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## Design and Implementation of Pre-processing System for DMB Early Warning Information

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**Abstract:** In order to realize visualization transmission for early warning information, a pre-processing system of DMB (Digital Multimedia Broadcasting) is proposed. The system is mainly composed of information compression, TS (Transport Stream) combination, error correction and intelligent stream rate control. Due to huge amount of multimedia information, warning information is compressed firstly. Then, compressed multimedia information is combined to transport stream to output. In order to improve communication reliability, error correction is realized through RS (Reed Solomon) encoding and external convolution interleaving. Furthermore, because output stream rate is changeable, a method based on inserting null packets is proposed. By this method, output TS stream rate is constant at 384 kbps and it meets the further requirement of early warning releasing. The whole system has been validated by experiments and has outperformed former DAB (Digital Audio Broadcasting) preprocessing system for early warning information in both reliability and stability.

**Key words:** Early warning information, rate control, TS combination, error correction

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### INTRODUCTION

In recent years, with frequent meteorological disasters, great harm has been caused. Due to the short time resistance of occurrence and unpredictable hazard, it is urgent to release early warning information to the public rapidly and accurately. In spite of the variety of distribution means for early warning information transmission at present, there are still many problems, such as single transmission mode, transmission delay and so on.

Digital Audio Broadcasting (DAB) is based on digital technology and is the third generation broadcasting (Dong, 2001). It is now widely used in early warning information transmission field for its powerful data broadcasting performance. However, DAB can only transmit audio information and it can't meet the visualization transmission for early warning information. With the development of DMB (Digital Multimedia Broadcasting), audio, text and video information can be transmitted simultaneously based on DMB standard. Thus, people can require warning information by multiple ways (audio, video and message) in the shortest possible time. In addition, DMB has superior transmission performance, such as anti-noise, anti-interference and

high-speed. Based on above advantage of digital multimedia broadcasting, a DMB pre-processing system for early warning information is designed. The system is mainly composed of information compression, TS (Transport Stream) combination, error correction and intelligent stream rate control. The whole designed DMB pre-processing system has been validated at present. Experimental results have shown that pre-processed DMB early warning information has good error correction capability and stable transmission performance.

### DESIGN SCHEME OF THE SYSTEM

The DMB pre-processing system for early warning information is consisted of information compression, TS combination, error correction and stream rate control. The whole realization of the system is shown in Fig. 1. Early warning information is compressed firstly. Then, the compressed audio and video information are combined into TS packets based on the DMB transmission standard. In order to improve the reliability of data transmission, error correction is realized through RS (Reed-Solomon) coding and external convolution interleaving. After that, by inserting error protection information into the combined TS, security of information

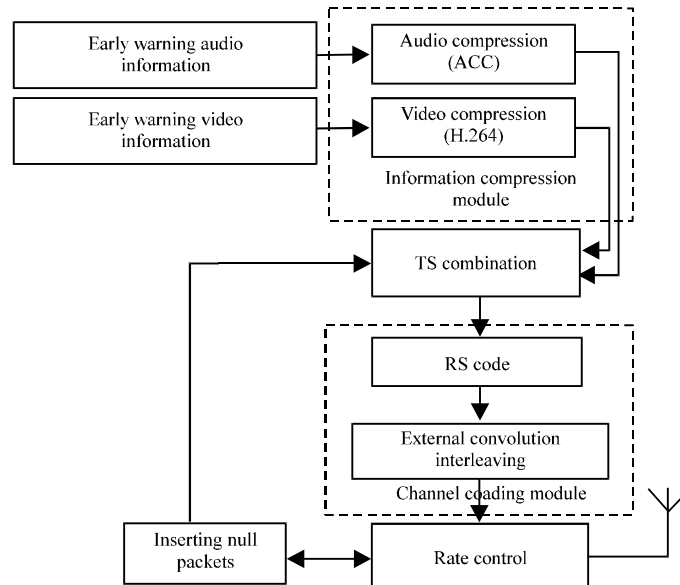


Fig. 1: Preprocessing system of DMB early warning information

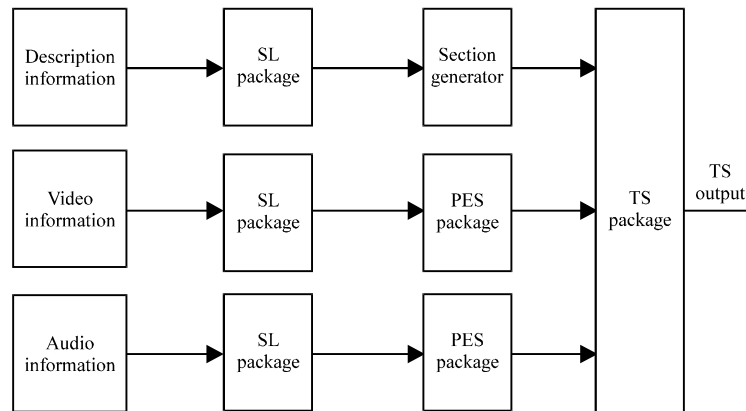


Fig. 2: Implementation process of TS (Transport stream)

transmission is improved. Finally, intelligent stream-rate control is realized to make the transmission stream rate stable and constant.

**DESIGN AND IMPLEMENTATION OF THE SYSTEM**

**Multimedia warning information compression:** In order to transmit visualization information for early warning information, efficient multimedia information compression is necessary. Early warning information is mainly consisted of audio compression and video compression. By using advanced technology of band recovery and parametric stereo, coding performance of AAC (Advanced Audio Coding) core encoder is greatly improved. For audio compression of early warning

information, the MPEG-4 HE AAC codec algorithm (Xu *et al.*, 2009) is used. Because H.264 algorithm outperforms MPEG and other classical video compression algorithms (Chivukula *et al.*, 2012) in both compressed ratio and visual quality, the H.264/AVC codec algorithm (Wei *et al.*, 2011) is used for video compression of early warning information.

**Implementation of TS (transport stream):** According to DMB standard, multimedia information transmission is realized through TS multiplexing form (ETSI, 2005). So, compressed multimedia information should be combined firstly and then it will be packaged to transport stream to output. The implementation process is shown in Fig. 2. During

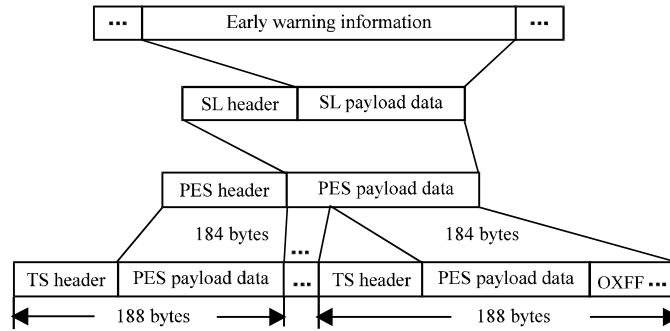


Fig. 3: TS (Transport stream) structure of early warning information

multimedia information transmission, supplementary description information is essential, such as relevant channels, configuration and synchronization information, which is mainly used to decode TS file. Description information should be also multiplexed in TS package in form of data segment. Thus, multimedia information which is included description information, video information and audio information is first sent to the SL (Synchronization Layer) package to realize synchronization. Then, output synchronization information is cut into the appropriate length with added header to form the PES (Packetized Elementary Stream) package. After that, PES package is put into the useful loading of TS package. Finally, TS packages are formed into transport stream to output.

According to the transmission demand of early warning information, a basic TS package structure is as followed in Fig. 3. Firstly, with the header part of SL package, compressed early warning information is added to part of SL payload data to form SL package. Then, with the added PES header, a whole PES package is constructed. After that, PES package is divided into several blocks whose length is fixed to 188 bytes according to the adaptive grouping demand for early warning information transmission. Finally, the header of TS package is added to each block to form TS package.

Among the whole process of TS implementation, how to realize synchronization between audio and video warning information is important. A synchronization method based on time stamp is proposed. As is known, time stamp is provided in SL header of SL package. There are two kinds of time stamps (You *et al.*, 2010), Decoding Time Stamp (DTS) and Composition Time Stamp (CTS). Furthermore, DTS indicates the decoding time of current block of elementary stream in the synchronization package and it is used as bi-directionally predictive frame (ISO/IEC, 2000, 2004). Similarly, CTS represents the composition time of current block of elementary stream. Because bidirectional prediction is not used in the whole

system, CTS is adopted to get time stamp information. According to time stamp information and system clock, cycle time of audio and video information can be calculated firstly. Then, on the basis of respective cycle time of audio and video information, synchronization can be realized by controlling corresponding coding time.

**Error correction coding:** To improve the reliability of warning information transmission, error correction is designed. Concatenate RS coding (Yang and Wang, 2010) and external convolution interleaving method are put forward to improve error correction performance.

According to RS coding (Claus and Jiang, 2009), 16 checking bytes are added to TS package in order to remove interference (Zhang and Liang, 2011). So RS (204,188) coding is used in the first step of error correction.

The field generating polynomial of RS coding is as follows:

$$px = x^8+x^4+x^3+x^2+1 \tag{1}$$

According to above expression, various elements of the Galois Field  $GF(2^8)$  coding and its corresponding decimal values can be calculated. Due to above values, the generator polynomial of our coding is as follows:

$$gx(x-\alpha^1)(x-\alpha^2)...(x-\alpha^{15}) \tag{2}$$

If the information polynomial of TS package is expressed as follows:

$$\mu(x) = \mu_{107}x_{107} + \dots + \mu_2x_2 + \mu_1x_1 + \mu_0 \tag{3}$$

Then the polynomial of coded information results as:

$$I(x) = x^{16} \mu(x) + x^{16} \mu(x) \text{ mod } g(x) \tag{4}$$

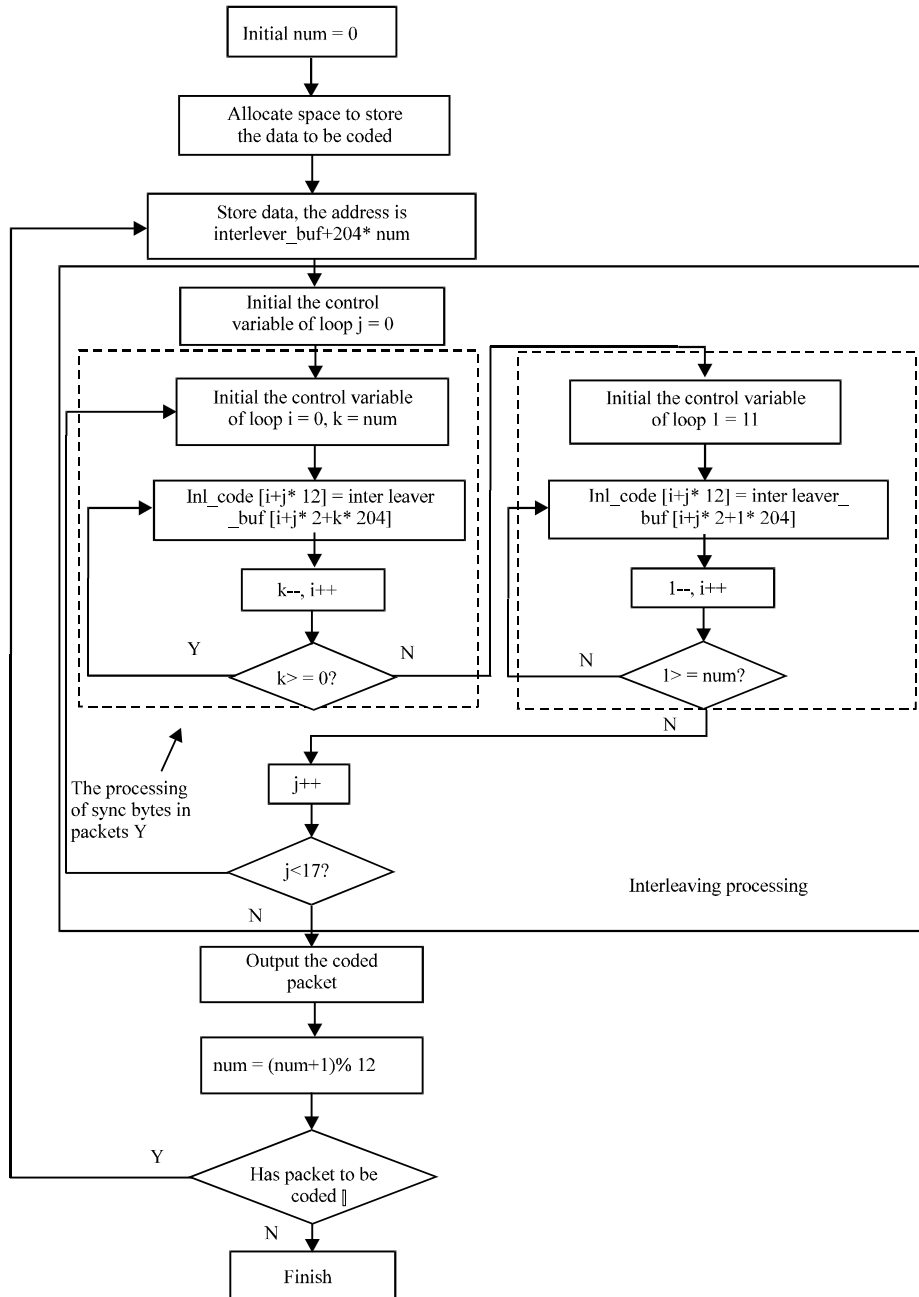


Fig. 4: Flowing chart of convolution interleaving coding

In the above expression 4,  $x^{16} \mu(x)$  corresponds to the 188 bytes of data information and  $x^{16} \mu(x) \bmod g(x)$  corresponds to the 16 bytes of checking part.

After RS coding, external convolution interleaving is used to improve error correction further. By convolution interleaving, the continuous error can be divided into several TS packets (ETSI TS 102 427) and errors can be corrected by RS coding (Lee *et al.*, 2005) in the decoder.

The depth of convolution interleaving is 12 bytes. Thus, the maximum length of continuous error which can be corrected in the decoder is 96 (8\*12) bytes (Ueng *et al.*, 2010). The flowing chart of external convolution interleaving is shown in Fig. 4 and the whole process is as follows:

- Step 1:** Initialize static variable num = 0
- Step 2:** Allocate storage space

According to the interleaving depth ( $I = 12$ ) and the length of the data packet ( $L = 204$ ), the whole  $L \cdot I$  bytes storage space called `int_buf` is allocated. Thus, data package to be interleaved is stored into `int_buf` and corresponding assigned address is `int_buf+204*num`.

**Step 3:** Convolution interleaving ( $I = 12$ )

There are two cycles in convolution interleaving. One cycle is to ensure no delay of the first byte (sync-byte) in each package. The other cycle is to realize convolution interleaving for other bytes of each package. The Implementing expression is as follows:

$$\text{Inl\_code}[i+j*12] = \text{int\_but}[i+j*12+1*204] \quad (5)$$

As above expression 5,  $i$  represents interleaving depth,  $j$  and  $l$  denotes circulation intertwined variables. The output result of convolution interleaved is stored into array `inl_code[]`.

**Step 4:** Let  $\text{num} = (\text{num}+1)\%12$

Return step 3 to continue next convolution interleaving until the whole convolution interleaving is finished.

**Rate control:** Because output stream rate of multimedia warning information is inconstant, in order to meet further requirement of early warning releasing, a method of inserting null packets is proposed to achieve intelligent stream rate control. Inserted null packets are undeclared and special transmission stream (Zhang *et al.*, 2011). According to the different ID number, null packet and practical information transmission packet can be easily distinguished. The detailed steps of rate control are as follows:

**Step 1:** Set the stream rate detection cycle  $T$

According to practical multimedia warning information, timing cycle is set for the current transmission frame. Once the periodic  $T$  is set, the output rate is checked every  $T$  ms.

**Step 2:** Calculate the stream rate

Let  $\text{ts\_num}$  is the number of the output packet, the rate of output stream  $\text{br}$  in the detection cycle  $T$  is calculated as follows:

$$\text{br} = \frac{L * 8 * \text{ts\_num}}{T} = 1.7 * \text{ts\_num} \quad (6)$$

In above expression 6,  $L$  is the length of the TS package.

**Step 3:** Calculate the number of inserted null packets

According to the calculated bit rate  $\text{br}$ , null packets are inserted if the calculated bit rate is less than initial bit rate. On the basis of the following formula 7, the bit rate of one TS packet in periodic  $T$  is  $1.7 \text{ kb sec}^{-1}$ , the number of the inserted null packages  $n$  is as follows:

$$n = \frac{\text{bitrate} - 1.7 * \text{ts\_num}}{1.7} \quad (7)$$

By inserting null packets to TS, stream rate control is realized and output rate of TS is stable at 384 kbps. This constant transmission rate meets the further requirement of early warning releasing. Meanwhile, only simple addition and division are used in the whole implementation of inserting null packets, it is suitable for real-time implementation due to its low computation.

**CONCLUSION**

In order to meet the visualization transmission demand, a DMB pre-processing system for early warning information is designed. According to DMB standard, multimedia information of early warning is combined to transport stream and realizes synchronization between audio and video information. Meanwhile, concatenate Reed Solomon coding and external convolutional interleaving methods are adopted to achieve error correction. By inserting null packets, output TS rate is stable at 384 kbps and this constant transmission rate meets the further requirement of early warning releasing. The whole system has been validated by experiments and has outperformed former DAB preprocessing system in both reliability and stability.

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