IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 3, March 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Design of Terrestrial Ultra-HDTV (UHDTV) Set-top Box

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Abstract

Increasing interest in immersive media service accelerates ultra-high definition (UHD) service realization. Several Korean broadcasters have started terrestrial UHDTV testing services for the first time in the world at the end of February 2017 based on the standard method which was fixed recently. However, large-screen of 60-inch TVs, which are aimed at UHD services, have been already on sale since 2013. In this paper, we present a design method of a set-top box for terrestrial 4K UHD broadcasting service. The proposed set-top box can be an efficient countermeasure against TV users who have already purchased large-screen UHDTVs.

Keywords: *Terrestrial UHDTV, Ultra-High Definition TV, Set-top Box*

1. Introduction

Increasing demand for realistic media service accelerates ultra-high definition (UHD) service realization. UHDTV is a next-generation broadcasting service that offers four times (4K UHDTV) more clear screen than existing HD broadcasting, and offers interactive services such as T-commerce and VOD. Indoor reception capability of UHD broadcasting is much better than the existing broadcasting, so if you have UHD antenna, you can enjoy ultra-high quality video in the terrestrial environment. The typical terrestrial broadcasting system, DVB-T2 [1], is one of the candidates for UHDTV transmission system. In ATSC, specification for UHDTV transmission system is underway with ATSC3.0 [2]. In Korea, terrestrial UHD broadcasting standard method was fixed and confirmed in September 2016.

Several Korean broadcasters have started terrestrial UHDTV testing services for the first time in the world at the end of February 2017. Also, the official service will start in Seoul and the metropolitan area of Korea at the end of May, and next year it will expand to nation-wide when the Pyeongchang winter Olympic Games will be held.

However, large-screen of 60-inch TVs, which are aimed at UHD services, have been on sale since 2013. Their reception method is somewhat different from the that of the current standardization. It is necessary to prepare countermeasures against TV users who have already purchased large-screen UHDTVs. One of the practical countermeasure is to deploy set-top boxes for terrestrial UHD broadcasting.

In this paper, we present a design method of a set-top box for terrestrial 4K UHD broadcasting service. The proposed set-top box can be an efficient countermeasure against TV users who have already purchased large-screen UHDTVs.

2. System Requirements and Model

The main function of the set-top box is to receive a terrestrial UHD broadcast signal, decode the signal, and display it on a display device. It is necessary to implement an RF signal reception module, baseband demodulation and efficient source decoding modules and a variety of interfaces for other home media or personal media devices. In addition, low power consumption, miniaturization, and image quality enhancement technology for UHD are required.

ATSC 3.0 supports video with a resolution of 3840×2160 at 60 fps (4K UHDTV). It also supports three video formats: Legacy SD Video, Interlaced HD Video, and Progressive Video [3]. Legacy SD Video and Interlaced HD Video support frame rates up to 60 fps and can only use the Rec. 709 color space [3]. Legacy SD Video and Interlaced HD Video are included for compatibility with existing content and can't use HDR (high dynamic range), HFR (high frame rate), or WCG (wide color gamut). The physical layer of ATSC 3.0 is based on orthogonal frequency-division multiplexing (OFDM) modulation with low-density parity-check code (LDPC) FEC codes [4].

3. Set-top Box System and Its Implementation

3.1 Set-top Box Components and Interfaces

In Fig. 1, we present an illustration of the proposed set-top box for terrestrial UHD broadcasting service and its interfaces with large-screen TVs which have already been sold to many consumers.

The set-top box is composed of several blocks; RF signal reception block, baseband demodulation and decoder block, external interfaces such as video/audio outputs, etc.

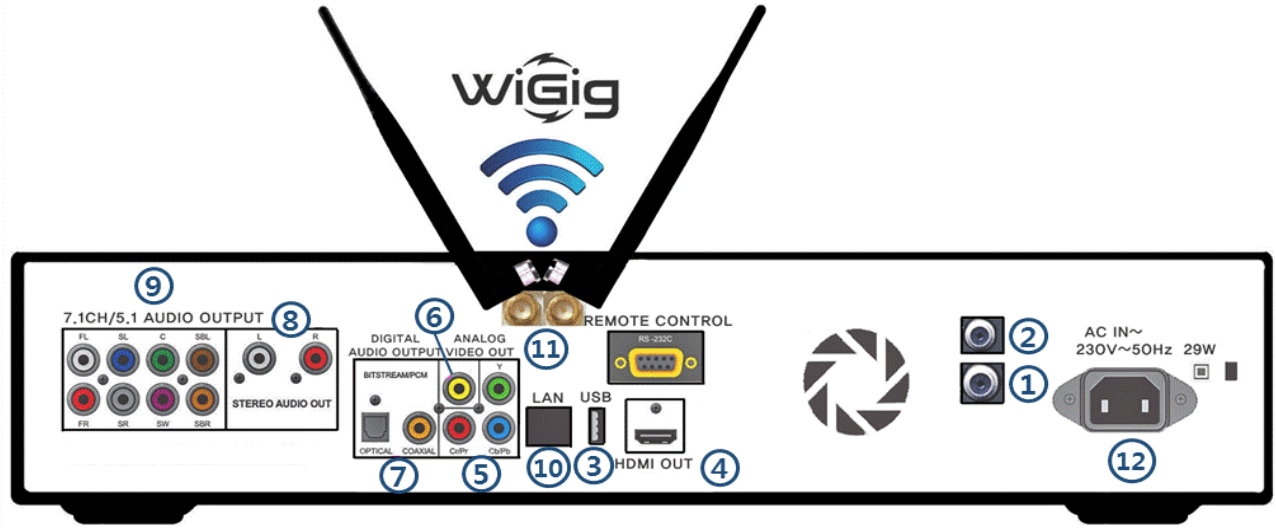

Fig. 1 Illustration of the proposed set-top box and its interfaces

(1) RF signal reception block

① terrestrial 4K UHD broadcasting(DVB-T2) reception antenna terminal

② terrestrial 4K UHD broadcasting(ATSC3.0) reception antenna terminal

(2) Baseband demodulation and decoder block

Internal baseband integrated chip - 4K UHD HD Dual Decoder (VC1/MPEGH.264/H.265)

(3) Recording and Play block

③ USB 3.0-external HDD interface for 4K UHD service recording with PVR or video play

(4) Video output

④ HDMI (HDMI 2.0) output- All TV connections with HDMI jack: 3840x2160@60p/30p, 1080p/i, 720p and UHD-Audio (maximum 32 channel support)

- In case of reception for 8K UHD service, 7680x4320 @120p/60p/30p, 3840x2160@60p/30p, 1080p, 720p

⑤ RGB component output- All TV connections with legacy TV (HD/SD): 1080p/i, 720p, 480p

⑥ Composite (Yellow) output- All TV connections with legacy TV (analog TV)

(4) Audio output

⑦ Digital audio output - optical(S/PDIF)/COXAL audio output-SD digital 5.1Ch audio output

⑧ Analog audio output - STEREO audio output

⑨ Analog multioutput - analog 5.1/7.1 audio output

(5) Network interfaces

⑩ wired LAN-1Gbps/smart TV function support

⑪ Wi-Fi-802.11ac(867Mbps) / Wi-GiG model for 8K UHD service reception

(6) Power supply

⑫ AC 100~200V

3.2 Block Diagram for UHDTV Set-top Box

In this sub-section, we present DVB-T2/ATSC3.0 dual-mode set-top box block diagram for terrestrial UHD broadcasting service. As we mentioned before, it is composed of several blocks; RF signal reception block, baseband demodulation and decoder block, external interfaces such as video/audio outputs, etc. The block diagram is shown in Fig. 2.

In the RF signal reception block, we consider two receive antennas. The terrestrial UHD broadcasting service requires very high data rate and high order modulation is indispensable. Therefore, the system requires higher C/N than the conventional HD broadcasting service, e.g. at least twice of C/N, in order to provide smooth service of terrestrial UHD broadcasting. The multi-input multi-output (MIMO) system can usually provide higher reception SNR in addition to diversity gain. In the proposed set-top box, we consider two receive antennas, which provide both higher reception SNR and diversity gain

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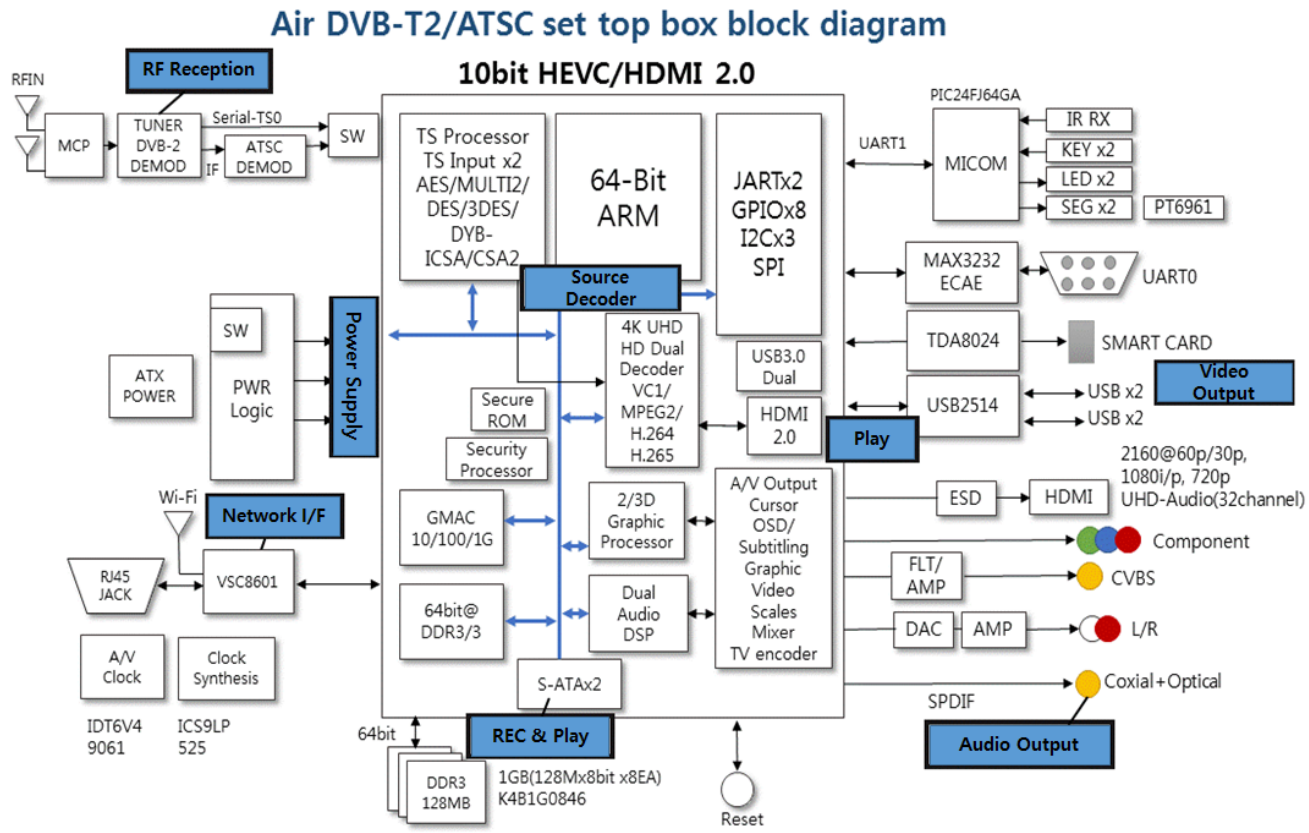

Fig. 2 Dual-mode (ATSC3.0/DVB-T2) set-top box block diagram

The tuner for broadcasting reception is designed to operate regardless of the broadcasting system. It allows you to watch legacy HD and UHD broadcasts in one system. When the user switchs the channels with a remote controller, the set-top box should switch automatically without inconvenience. In Fig. 3, the tuner is shown and its function is explained in short.

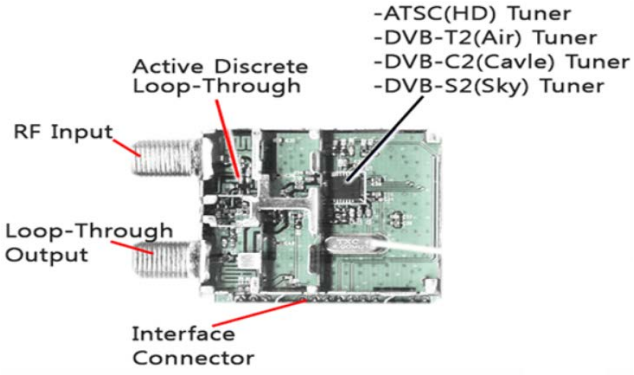

Fig. 3 Tuner of the RF signal reception block

The source decoder block is most important and power-consuming block which receives various kinds of incoming video and audio compressed signals, and restores (decodes) them to the uncompressed signals. Its controller block is implemented by 64-bit ARM core. The restored image and audio are sent to the video-audio output unit. The source decoder block must support both HD compression codec and UHD compression codec which is known as HEVC decoder.

The recoding and playback (R&P) block redirect the received signal from RF reception block to the SATA terminal and stores it in the internal HDD in order to replay later. The playback block can play the recorded video or various video files stored in the external HDD via the USB terminal. This playback is accomplished through the source-decoder block and the video-audio output block.

4. Conclusions

The terrestrial UHD broadcasting service is now scheduled to begin. Since large-screen of 60-inch TVs already began on sale before the specification was fixed. It is necessary to provide complementary measures to the users who have already purchased the TV. In this paper, we presented a

design method of a set-top box for terrestrial 4K UHD broadcasting service. The proposed set-top box can be an efficient countermeasure against TV users who have already purchased large-screen UHDTVs.

Acknowledgments

This study was supported by the Research Program (2016-0841) funded by the Seoul National University of Science and Technology.

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