Fourth Version of Terminal Device

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MOBILE3DTV

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Abstract: This report describes the design and implementation of the fourth version of the terminal device. In this version, the final form factor of the mobile device has been designed to include all components of the final system. Namely, the processing platform has been designed and coupled to newer version of NEC auto-stereoscopic LCD. New software support for the key project-specific components such as for processing and playing stereo video content, have been developed as well. This includes a new DSP version of the MVC decoder and new drivers for the Android operating system.

In this version, the final form factor of the device has been improved. It contains now the final auto-stereoscopic display and the DVB-H receiver as a chip, both integrated into the platform.

Keywords: OMAP, DVB-H, auto-stereoscopic LCD

Executive Summary

The fourth version of the terminal device (prototype) has been developed. Compated to the third version, the final form factor has been improved. All components such as the processing platform, auto-stereoscopic LCD, and the DVB_H receiver have been coupled together and operate simultaneously. A new hardware platform have been developed to reach the form factor and the functionalities of a modern PMPs (Portable Media Player) enriched with Mobile 3DTV features such as a modern auto-stereoscopic LCD and DVB-H receiver.

The newly developed HW components are as follows:

- The new version of the auto stereoscopic LCD (NEC) module was integrated.
- The new version of the processing platform (OMAP3621) in a new form factor confirming the requirements of the modern consumer PMP.
- The housing for the device reflecting the form factor of the processing platform is being designed as a “rapid prototype”, and will be finalized after the full design is stacked up.

Key SW components and tools have been ported and used to support this version of the mobile terminal device. Those are the platform-specific operating system, file system, tool-chain, DVB-H low level drivers, auto-stereoscopic LCD drivers and a multi-view decoder based on H.264 decoder. For the fourth version, the Android OS has been ported. It is characterized by growing popularity and the availability of many additional software tools and applications.

New HW and SW components have been integrated. A new version of the multi-view decoder has been designed based on an DSP implementation. After integration, the device software provides the capability to decode and render stereoscopic video content in MVC from stored files or received via the DVB-H (DVB-T) broadcast.

Table of Contents

Description of the fourth version of the mobile terminal device

Form factor of the terminal device

For the fourth version of the terminal device a new portable platform has been developed. It improves the form factor of the device as it turns it to a PMP (Portable Media Player) device, with all the additional features needed for the Mobile 3D TV project.

Compared to previous versions, the platform has been fully redesigned. The dimensions of the PCB are 100x52mm which gives the device modern form factor.

Fourth mobile terminal device HW features

The device HW incorporates:

- New processing platform developed by MMS integrating OMAP3621, 2Gb LP-DDR, and 16GB eMMC;
- New auto-stereoscopic display module, procured from NEC LCD
- DVB-H receiver chip, integrated to the platform
- Battery and wall adapter power
- Integrated audio system
- Navigation buttons
- Connectivity options – WLAN, Bluetooth, FM, UART, USB host and function
- Debug interfaces – JTAG, UART

Fourth mobile terminal device SW support

The Fourth version of the device works under Android OS. All the drivers required for the hardware operation have been ported to for that OS. Fully operational Android GUI with all features available in the OS has been added to the device.

Design of the processing platform for the fourth mobile terminal device

Design of the processing platform

Block diagram of the device is shown in Figure.5. This diagram shows the main features of the device.

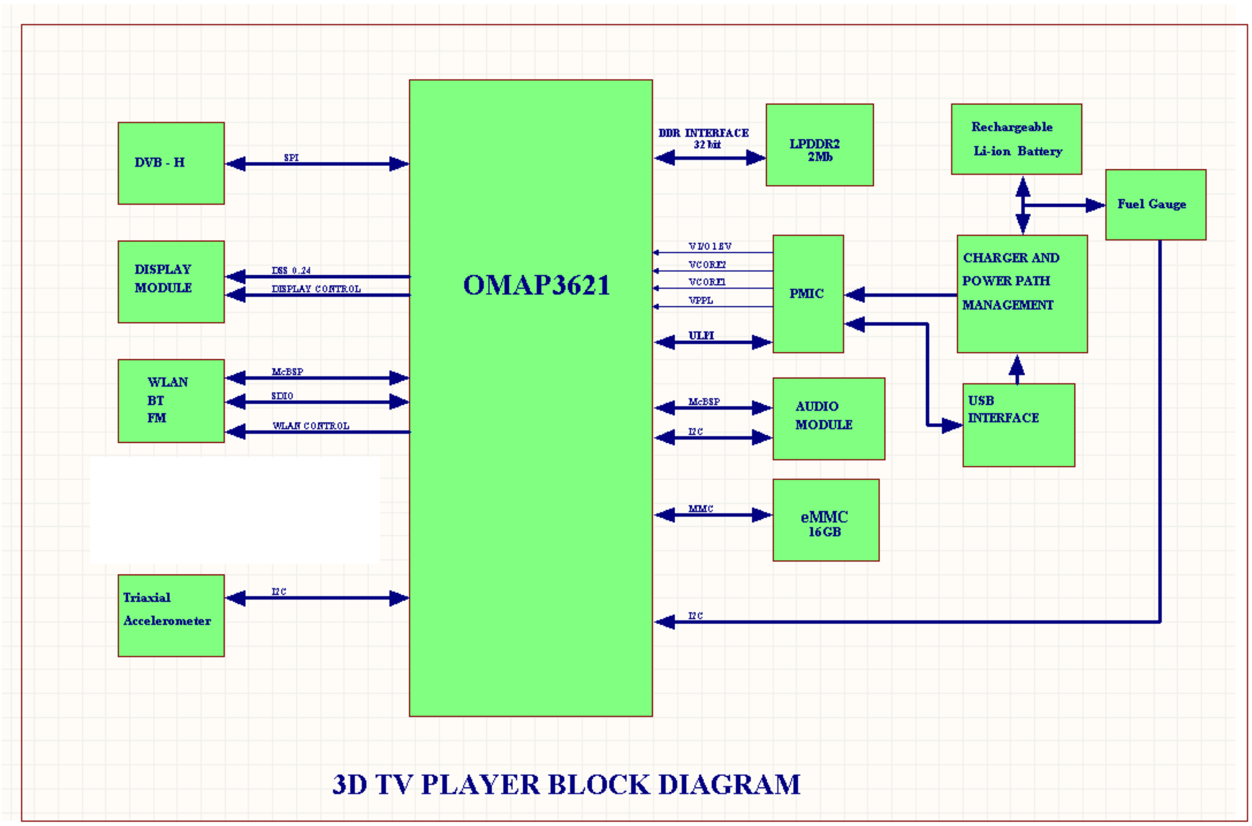

Figure 1. 3D TV player block diagram showing the main features

Additional features

The new fourth version of the device has combined the third version SOM module and mainboard into single board with better form factor. New features have been added, typical for modern devices of that type.

Additional features are:

- Audio module – Low-Power Audio Codec With Embedded miniDSP and Stereo Class-D Speaker Amplifier
- Accelerometer - used to detect any movement of the device
- Battery charger and Li-Ion battery – to assure the mobility of the device

- W-lan
- Bluetooth
- FM radio
- USB Battery charge
- Microphone – for voice recording

Housing of the third mobile terminal device

A new housing has been designed. The main requirement for the housing at this stage is the form factor of PMP. In particular, the new housing must hold the whole stack including the battery, the new PCB, the new display module (interface board and display). Holes for all plugs (USB, stereo phones, microphone, ect) should be considered in the design.

A “rapid prototype” housing for demonstrations is being designed and will be finalized after confirmation of the form factor of all physical parts in the stack.

Multi View Coding (MVC) H.264 decoder on DSP

Basic decoder

The developed version of hte MVC decoder has been based on a H.264 decoder implemented on the DSP size of the processor. The H.264 decoder has the following features

- eXpressDSP Digital Media (XDM 0.9 IVIDDEC compliant)
- Validated on the OMAP 3430 EVM
- Up to Level 3.0 features of the Baseline Profile (BP) supported
- Progressive frame type picture decoding supported
- Multiple slices and multiple reference frames supported
- CAVLC decoding using the iVLCD hardware accelerator provided on OMAP3430 supported
- In loop deblocking filtering is performed using iLF hardware accelerator
- All intra-prediction and inter-prediction modes supported
- Up to 16 MV per MB supported
- Frame based decoding with frame size being multiples of 16 and non multiples of 16 supported
- Outputs are available in YUV420 planar and YUV422 interleaved formats
- All resolutions up to and below WVGA including PAL and NTSC D1, CIF,QCIF supported
- ASO and FMO error concealment features supported
- Redundant slices supported
- Supplemental Enhancement Information (SEI) and Video Usability Information (VUI) supported
- NAL unit stream supported
- Reference picture list reordering supported
- Frame cropping and display with supported
- Configurable display delay supported
- Adaptive reference picture marking supported

Table 1 summarizes the performance of the TI AVC/H264 decoder giving cycles Information for 420 format as profiled on OMAP3430 ES 2.0 Hardware with Code Generation Tools Version 6.0.8.

Table 1. Profiling of TI H.264/AVC decoder on OMAP 3430

Configuration	Performance Statistics (in mega cycles per second)		
	Test description	Average	Peak
Level 3.0 Baseline Profile	football_5mbps_30frames.264n, YUV420, 4MV, VGA(640x480),@ 5 mbps	271	313
	fire_30frames_2_Mbps.264n, YUV420, 16MV, D1(720x480), @ 2 mbps	252	265
	fire_30frames_5_Mbps.264n, YUV420, 16MV, D1(720x480), @ 5 mbps	301	313
	call_log.h264n, YUV420, 4MV, WVGA (864x480) @ 1.4Mbps	189	280
	00005_854x480_H264_10Mbps.264, YUV420, 4MV, WVGA (854x480) @ 10Mbps	339	494
	harryPotter_800x480_30_BP_4MV.264, YUV420, 4MV, WVGA (800x480) @ 10Mbps	331	363
	coastguard_848x480_420_cavlc_BP.264, YUV420, 16MV, WVGA (848x480) @ 10Mbps	375	406
	cyclists_p864x480_420_BP_4MV.264, YUV420, 4MV, WVGA (864x480) @ 10Mbps	347	401

Memory setup: L1P cache=32k, L1D cache=16k, L2 Cache=64k.

Average: Based on average number of cycles per frame @ 30 fps.

Peak: Based on worst case number of cycles per frame @30 fps

Based on worst case cycles per frame @ 30 fps.

MVC requirements

Compared with AVC, MVC coding offers compression both in time and spatial domain, exploiting to the maximum the available redundancies of both domains, thus reducing the achievable transmission rate of the stream. Considering two views (stereo), in order to ensure backward compatibility, he base view is coded as a typical AVC stream. The additional view however is compressed spatially and temporally. Its decoding is based on several decoded reference frames from the base view and several decoded reference frames from the view itself (at different time intervals).

The NAL (Network Abstraction Layer) bitstream for MVC is more complicated than the one for AVC. Some NAL units (SPS, PPS, etc.) must be repeated in order to provide decoding parameters for both views. Additional features are added in their frame structure. New NAL units are added such as the Prefix NAL unit which precedes each new access unit. Reordering of the reference pictures of both the base view and the secondary view is supported. Once the reference picture lists (lists of decoded pictures used for reference during the decoding of a new picture) are set up, the DSP processing is the same for AVC and MVC. Therefore changes at the level of DSP decoding (prediction, DCT, deblocking , etc.) are not necessary and therefore have not been implemented.

Changes implemented in the H.264 decoder running on the DSP

The H.264 MVC decoder consists of the algorithm itself and a socket node (framework) to interface with the calling program. No changes have been done in the framework part. All the changes are in the algorithm part of the decoder. They include the addition of new NAL units, change of some existing ones, and their parsing and integration within the algorithm structure. The changes have been done only on the NAL level layer. All the DSP processing functions have been reused.

Based on the comparative analysis done in D2.2, and D4.3, only the Baseline profile have been implemented, i.e. only “I” (intra-prediction) and “P”(inter-prediction) pictures are present (no ‘B’ pictures) and the supported GOP size is therefore 1.

Two types of coding schemes have been tested. In the first scheme, both the base view and the secondary view start with an intra-predicted picture (I picture). In the second scheme, only the base view starts with an I picture whereas the starting picture of the secondary view is inter-predicted from the base view (“P” picture). Block schemes are given in Figure 5.

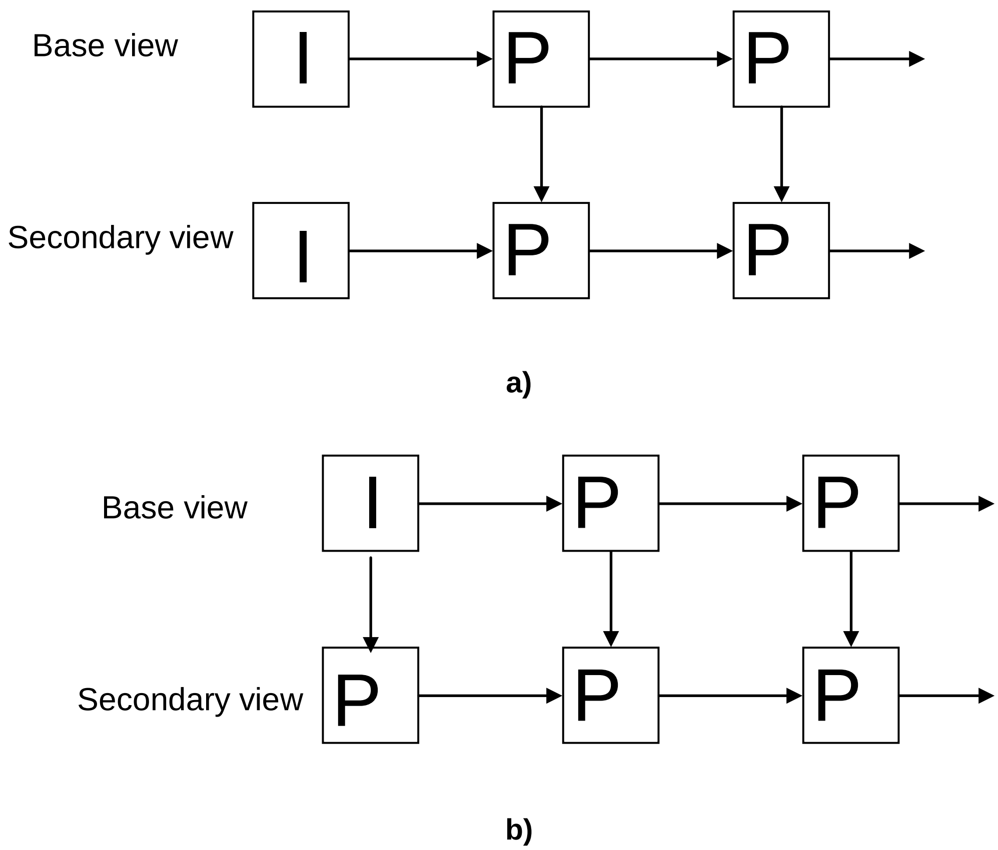

Figure 6. a) NAL ordering with I pictures in both views; b) NAL ordering with I pictures in the base view only

The implemented modifications have been tested on the OMAP3430 platform. The MVC (double-view H.264) decoder has been tested without the overhead from calling/setup functions. The settings for the tests are the following:

Picture size: 432 x 240 x 2

Frame Rate : 30fps

NAL ordering: I picture in the base view only

QP : 26

Intra - picture period : 15

Number of reference frames: 2

Input format: 420P

Table 2. MVC decoder cycles Information for 420 format – Profiled on OMAP3430 ES 2.0 Hardware with Code Generation Tools Version 6.0.8

Configuration	Performance Statistics (in mega cycles per second)		
	Test description	Average	Peak
Level 3.0 Baseline Profile	RhineValley..264 @ 2Mbps	203	221
	HeidelbergAlleys.264 @ 1.5 Mbps	185	281
	KnigthsQuest.264 @ 0.36 Mbps	143	202

Memory setup: L1P cache=32k, L1D cache=16k, L2 Cache=64k

Average: Based on average number of cycles per frame @ 30 fps.

Peak: Based on worst case number of cycles per frame @30 fps

Performance of the MVC decoder in test application under Linux:

ARM Cortex working frequency – 600 MHz

DSP C64 working frequency – 450 MHz

Picture size: 432 x 240 x 2

Frame Rate : 30fps

NAL ordering: I picture in the base view only

QP : 26

Intra - picture period : 15

Number of reference frames: 2

Input format: 420P

Table 3. MVC decoder frame rate Information for 420 format – Profiled on OMAP3430 ES 2.0 Hardware with Code Generation Tools Version 6.0.8 under Linux, using OMX test application

Configuration	Performance Statistics (in frames per second)		
	Test description	Average	Peak
Level 3.0 Baseline Profile	RhineValley..264 @ 2Mbps	78	66

Conclusions

Based on TI AVC/H264 decoder, a new decoder supported MVC has been implemented. The performance of the new decoder meets the requirements for a real-time 3DTV DVB-H stream decoding. This performance is achieved on lower working frequency, than maximum frequency supported from the OMAP chip. At the same time ARM Cortex MPU is used only as HOS MPU (Linux). This improves the parallelization between processing cores and enables integration of additional algorithms for post-processing of stereo video.

Mobile 3DTV Content Delivery Optimization over DVB-H System

MOBILE3DTV

MOBILE3DTV - Mobile 3DTV Content Delivery Optimization over DVB-H System - is a three-year project which started in January 2008. The project is partly funded by the European Union 7th RTD Framework Programme in the context of the Information & Communication Technology (ICT) Cooperation Theme.

The main objective of MOBILE3DTV is to demonstrate the viability of the new technology of mobile 3DTV. The project develops a technology demonstration system for the creation and coding of 3D video content, its delivery over DVB-H and display on a mobile device, equipped with an auto-stereoscopic display.

The MOBILE3DTV consortium is formed by three universities, a public research institute and two SMEs from Finland, Germany, Turkey, and Bulgaria. Partners span diverse yet complementary expertise in the areas of 3D content creation and coding, error resilient transmission, user studies, visual quality enhancement and project management.

For further information about the project, please visit **www.mobile3dtv.eu**.

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SEVENTH FRAMEWORK PROGRAMME

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