Power Consumption of Android Device Using Different Video Codecs: An Analysis

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***Abstract*— Power is a critical factor for working of hand held devices. The video applications are one of the widely used functionality of hand held devices and are prime factor for deciding the usability of product. These video applications are consists of complex algorithmic operations which depend on codec used for video. Because of difference in complexity these codecs, the power consumption is also different. The work presented here analyzes the power consumption for different video codec for same video on Android device. It gives the better view of power consumption for the device running on battery as power model used for calculation computes the power consumed in mAh unit. The results show that the video codecs in descending order of their power consumption are DivX, MPEG 4, H 264, and Xvid.**
Keywords—power consumption, video codec, Android device,

I. INTRODUCTION

Video application is one of the major factors for usability of a handheld device [1]. These applications when execute on battery consumes significant amount of energy due to high operation complexity. The complexity is directly related to video codecs used for compression and decompression. The expected growth in capacity of battery is around 5% to 10% every year [2]. This growth was fine when the usage of handheld devices were limited. Now the devices are giving additional features like high speed 3G connectivity, Wi-Fi hot spot for internet sharing, internet messaging, VoIP etc. These features are very costly in terms of power consumed. One way of reducing the power consumption is to power optimizes the complex calculations. Identifying this region is difficult task, especially when the device is running on battery. Traditional way to calculating power consumption for these devices by removing battery and connecting resister in parallel could be misleading as it will consider the power consumption by additional hardware also and its effect on overall power consumption is unknown.

In order to analyze the effect of video codecs on power consumption of device the same video is encoded using four codecs DivX, XviD, MPEG-4 and H.264/AVC using SUPER© software. The power consumed by these codes is measured by Little Eye software installed on a Windows 7 desktop to which Akash UbiSlate7C+ is connected through USB interface provided with the tablet.

II. RELEATED WORK

For analyzing and optimizing circuit in hand held device, in [3] Aveek, Shen and Kai have used full-chip level capacity with transistor level accuracy. The method can be used for transient simulation and DC average current analysis. Omar and Sandip in [4] have proposed architectural-level mechanism for exploiting intra thread variation in order to increase power performance efficiency. The offline empirical model used can deliver 35% power-performance efficiency. In order to manage power for streaming application, integrated power management is used in [5] which is able to save 70% of energy consumed by wireless network interface. The analysis shows the relationship between integrated frameworks supporting tight coupling with user experience on handheld devices.

The survey done by Antonio Nunez in [6] explains need of multidisciplinary approach for video codec in hand held devices. The work give emphasis on combination of architecture, design and algorithm for development of better resource efficient model of hand held device. Martien, Hrishikesh and Gabriel have tried to analyze the energy consuming component in [7] for saving energy of an application. Energy efficient display is majorly focused component in this. Jaehoon and Seungmoon in [8] have analyzed power consumption by vibration motor which is used for vibration alert in hand held devices. It shows that increasing power do not affect its performance which supports the existence of power independent performance for some component. Sangwon et. al. have tried to reduce the power consumption in[9] by using Diet SODA for DSP application. The proposed technique is 340 times more power efficient than the original.

III. POWER MODEL USED

The power model used here is given by Littttle Eye tool which is based on are supported power models- Google Nexus One and Google Galaxy Nexus [10]. The tool automatically selects the appropriate model as per the device used. The power model is based on following parameters which are utilized by an Android application:

A. CPU

While considering CPU for power consumption it is necessary to check for number of cores as increasing number of cores and mapping appropriate task to it, is an efficient way for power consumption reduction. Power consumption also depends on frequency stepping of the processor and frequency scale. In order to check duration of power consumption CPU cycle consumed is taken into consideration.

B. Display

For checking the power consumption by display brightness of screen is considered. Here based on a uniform sample actual color of pixels on the screen is also used.

C. Wifi Radio

The power model considers Wifi radio state and power levels of Wifi Radio as they are vital components which consume very high power. Although for this analysis there is no role of this factor.

D. 3G Radio

For calculating the power consumed by a 3G radio same approach as in Wifi radio is used. Here also radio state and power level is considered.

E. GPS

For GPS three states are being considered: On, Off, Looking for fix.

IV. BACKGROUND

A. DivX Codec

DivX is one of the most common video codec used for movies, especially in DVD players. It overcomes the problem of saving MPEG-4 streams into AVI format for Microsoft's encoders. Because of increasing storage capacity for hand held mobile and high bandwidth, viewing movies on these devices is common. So it is one of important codecs for analyzing. [11]

B. H.264

H.264 is one of the popular codecs for video compression in industries, as it takes less capacity for storage and transmission. It is very popular for online video on demand and for video conferencing, making it center of attraction for analysis. [12]

C. MPEG-4

MPEG-4 was developed in 1998. It is having the capability of both MPEG-1 and MPEG-2 through which it gives more support to Virtual Reality Model Language. It gives flexibility of assigning profiles and levels to define functions for some applications [13][14]. This codec is very common for music video in hand held device.

D. XviD

Xvid (formerly XviD) codec is based on MPEG-4 standard. It is having features like b-frame, global and quarter pixel motion compression etc. which are inherited from Advanced Simple Profile. It is another frequently used codec for video application. [15]

V. EXPERIMENT SETUP

For analyzing a Android device it is necessary to have Java JRE or SDK - V 1.6 + (Java 6 or above) and Android SDK installed in the system as per operating system version of android device as well as system. Before starting the monitor it is necessary to enable debugging mode from "Setting" option in android device which is available under "Developers Option". This feature is common to the entire Android device.

The device is connected to system through micro USB cable. Little eye power monitor is used for monitoring the power consumption for different codecs. The little eye software in system is capable of listing all the applications running on device in the system. The appropriate video player application can be selected for monitoring based on the power model. To calculate power consumed by video application, monitor must be activated almost at the same time when video start playing in the device. The graphical results can be analyzed for further study.

VI. EXPERIMENTAL RESULTS

The results are analyzed on five video samples for four video codes:" DivX, XviD, MPEG-4, H.264/AVC". To make the comparison more generic, technical specification for all video samples are kept same. Each sample is having video scale size of 560:320, 16:9 aspect, 25frame /sec and 1008 Kbps bitrate.

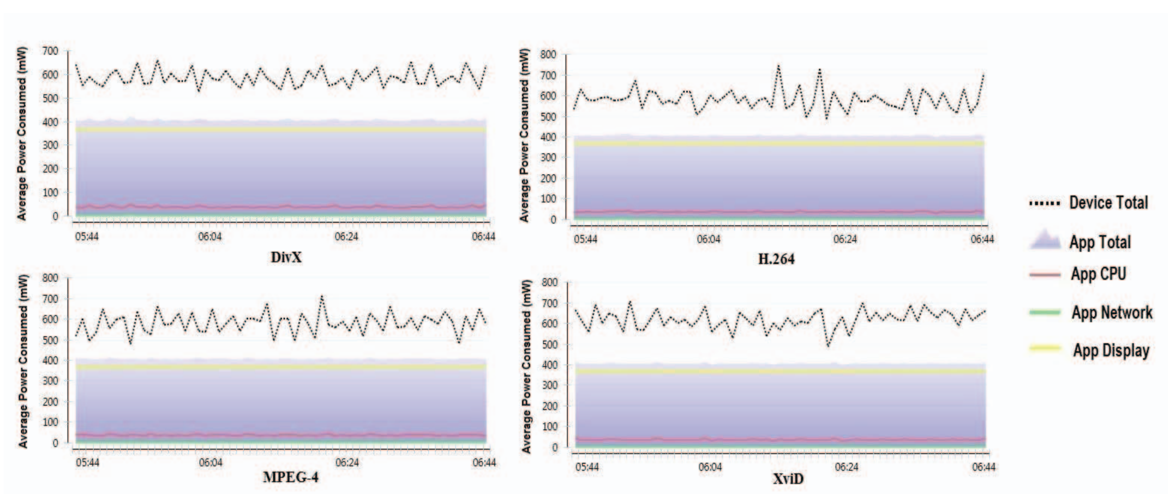

Figure 1. Average power consumption vs time graph for sample I

The audio encoding for all samples consists of sampling frequency of 22050, 2 channels and 64Kbps bitrate.

These common standards are applied on video samples of different types in order to make a valid comparison of power consumption. Sample I is a video of a game console having duration 6 minutes 51 second. Sample II is an animated video of duration 5 minutes 16 seconds. Sample III is a Hindi music video of duration 4 minutes 56 seconds. Sample IV is a trailer of a Hollywood movie of duration 2 minutes 31 seconds whereas sample V is a trailer of a Bollywood movie of duration 3 minutes 41 seconds.

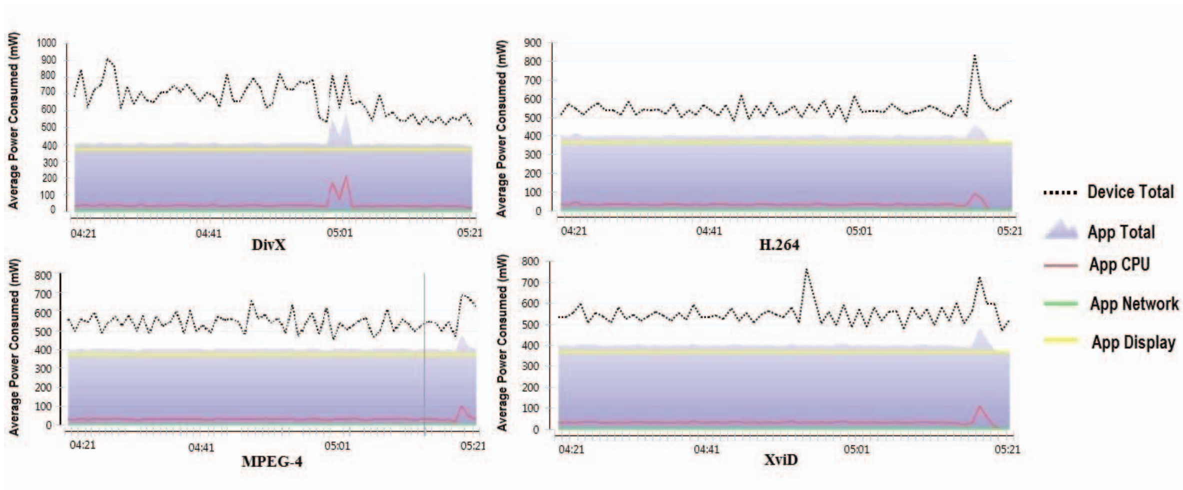

Figure 2. Average power consumption vs time graph for sample II

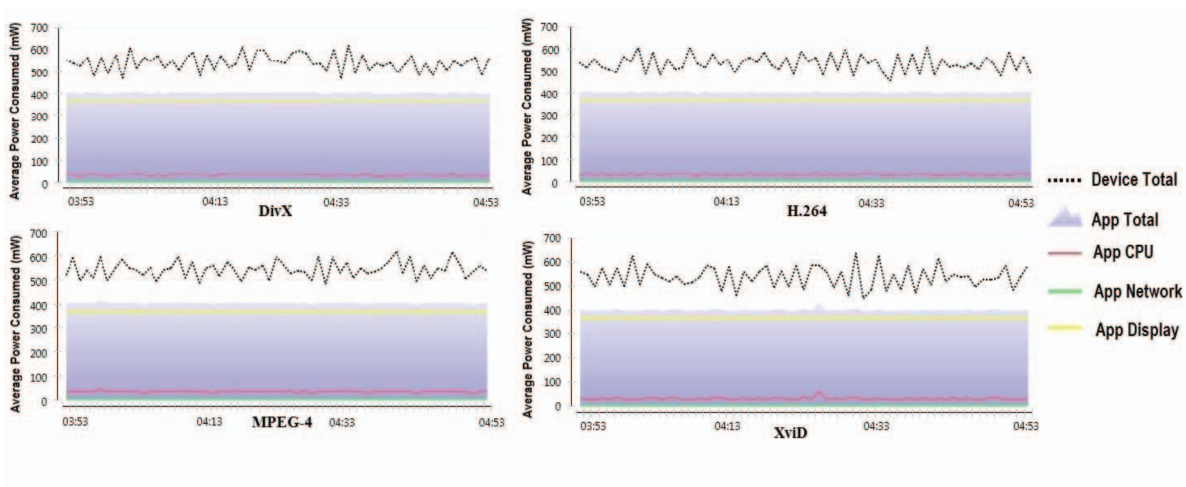

Figure 3. Average power consumption vs time graph for sample III

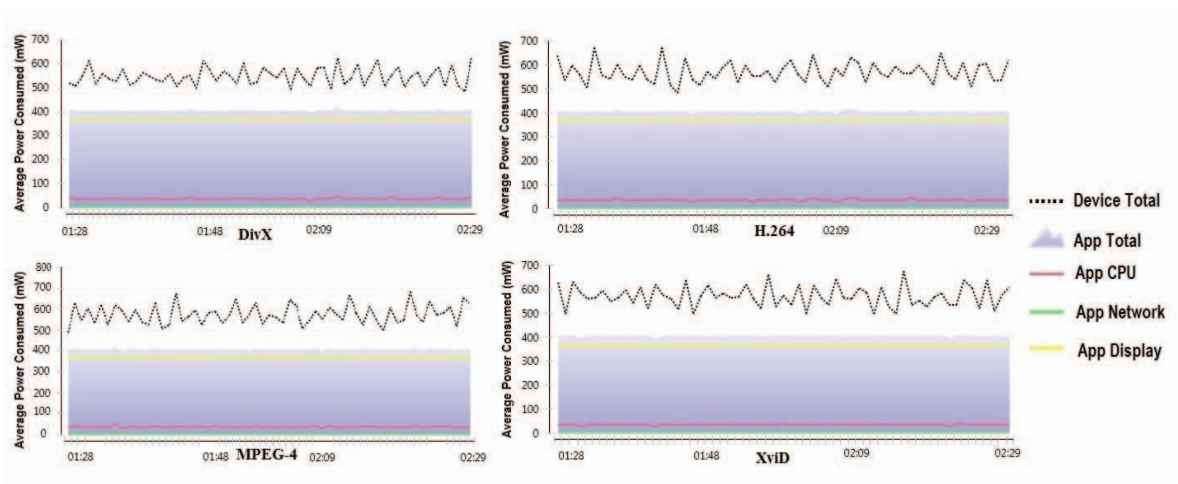

Figure 4. Average power consumption vs time graph for sample IV

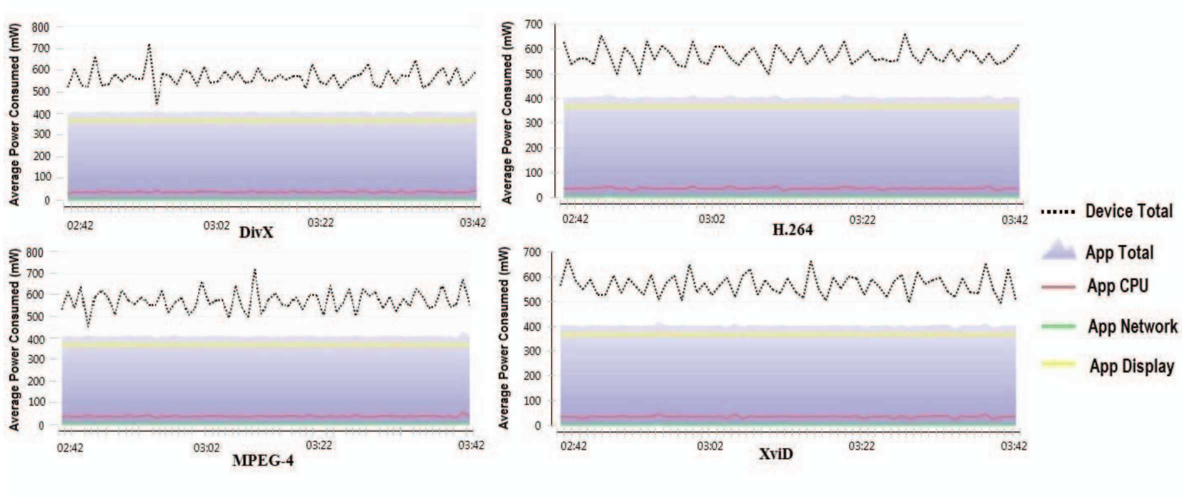

Figure 5. Average power consumption vs time graph for sample V

TABLE I. POWER CONSUMPTION COMPARISON FOR DIFFERENT VIDEO CODECS.

	DivX	H.264	MPEG-4	XviD
Sample1	12.36 mAh	12.19 mAh	12.23 mAh	12.16 mAh
Sample 2	9.82 mAh	9.59 mAh	9.65 mAh	9.57 mAh
Sample 3	8.88 mAh	8.80 mAh	8.82 mAh	8.74 mAh
Sample 4	4.59 mAh	4.51 mAh	4.54 mAh	4.50 mAh
Sample 5	6.78 mAh	6.72 mAh	6.73 mAh	6.72 mAh

TABLE II. AVERAGE CPU USAGE FOR DIFFERENT VIDEO CODECS.

	DivX	H.264	MPEG-4	XviD
Sample1	6.81%	6.46%	6.65%	6.24%
Sample 2	6.71%	6.27%	6.70%	6.27%
Sample 3	6.69%	6.38%	6.63%	6.21%
Sample 4	6.72%	6.64%	6.72%	6.24%
Sample 5	6.66%	6.52%	6.67%	6.29%

VII. ANALYSIS

The result obtained are clearly showing variation in power consumption for the same video when codecs are different. From Figure 1,2,3,4 and 5 it is clear that, not only overall power consumption but trend in variation of power consumption during running of video application is also different. Table I shows that Divx is the highest power consuming codec followed by MPEG-4, H.264 and XviD for all five video samples. This is supported by the fact that average CPU usage for these codecs also follows the same order which is shown in Table II. The naked eye can not differentiate between video composed of different codecs, so power can be reduced while maintaining usability.

Since these video codecs are designed for specific purpose, for example H.264 is used for video calling application. So it is not suggested to replace the existing codec by a low power consuming codec in all the applications. Instead focus can be on optimize the existing codecs so that they are specific to the application area as well as power consumption is also minimal.

VIII. CONCLUSION AND SUMMARY

The proposed method for monitoring power is one of the simplest ways which does not require any additional hardware support. Unlike previous methods, the proposed method gives clear impact of codec on power consumption since unit of calculation is milli-Ampere hours which is more closely relates to battery rather than power calculated in Joules. The result exhibits variation in power consumption and average CPU usage for same video samples with different video codecs.

For future work, video codecs can be optimized by identifying hot spot of power consumption while maintaining its application.

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