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

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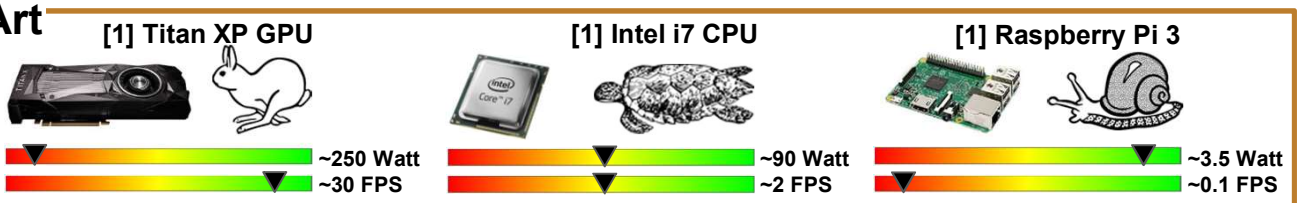
Monocular depth estimation is an appealing technique to estimate dense depth maps leveraging unconstrained imaging sensors. State-of-the-art technique [1] deploys energy-hungry deep networks.

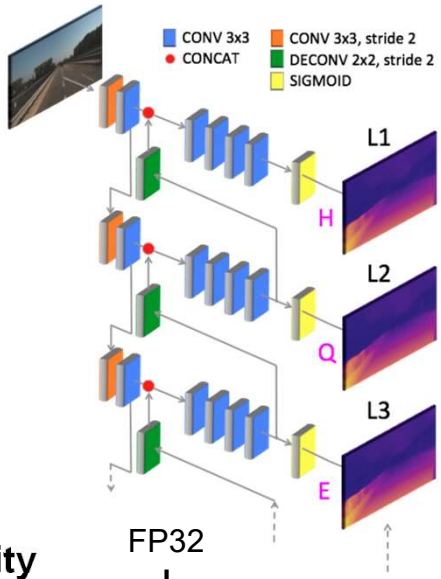
State-of-Art

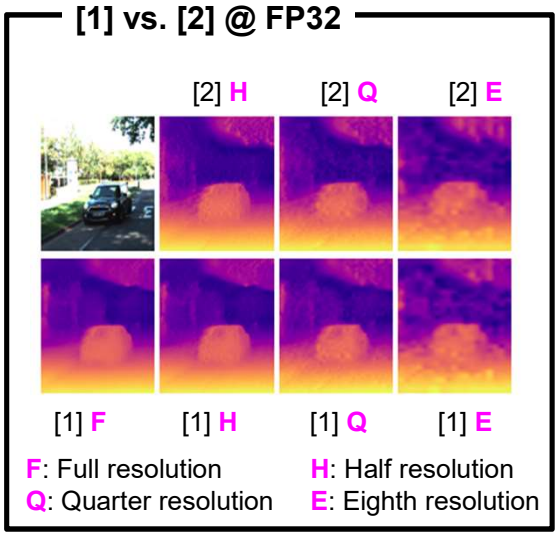


EQ-Scalable PyD-Net

PyD-Net Architecture

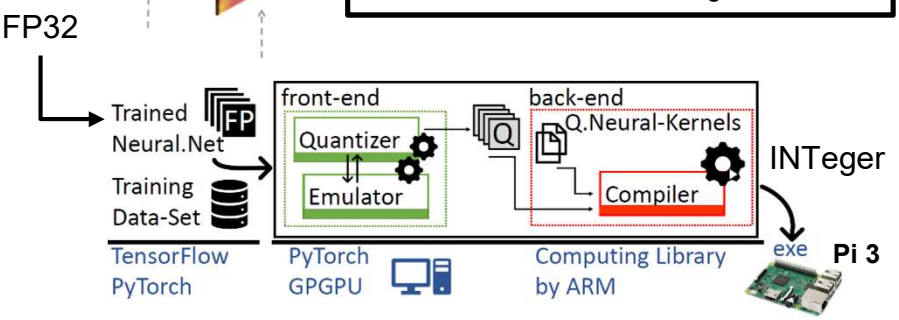
Whereas state-of-the-art models [1] count millions of parameters, have large memory footprints and are far from real-time computation on low powered devices, PyD-Net [2] is compact (1.9M vs more than 30M params) and runs at around 1 FPS on Raspberry Pi 3 with comparable accuracy. Moreover, PyDNet is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

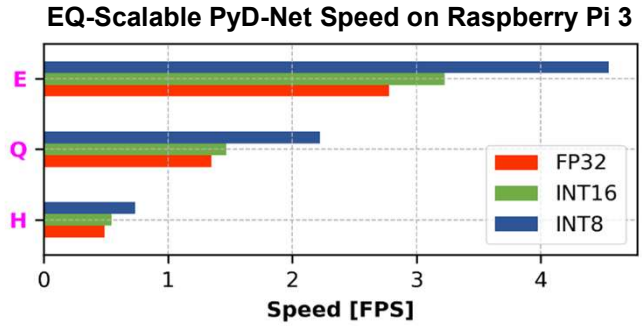


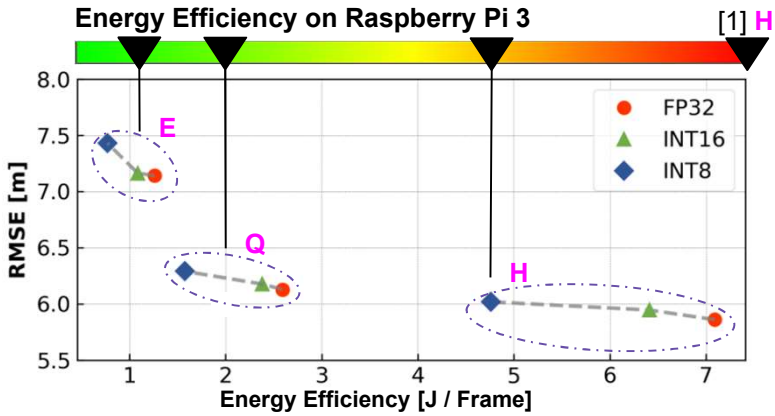


Energy-Quality Knobs

Coarse-Gain: PyD-Net infers disparity maps at different resolutions (H,Q,E) due to a reconfigurable architecture.
Fine-Grain: a quantization engine can shift the PyD-Net from 32-bit Floating-Point to 16-/8-bit INTeger.







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

[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