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WHDVI: A wireless high definition video interface technique for digital home

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ABSTRACT

Owing to the rapid progress of semiconductor industry, the vision of digital home is getting more real. For this reason, many high speed transmission standards have been proposed. For digital home, multimedia sources come from various media players. Display media are also with this diversity. At present, the corresponding transmission standards are dedicated for some media players. This will be a bottleneck for integration of various multimedia systems. This paper proposes a wireless high speed video transmission system compatible for various digital media player and display media. This project can support various display resolutions from high-definition television (HDTV) (1280×720) to Blu-ray Disc (1920×1080). The core technology can be classified into two categories: (1). embedded compression techniques, (2). wireless transmission techniques. With the high integration on multimedia and communication technique, the proposed design exploits the realization on wireless high data-rate transmission in a digital home environment.

1. Introduction

The evolution of electronic technology has led to the development of the digital life. Owing to the great innovation of display and information technology, the stringent requirement of data capacity has been drastically increased in human daily life. This trend makes a significant impact on storage and communication evolution. Construct digital home contours can be used as shown in Fig. 1. For digital home, multimedia source comes from various media players, and multimedia displays are also with this diversity. The transmission with these high data rate video is still a critical challenge in digital home.

Some high speed transmission standards, such as high definition multimedia interface (HDMI) and digital visual interface (DVI), use wired connections. However, to satisfy the wireless transmission of high-rate video data in digital home, upgrading the transmission technique to wireless domain is unavoidable. Coupled with a wireless network to flourish, various wireless transmission specifications are starting to be worked out, and have attracted major plant investment support and research, like headed by Intel Wireless HD, Amimon launched Wireless HDI (WHDI), and Ultra Wideband (UWB). Concerning the bandwidth demand to provide a high transfer rate, 2–20 GHz spectrum has filled view of existing applications and services. These short-range wireless communications transmission techniques are designed for digital home interface and gradually toward to 60 GHz high frequency [1–3]. These norms are introduced with data rate 3–4 Gbps for lossless transmission of high-definition video.

Therefore, a new system, named wireless high definition video interface (WHDVI), is proposed in this paper to integrate various types of transmission interfaces in the digital home whole. It is well established as an integration of communication and multimedia considerations. Based on the proposed high quality video compression technique, embedded compression (EC), high transmission data rate of multiple gigabits per second on video is accomplished. With this high data-rate technique, the consumers can enjoy the original digital video device services by the wireless transmission of high-definition video technology to make all kinds of digital multimedia video devices integrated in the common transmission interface. This paper is organized as the order below. In Section 1, an introduction is derived based on digital home consideration. In Section 2, the system is proposed with respect to some well-known wireless transmission techniques. Based on the proposed system, the overall system architecture is presented in Section 3, including the video module and wireless transmission module architecture. Section 4 submits the conclusion.

2. System specifications

Several well-known wireless transmission standards are originally initiated by data transmission issue, such as IEEE 802.11n

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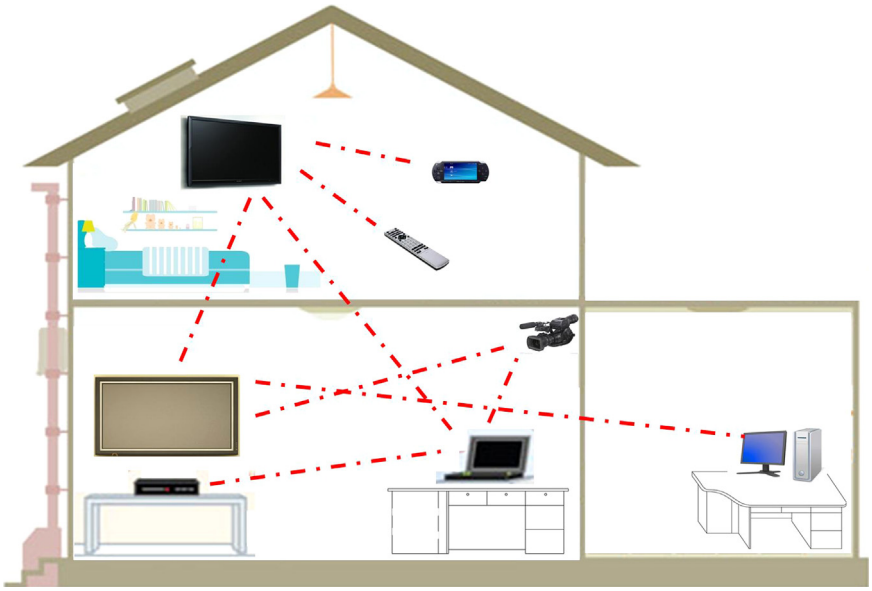

Fig. 1. Wireless digital home scenario [4,5].

and UWB. WHDI and Wireless HD are the standards designed for multimedia transmission consideration [6–10]. However several issues on the digital home are not fully explored, such as the multi-source application and lossless and/or near lossless video compression techniques.

These existing wireless transmission standards use unlicensed frequency bands [11]. However, the low frequency bands, e.g. 2.4 GHz, is too congested to have wide bandwidth, and consequently the high data rate could not be reached. To meet our needs in digital home, the rise of 60 GHz band is very suitable for the characteristics of high data bandwidth in this scheme. So the 60 GHz band is adopted to convey the multimedia.

However, under such a high carrier frequency, the transmission distance is severely affected by the air and obstacles [12], and the link distance is usually shorter than that under low carrier frequency. For example, to use 60 GHz unlicensed band in Wireless HD [13], its transmission distance is shorter than the WHDI of 30 m. Therefore, in the proposed system, the target transmission distance is 10 m.

The data rate is the next important assessment. When more and more data sources arise, data rate demand will be higher and higher. In addition to the number of data sources, the size of each image playback frequency (frame rate), as well as quality range are also considered. The amount of the number of data sources can be divided into the following situations:

1. Small number of sources, roughly 1–2.
2. Moderate number of sources, roughly 6.
3. Large number of sources, roughly 10–18.
4. Very large number of sources, roughly 30.

The devices in digital home support various image formats, for example, QCIF (176×144) or CIF (352×288), VGA (720×480) and 1080p (1920×1080). In order to analyze the distribution of the data bandwidth in a variety of circumstances, we have the number of screen size/playback frequency, as well as the information sources as a form of two axial data rate of each case shown in Table 1.

From Table 1, the number of data sources, the resolution of video size, and the frame rate are proportional to the data rate. In the general case, we may look at each of the respective TV channels, or some play games and even watching video sharing websites at the same time. Therefore, the data rate scheme in Table 1 reveals the family's daily life. In our system plan, we set the data rate to 3 Gbps to cope the variety application on video based application in digital home. For example, we can support the transmission with DVD-resolution screen playback with 6 sources, or even 30 CIF-resolution sources simultaneously.

Table 1
Video data rate with respect to screen size/playback rate and number of information sources.

The number of sources	CIF (352×288) @30 fps	DVD (720×480) @60 fps	720p (1280×720) @120 fps	1080p (1920×1080) @60 fps
1	72.99 M	497.66 M	2.65 G	2.99 G
2	145.98 M	995.32 M	–	–
6	437.94 M	2.99 G	–	–
10	729.9 M	–	–	–
18	1.31 G	–	–	–
30	2.19 G	–	–	–

In addition to the wireless transmission module, the video compression technique is developed elaborately and proposed in our previous literature [14]. This technique, called EC, provides the compression technique for high visual quality and high performance. It provides two different modes:

1. Lossless mode
2. Near lossless mode

In an ideal situation, video with lossless transmission is granted with best visual quality. However to provide a higher transmitted data rate, a near lossless technique is presented. This near lossless mode should be designed as even insensible to people on displaying. This is because in our digital home scenario, an excessive distortion of the video is unacceptable.

When the data rate is enough, the system will start lossless compression mode. If the data rate is tight, it will start slightly lossless compression format. Although the picture quality is not the same as the original image, but through the proper control of the amount of distortion, image distortion is hardly noticeable to the human eye. In our design, the compression ratio of lossless mode is about 2. For the compression ratio of near-lossless mode, it is reached to 3. The overall system specification is developed as in Table 2, also compared with other reference standard designs.