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Energy-Efficient Monocular Depth Estimation on ARM-based Embedded Platforms

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Monocular depth estimation is an appealing technique to estimate dense depth maps leveraging unconstrained imaging sensors. State-of-the-art technique [1] deploys energy-hungry deep networks.

[1] Titan XP GPU

~250 Watt
~30 FPS

[1] Intel i7 CPU

~90 Watt
~2 FPS

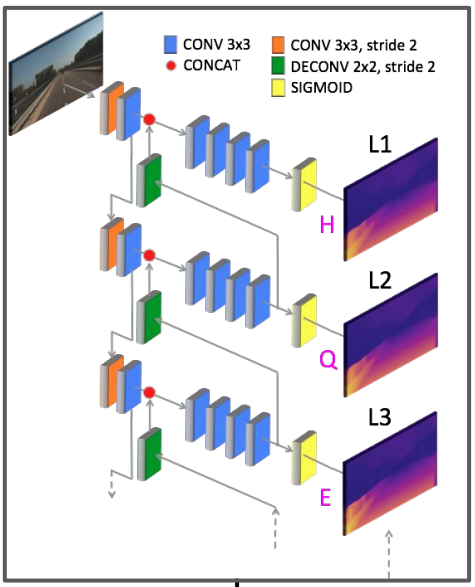
[1] Raspberry Pi 3

~3.5 Watt
~0.1 FPS

BEFORE

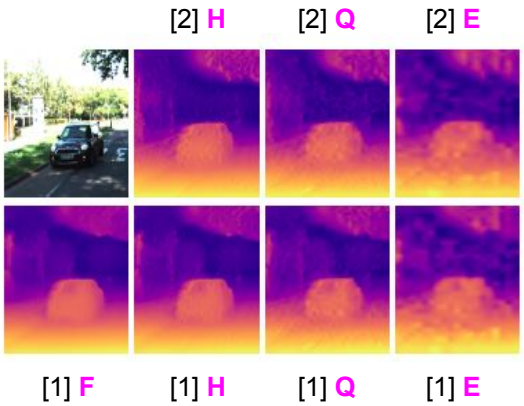
EQ-Scalable PyD-Net

NOW...

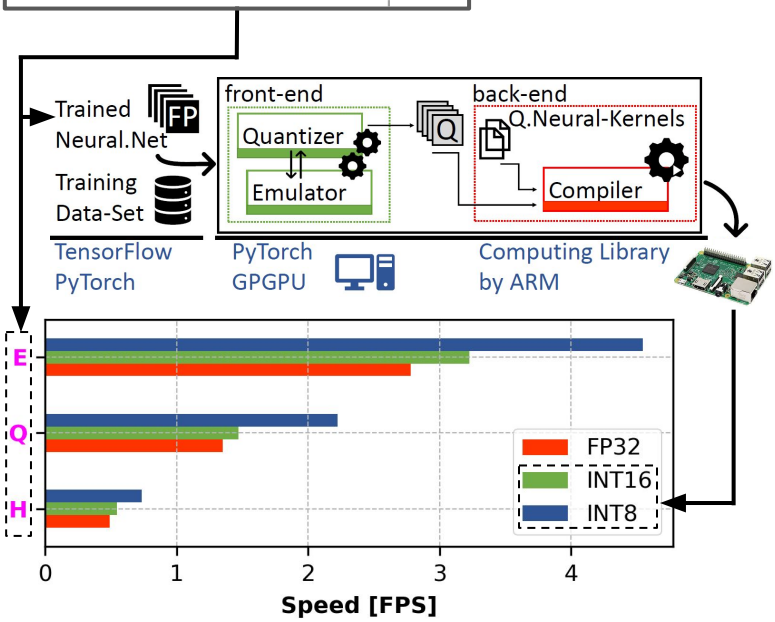


Architecture

Whereas state-of-the-art models [1] count millions of parameters, have large memory footprints and are far from real-time computation on low powered devices, PyD-Net [2] is compact (1.9M vs more than 30M params) and runs at around 1 FPS on Raspberry Pi 3 with comparable accuracy.
Moreover, PyDNet is an energy-scalable architecture with better performance than more complex models like [1].



F: Full resolution
H: Half resolution
Q: Quarter resolution
E: Eighth resolution

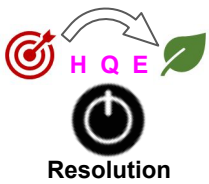


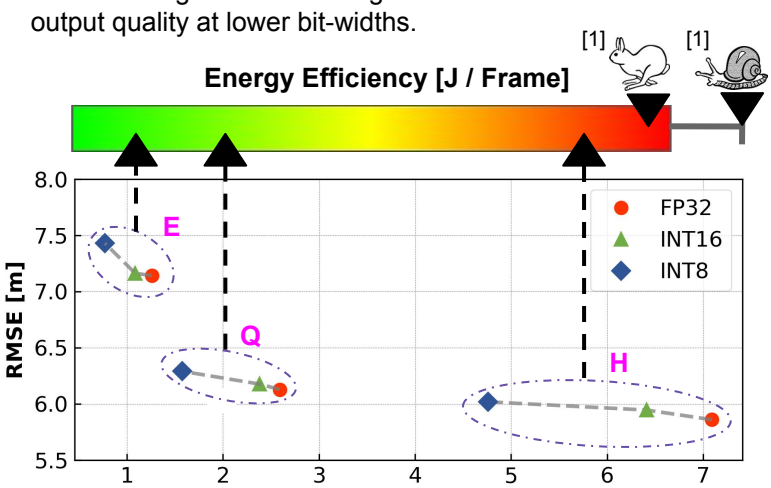
A sensing technology [3] with such ability to implement accuracy-energy scaling represents a practical option for adaptive embedded systems: contexts or applications which tolerate lower accuracy might pursue higher energy efficiency by tuning resolution and precision.

Energy-Quality Scaling

- Coarse-Gain Knob: PyD-Net infers disparity maps at different resolutions. Its reconfigurable architecture enables to scale energy with output resolution.

- Fine-Grain Knob: in-house neural kernels enables to scale energy with precision. The optimization flow sketched on the left guarantees marginal loss in output quality at lower bit-widths.





[1] Godard et al., "Unsupervised Monocular Depth Estimation with Left-Right Consistency", CVPR 2017
[2] Poggi et al., "Towards real-time unsupervised monocular depth estimation on CPU", IROS 2018
[3] Peluso et al., "Energy-Efficient Monocular Depth Estimation on ARM-based Embedded Platforms", DATE 2019