Real-Time Low Power Software HEVC Decoder on Embedded GPP: A Side-by-Side Comparison

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***Abstract*—Video on mobile devices is a must-have feature with the prominence of new video-centric services and applications such as streaming or conferencing. By improving the compression performance by a factor of two with a similar image quality, the new video standard High Efficiency Video Coding (HEVC) is an appealing technology for service providers. Besides, with the recent progress of Systems-on-Chip (SoC) for mobile devices, software video decoders are now a reality. They offer a high flexibility of implementation as well as a means to rapidly deploy HEVC on existing devices without waiting for compatible hardware solutions. In this context, a challenge is to design a power efficient system that fits the compelling demand for long battery life on mobile devices. In this demo, a subjective evaluation of a low power HEVC decoder is presented on a big.LITTLE ARM-based embedded development platforms. It shows the performance of a standard compliant decoding system versus a low power decoding system in a side-by-side format on two 9-inch displays. Power savings close to 7% have been demonstrated on the whole energy consumption of a mobile device by using low power decoding.**

I. Introduction

A high pressure is put on portable devices to support a wide range of applications from telecommunications to multimedia services. Embedded systems require an ever greater onboard processing capacity. Thanks to recent advances, modern Systems-on-Chip (SoC) can offer the necessary processing capacity to software defined applications. Hence, many applications that were traditionally hardwired can now be implemented in software, increasing flexibility and shortening time-to-market. This is particularly the case of the latest video standard High Efficiency Video Coding (HEVC) [1], [2]. However, high computational capacity comes at the cost of a high power consumption if no precaution is taken at the design phase. As mobile video will generate more than 69% of mobile data traffic by 2019 [3], it is crucial to provide a sufficiently long battery life to high-end devices when decoding video. This battery life is directly affected by the energy needed for the decoding.

Acknowledging that video on mobile devices will secure the future of video compressions standard, MPEG issued a Call for Proposals (CfP) on energy-efficient video consumption called Green Metadata [4]. In order to extend battery lifetime, one may choose to trade the Quality of Experience (QoE) for energy efficiency. Within this scope, we propose a software-based modified HEVC decoder that reduces the overall decoder complexity. Using this decoder, power savings close to 7% have been demonstrated on an on-the-market device with a slight degradation of the QoE [5]. The device is a Samsung GT-i9070 which embeds a dual-core 1GHz Cortex-A9 General Purpose Processor (GPP). Results presented in [6] show a comparison between an optimized compliant decoder and an optimized tunable one achieving up to 22% decoding-time reduction in the optimized tunable decoder compared to the optimized compliant decoder.

In this demo, we show that pure software decoders can achieve real-time HEVC decoding thanks to multi-level optimizations [7]. This is particularly appealing for service providers that want to deploy HEVC rapidly on devices that do not natively support HEVC decoding. Secondly, we propose a subjective comparison between the proposed HEVC decoder and a compliant one through a side-by-side demo on two 9-inch displays. This demo allows the viewers to assess the slight degradation of QoE induced by low power decoding. Last but not least, instantaneous power consumption of CPUs, memory and GPU is displayed on the screens thanks to power sensors integrated in the platform.

II. OpenHEVC decoder for Mobile devices

Targeting power efficient HEVC decoding, we propose here a modified decoder structure. The modified HEVC decoder was presented at Green MPEG ad hoc group [8]. A typical HEVC decoder is depicted Fig. 1. Based on the high relative complexity of the filtering functions in the legacy decoder, the proposed modified HEVC decoder substitutes simplified filters for legacy HEVC filters. This implementation is detailed in [9], an optimized version is presented in [6].

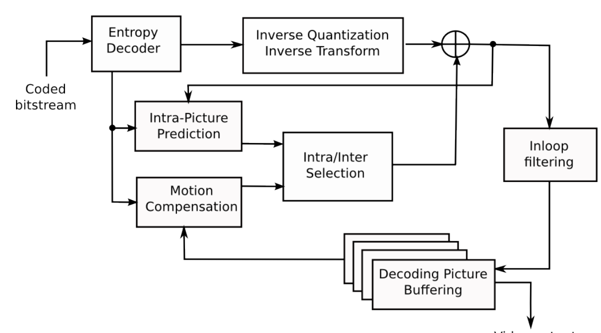

Fig. 1: Simplified diagram of an HEVC decoder.

III. Bench Set-Up

In this section, the demo test bench is depicted as well as the software set-up.

On the hardware side, two identical systems are used as shown in Fig. 2. The embedded development platform is an Odroid-XU3 based on a quad-core Samsung Exynos5422 CPU with Cortex-A15 @2.0Ghz and a quad-core Cortex-A7 CPU in big.LITTLE Heterogeneous Multi-Processing (HMP) configuration. This platform does not embed an HEVC hardware decoder. The display is done on an Odroid-VU, a 9-inch 1280x800 pixels TFT LCD HDMI screen with a 10-point capacitive multi touch surface.

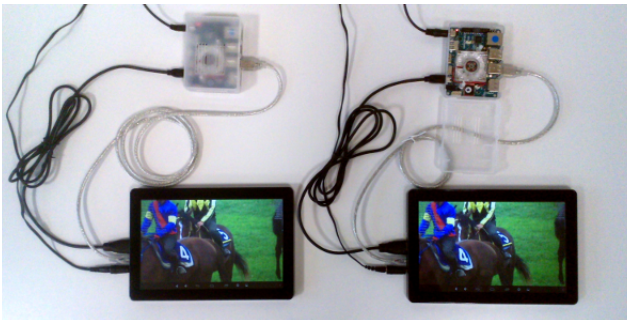

Fig. 2: Bench set-up

On the software side, Android 4.4.4 runs on each platform with *Interactive CPUFreq* governor which drives Dynamic Voltage Frequency Scaling (DVFS). Moreover, thanks to dedicated power sensors, the system can read and display the instantaneous power consumption of CPUs, memory, and GPU as well as the CPU frequency.

The HEVC decoder is taken from the standard compliant implementation named OpenHEVC [10]. The modifications applied for low power decoding are described in our previous work [9][6]. Real-time management of video rendering is performed with the Android version of the GPAC [11] client software.
The reference input HEVC bitstreams, named RaceHorses [12], are used with a resolution of 832x480, at 30 frames per second (fps), with different Quantization Parameters (QP). Each bitstream is encapsulated in an MP4 file using the MP4Box utility.

IV. Conclusions

In this paper, a real-time software HEVC decoder is presented for a demo on an on-the-market embedded platform with no native HEVC hardware decoder. The real-time constraints necessary to standard mobile services and applications relying on the HEVC standard can be met. We also present a subjective comparison between a proposed low power HEVC decoder and a standard compliant one through a side-by-side demo on two separate 9-inch displays. This demo provides assessment of the slight QoE loss due to low power decoding. Finally, the proposed low power software HEVC decoder can achieve power savings with a limited impact on the QoE. Hence, it can improve the stand-by-time of battery powered devices. In a future work, our HEVC decoder will embed more power efficient schemes such as voltage and frequency control to make further energy savings.

Acknowledgment

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