

38: Operational Refinement of Image Processing (ORIP) Demonstrator

Abstract: ORIP is a software framework that, in its current version, realizes *incremental computation* of transform decompositions, 2D convolution and frame-by-frame motion estimation with fully-scalable output-quality vs. processing-throughput characteristics. The uniqueness of ORIP is that it processes each input frame progressively and the results are produced with increased precision for increased processing time. In this demonstrator, ORIP is ported on the OLPC (“100\$ laptop”) low-power multimedia platform for real-time frame capturing and processing with dynamically-adjustable quality vs. throughput.

Motivation for creating ORIP: We have witnessed a significant volume of research on multimedia streaming to bandwidth-constrained wireless (portable) devices. However, currently there is very little work addressing the synergy between the *system layer* (software design, processor, task scheduler) and the *multimedia application layer* (e.g. image processing task, such as filtering). As a result, even though existing wireless infrastructure technology may provide for sufficient bandwidth for high framerate/high resolution video transmission, the device capabilities (e.g. battery life, uncertain task scheduling deadlines) remain a significant bottleneck. For example, if one is watching a streamed movie on a multimedia-enabled mobile phone and this is draining the system resources (battery), current systems do not allow for seamless tradeoffs in visual quality vs. battery life (execution time per task). In such cases, the user is practically facing the on/off approach of digital systems, while one would strongly opt for a best-effort approach, often found in analogue systems, where energy autonomy would be increased with graceful degradation in the decoded video quality. We created ORIP as an early prototype that systematically addresses this challenge.

Overview: ORIP achieves progressive computation of image processing algorithms commonly used in coding systems based on the combination of bitplane-based computation with a recently-proposed packing approach that enables the calculation of multiple limited dynamic-range integer operations via one 32-bit or 64-bit arithmetic operation. Based on the derived design, ORIP is capable of stopping *virtually any time* during the frame processing and providing the result up to the computed precision. This provides for truly complexity-distortion scalable computation with a linear relationship between the average processing (execution cycles, drop in battery power level, or memory accesses) and achieved fidelity (distortion) measured via signal-to-noise ratio (SNR) or peak-signal-to-noise ratio (PSNR). A detailed description of ORIP is given in our synonymous paper in DATE’10. The current version (v2.0) is also available online for non-profit purposes at

www.ee.ucl.ac.uk/~iandreop/ORIP.html.

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