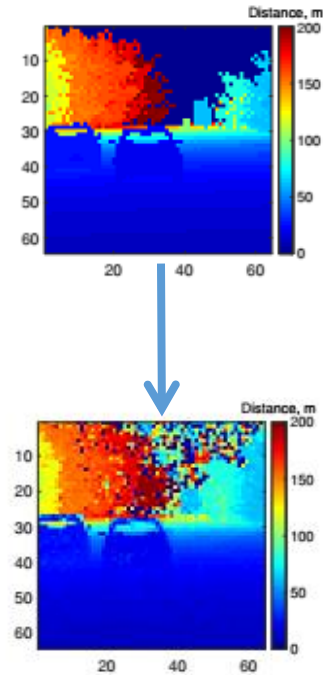
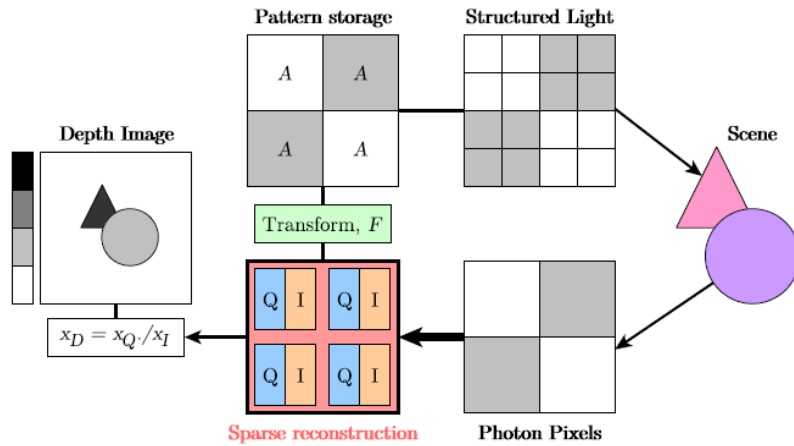


Goal: design computational approximation strategies through entire stack to save resource

Research Outcomes

Approximate 3D depth reconstruction

↓ 79.65% logic reduction
over 6 × throughput



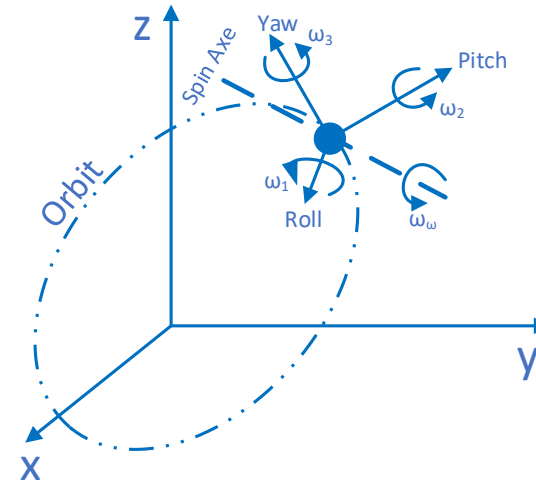
ADMM - Alternating Direction Method of Multipliers

Aßmann, Wu, Stewart and Wallace, *Accelerated 3D Image Reconstruction for Resource Constrained Systems*, EUSIPCO, 2020

Wu, Aßmann, Stewart and Wallace, *Energy Efficient Approximate 3D Image Reconstruction*, IEEE T-Emerging Topics in Computing, 2021

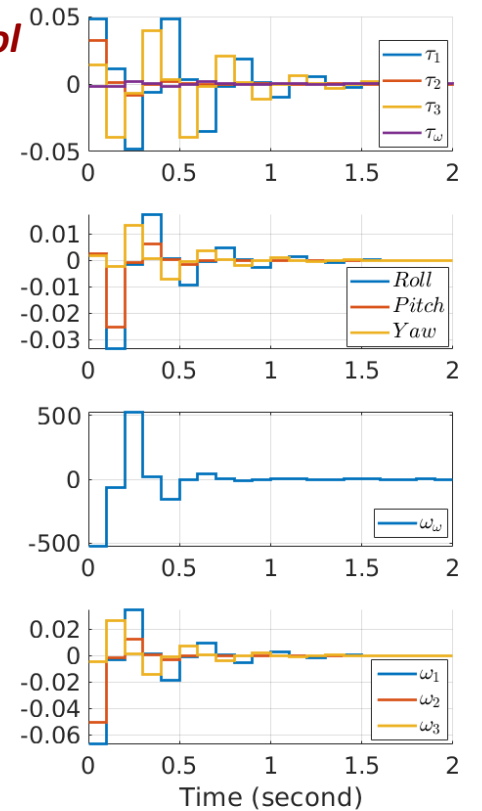
Approximate Model Prediction Control

↓ 63.44% logic reduction



PGD - Proximal Gradient Descent

Wu, Mota, Wallace, *Approximate LASSO Model Predictive Control for Resource Constrained Systems*, SSPD, 2020

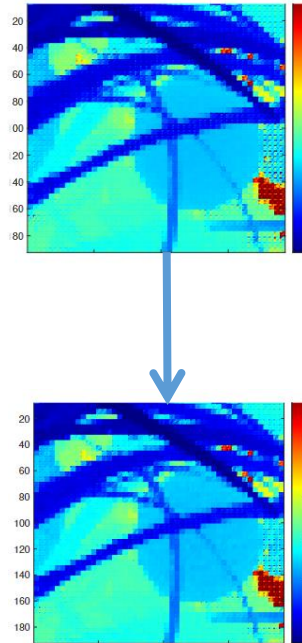
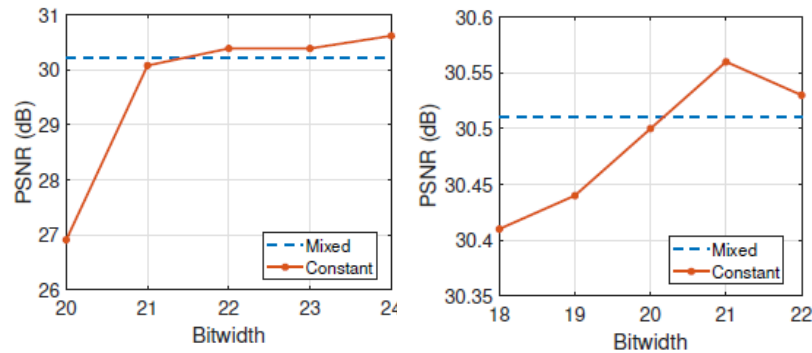


Research Outcomes

Mixed Precision convex optimization solver

↓ 55% logic reduction

↓ 78% power reduction

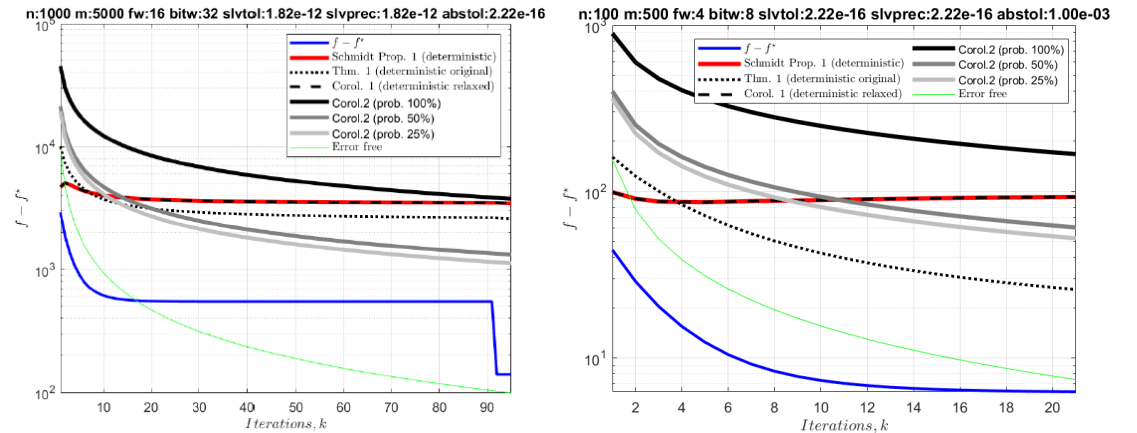


ADMM - Alternating Direction Method of Multipliers

Wu, Wallace, Aßmann and Stewart, *Mixed Precision I1 Solver for Compressive Depth Reconstruction: An ADMM Case Study*, IEEE Int. Workshop on Signal Processing Systems, Portugal, Oct 2021

Bounded Approximate PGD

- Guaranteed performance
- Better performance bounds than literature



PGD - Proximal Gradient Descent

Hamadouche, Wu, Wallace, and Mota, *Approximate Proximal-Gradient Methods*, SSPD, 2021

Hamadouche, Wu, Wallace, and Mota, *Sharper Bounds for Proximal Gradient Algorithms with Errors*, in preparation, 2022

Development Outcomes

Synthesizable Approximate Linear Algebra Library (SXLALib)

Synthesizable: can be used to prototype accelerator directly

Approximate: supports several arithmetic types and precision

Matrix types

- Real – general (nonsymmetric) real
- Complex – general (nonsymmetric) complex
- SPD – symmetric positive definite (real)
- HPD – Hermitian positive definite (complex)
- SY – symmetric (real)
- HE – Hermitian (complex)
- BND – band

Matrix Operations

- BA – Basic Arithmetic (add, sub, mul, div, inv, etc.)
- TF – triangular factorizations (LU, Cholesky)
- OF – orthogonal factorizations (QR, QL, generalized factorizations)
- EVP – eigenvalue problems
- SVD – singular value decomposition
- GEVP – generalized EVP
- GSVD – generalized SVD

	Real	Complex	SPD	HPD	SY	HE	BND	BA	TF	OF	EVP	SVD	GEVP	GSVD
Approximate Linear Algebra Library (XLALib)	Yes	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No

Development Outcomes

Approximate accelerator generation

- Support of various arithmetic types through C++ template
- Arithmetic precision adaptation-based approximation
- Hybrid MATLAB and C validation and verification
- C-to-VHDL based accelerator fast prototyping

