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Optimization design of vehicle mounted stereo player chip based on dual gate voltage assignment algorithm

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Abstract. Aiming at multi-direction development tendencies for stereo, interconnection and intelligence of vehicle mounted player system, the author researches and develops a vehicle mounted player system based on QNX. The author proposes an application scheme about stereo player technology in vehicle mounted entertainment field and adopts in-time QNX system which is counted in microsecond as software platform; the author proposes layered and logical architectural model for system to enhance independences between modules; the author also proposes layered and logical architectural model for system; taking advantages of FFMPEG core technology, the author finishes decoding for stereo video; the author designs GLES stereo rendering container for making a synchronously real-time rendering. The experiment show that the scheme can effectively improve impressions on vehicle mounted videos as well as increase the scientific and technological competitiveness for the whole car series.

Key words. Three-dimensional broadcast system, Dual threshold, Voltage distribution, Layered logic, Video decoding, rendering container.

1. Introduction

Multi-direction development tendencies for stereo, interconnection and intelligence of modern video technology create a favorable eco-developmental environment for vehicle mounted informative entertainment industry. At present, it is hard to meet people's new-type requirements for future vehicle mounted entertainment by widely adopting two-dimensional video playing technology. Therefore, some advanced design concepts about vehicle mounted entertainment has appeared in high-end vehicle series, such as interconnection of portable equipment and vehicle mounted terminal, push technology for remote video-on-demand, high definition digital player system and etc, and these new-type video playing technologies will dom-

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inate the development of future vehicle entertainment market. Traditional design concept is broken through in the research. The most cutting-edge stereo playing technology for consumable electronic products is brought in the vehicle mounted products design for guaranteeing the real-time QNX system as a software platform, designing a new-type scheme which is exclusively used in stereo playing of vehicle mounted entertainment, which are of great significance to improve scientific and technological competitiveness of the whole vehicle series on the basis of enhancing the sense of visual impact

Vehicle mounted informative entertainment system, as one of the limited man-machine interaction units in vehicles, is the most direct embodiment for scientific and technological contents of the whole vehicle. The system is not only the control center of each ECU in vehicles, but is also an informative entertainment center for passengers to relieve fatigue. The current vehicle mounted entertainment system has the following two architectural modes: (1) DVD plug-in mode is completely adopted; (2) audio and video decoding chips are embedded in terminal. Traditional entertainment systems of low and middle-ranged vehicles usually adopt the first mode, because huge data volumes of audio and video easily cause overloads for vehicle mounted terminal which will influence the performance of the whole system. In 2007, Dai Hongbing from Nanjing University of Posts and Telecommunications, discussed the development and application of DVD system under embedded circumstances in details in his master thesis–*Research on Integrated System Vehicle Mounted DVD*[1], but the stability and time-delay of the system can not meet harsh requirements for vehicle. Systematic mode of audio and video embedded in terminal not only balances resource allocation of the whole terminal system but also effectively enhances the stability of the system. Therefore, modern vehicles general bring in high-performance video processing chip, which greatly improves the playing quality of vehicle mounted video. Ren Hong was from Harbin University of Science and Technology, brought in video processing chip of Philips in designing of his master thesis–*Design of Vehicle Mounted Video Player system* [2] in 2009, realizing real-time processing to huge data volume of video. In 2013, Ma Jianshe and other postgraduates from Tsinghua University proposed a research scheme of key technology for stereo video playing of Android system [3], and they discussed that the application of stereo playing technology based on tablet computer to provide a valuable reference template for the design concept in the thesis.

2. Layered architectural model for player system

Based on layered and logical architectural model, the complete set of system is divided into three logic layers in the scheme, which mainly includes: man-machine interaction layer, logical application layer, functional encapsulation layer. Man-machine interaction layer is mainly responsible for the response of external messages and the display of playing state, while the logical application layer organizes operational process of the whole system and the core processing procedures are as follows:

1) Code stream analysis: it adopts core decode library of FFMPEG, real-time

reading stereo file streams and encapsulates packaging data into frame data.

2) Code stream rendering: it takes timestamp as unit and takes advantages of the frame data which are real-timely rendering and buffering in GLES image rendering library, and it realizes sync output for multi-code stream data;

3) Image display: it bounds textures and triangle patches and sends them into video memory for real-time playing.

Layered architectural model for a complete set of stereo player system is as shown in Fig. 1, while the corresponding hardware working process is as shown in Fig. 2.

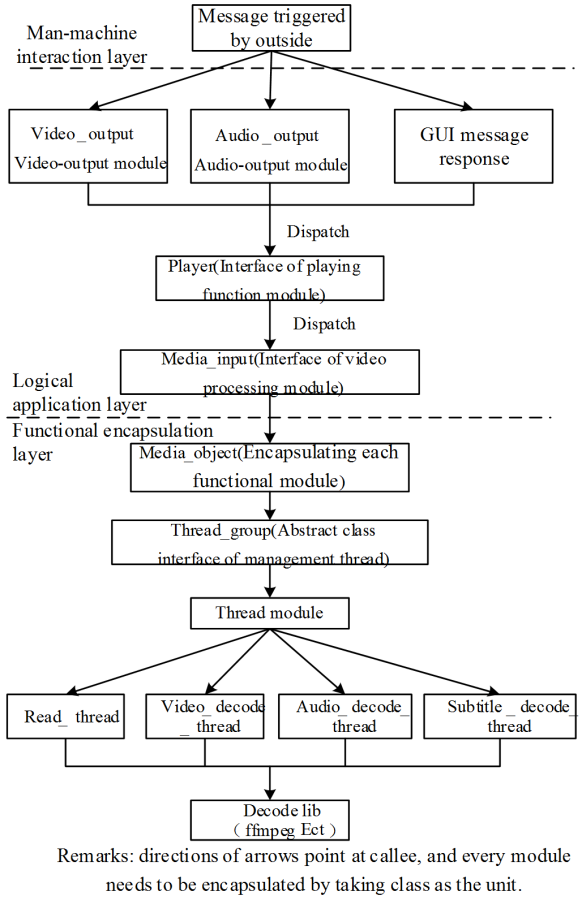

Fig. 1. Architecture model graph of system

Code stream analysis, as the core treatment in the whole process, brings in FFMPEG decode library which is recognized in the industry and finishes open, read, analysis and encapsulation and other processing procedures of the stream file, and it buffers frame data after decoding. While the rendering process chooses currently mature GLES rendering library which mainly finishes patch drawing for frame data and map and bind for texture data which are sent to video memory by

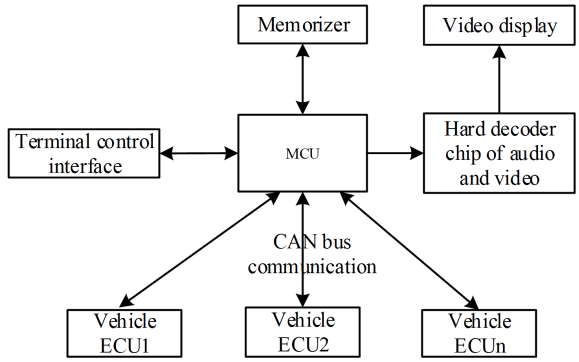

Fig. 2. Hardware working block diagram

taking timestamp as a unit. Finally, the video memory further processes graphic data which are sent to display screen taking pixel as a unit.

In addition, in order to meet harsh requirements of front loading market for vehicles, the scheme chooses the hard real-time system software QNX which is globally top-level. The system software has high priority preemptive scheduling policies, independent operational memory space and microkernel system architecture, all of which adopt modern new-type technology, potently ensuring the stability and security of the whole system.

Therefore, the proposed scheme not only ensures the stability and security of the upper layer application software from operation system level, and it also adopts mature open source library to finish decoding and rendering of video streaming, which effectively reduces the research and development cost, improving market competitiveness for products.

3. Functional module for player system

Functional module of the scheme adopts two mature open source libraries FFMPEG and GLES separately realizing synchronous decoding and real-time rendering for stereo video stream, which not only effectively reduces research and development cost but also improves market competitive for the whole products.

3.1. Decoding module for stereo video

Decoding module for stereo video is mainly responsible for opening, analysis, decoding, frame encapsulation and other processing procedures of video files. As the core module of the whole player system, it supports code stream processing for H264, MPEG4 and other coded formats and it has functions to filter redundant information, effectively ensuring real-time processing to code stream. The main process flows are as follows:

1) Support the registered decoding format
2) Open and extract stream information

3) Look for effective stream data and choose corresponding decoder
4) Open decoder and allocate storage space
5) Constantly extract package information from effective code stream data
6) Encapsulate package information to image frame and transfer decoder
7) Decode frame data and output them to the buffer
8) Release relevant sources and close stream files

3.2. Analysis on OLED driving technical and key index for driving control chip

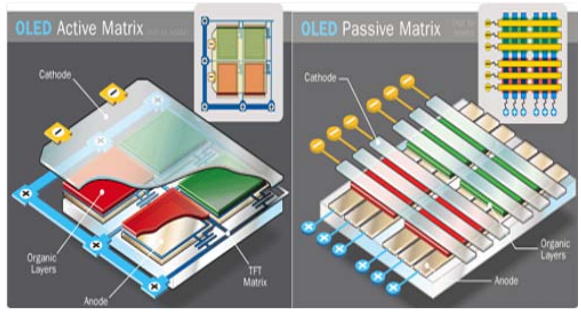

Fig. 3. Architectures of AMOLED and PMOLED

According to differences of architecture and drive mode, OLED display screen can be divided into PMOLED (Passive Matrix OLED) and AMOLED (Active Matrix OLED) (see Fig. 3 and Table 1); according to differences of luminescent materials, it can be divided into SM-OLED (Small Molecule) and PLED (Polymer OLED)(see Table 1). Architecture, drive mode and used materials are different, which makes drive technology and drive control chip of OPLED screen different. Let's focus on drive technology and drive control chip of AMOLED screen and FMOLED screen.

Table 1. Classification and application of OLED

Drive mode	Passive Matrix OLED		Active Matrix OLED	
Material	SM-OLED	PLED	SM-OLED	PLED
Application	Small-size products (such as touch screen of mobile phone, watch and etc.)		Middle and large-size products (such as mobile phone with large-size screen, television and etc.)	

In addition, in order to support synchronous mechanism of upper layer application and ensure synchronous execution of audio and video, FFMPEG tags a time stamp on every data package of streaming media and real-timely processes each packet of stream data by taking timestamp as a unit. At present, common time stamps have two categories, one of which is DTS (Decoding Time Stamps) and the other of which is PTS (Presentation Time Stamps). According to time stamps, decoder and renderer make sure the specific decoding time and rendering time, which

effectively ensure synchronous display of multi-code stream data.

Thus, decoder used not only simplifies many redundant processing procedures but also adopts synchronous processing mechanism provided by FFMPEG, ensuring synchronous and real-time decoding and display of multi-code stream stereo video, which really make rendering frame rate real-time and controllable.

3.3. Rendering container for stereo video

The scheme adopts GLES open source library as the bottom layer rendering engine [4]. Multiple shooting angles of stereo video generate different code streams, thus rendering container is designed exclusively to be used in multi-code stream stereo video. Before code stream data enter rendering container, categories of code stream needs to be judged and relevant parameter needs to be set first; then code stream needs to be pushed into rendering container; finally, it needs to be synchronously and in-timely outputted by taking timestamp as a unit. Moreover, because stereo video has various kinds of stereo modes and flip modes, on the basis of original rendering mode, it adopts branching logic to real-timely draw corresponding graphic texture. The whole model processing logic is shown in Fig. 4.

It is clear that the design concept is based on branching data structure and determines relevant input parameter of rendering container according to the property of code stream, and it makes a real-time responsive processing for corresponding operation of terminal user. The core processing procedures for the whole rendering container includes texture processing, graph drawing and vision setting. Among the procedures, texture normalization is mainly responsible for texture mapping, texture activation, texture binding, texture change and other processing procedures, and then it takes advantages of GLES rendering engine to make a real-time drawing on current binding texture and inputs multi-code stream graphic frame to somewhere within the scope of vision for fast integration of stereo glasses.

It is summarized that the rendering container adopts GLES as rendering engine and designs modularized functional logic, providing a unique rendering interface for different attributes of code stream. It not only realizes the independence and reusability of modules, but also improves instantaneity of the whole rendering procedure.

4. Experimental results and evaluation

4.1. Hardware structure

Latest dual-core processor OMAP4470 owned by TI (Texas Instruments) is adopted in the research, and the main technical parameters are as follows: 1.5GHz dominant frequency, Cortex-A9 dual core, 384MHz PowerVR SGX544 graphic core, 2.5 times of display performance, supporting DirectX, OpenGL ES 2.0, OpenVG 1.1, OpenCL 1.1, hardware image synthesis engine, independent 2-dimensional graphic core, freeing CPU for more important jobs, supporting the highest 3-screen high-definition output, the biggest QXGA(2048x1536) resolution, HDMI 3-dimensional

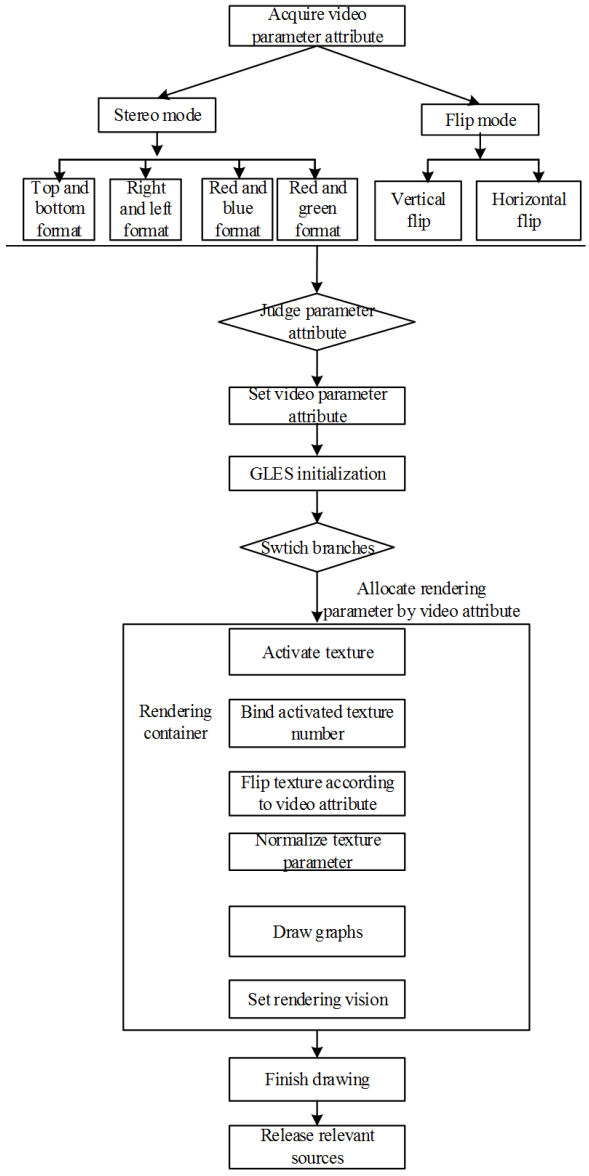

Fig. 4. Stereo rendering container

stereo supporting dual channels and LPDDR2 466MHz memory. The software platform chooses QNX hard real-time system owned by Haman Company and adopts code integration debugging tools IDE6.0, and it makes simulation test and logic design on code of prototype machine.

Research and development of the project is conducted along with Baic Group, and experiment and test are directly conducted in vehicle-mounted terminal laboratory

of Baic Group. Stereo player, as a functional interface of the whole terminal system, is controlled by human-computer interactive interface; inputted multi-code stream stereo video sources are directly snapped to multifunctional display screen after being processed by GPU and decoding chip.

Compared with traditional player, its result is shown in Fig. 5; when other conditions are completely identical, memory consumption rate of stereo player is 0.76 times of traditional player; all of these are because advance video decoding and image processing chip adopted by stereo player greatly alleviate loads of CPU. In addition, frame rate of stereo is twice of the traditional player, which effectively improves the smoothness and definition of images; and the percentage of its frame lost rate is less than 0.05, which is significantly lower than traditional player. It is clear that jobs which are done not only verify feasible plan for the system, but also fill the gap in domestic vehicle mounted stereo player field, providing important reference template for the course of future vehicle mounted entertainment stereo.

Fig. 5. Playing effect picture

Table 2. Performance index comparison between traditional player and stereo player

Player categories	CPU occupancy rate	Playing frame rate	Frame drop rate
Traditional player	18.35	29.87%	Less than 0.1%
Stereo player	13.95	59.74%	Less than 0.05%

4.2. PMOLED driving technology

In accordance of the connection mode of positive and negative poles for every luminous pixel, PMOLED is divided into static drive and dynamic drive as well. Static drive connects negative pole of every pixel to construct common-cathode structure and to change voltage of positive pole added by constant flow source for controlling luminescence of every pixel and forming images, however, the drive mode will easily generate "cross effect" under the circumstance of images changes fast and quickly, thus it is usually used for drives of segmented display screen; while dynamic drive mode draws forth the two poles of luminous pixel to construct matrix structure

(see the right of Fig. 1), it means that the same electrode of a pixel in the horizontal direction is shared, while anther electrode of a pixel in vertical direction is also shared; the drive mode chooses the way of progressive scan in the process of drive, at the time drive impulses are circularly imputed to Common Electrode (Common, which is also called scan electrode), data impulses of pixel in the line are imputed to Segment Electrode (Segment, which is also called data electrode) as well for realizing luminescence and display for all the pixels of the entire line; the drive mode can effectively avoid "cross effect", which are mostly used for drives of touch screen and other dot-matrix display screen. But no matter what kind of drive mode, they all need instantaneous heavy current to drive leading to low energy efficiency and power consumption improvement.

(1) Key index for drive control chip

Drive control chip of most OLED screens are composed of drive and control, which needs to finish transmission processing and other additional functions of video image data at the time of driving OLED pixel for luminescence and display. Therefore, there are lots of parameter indexes for OLED drive control chip, and they mainly include display index, drive index, integrated functional index.

(2) Display index

Display Index of drive control chip directly influences display performances of OLED, mainly including dot matrix resolution, display cache, display levels, contrast and other parameters. Dot matrix resolution determines the biggest pixel matrix run by single set chip; if there are strict requirements for improving image switching speed of display screen, improving scan rate, reducing luminance loss when scanning, and other, the size of display catch needs to be considered; display levels and contrast influence the biggest color quantity, maximum brightness and color degree displayed on the OLED screen.

(3) Drive index

In terms of PMOLED, imaging quality, to a large extent, determines current-voltage characteristics imputed by drive control chip. Among drive indexes, there are some comparably critical indexes, such as SMSC (Segment Max Source Current), CMSC (Common Max Sink Current) and OLED drive voltage. SMSC refers to the maximum current value imputed by drive control chip to pixel units, and it directly influences the image quality of display screen and it will reach to maximum under the state of white balance; CMSC is the maximum current flowed into pins, which is affordable for drive control chip, when the pixel beams; and parameter of the part is to ensure operational reliability of the chip and to show the significant index of quality; different manufacturing process of screens correspond to different drive voltage, thus OLED drive voltage supplied by chips is the preferred parameter. In terms of AMOLED, due to the drive circuit of constant flow source has been integrated with display array on the same substrate, the chip just needs to output breakover strength of voltage control LTP-Si TFT. There is no need to consider current index but need to consider the output scope of drive voltage by chips.

5. Conclusion

Taking multi-direction development tendencies for stereo, interconnection and intelligence of vehicle mounted player system as research background, taking exploration of vehicle mounted application of new type of electronic technology for high-end consumption as research objectives, the author designs a set of vehicle mounted stereo player system based on QNX system. Proposing system layered and logical architectural model, taking advantages of FFMPEG core technology, the author finishes decoding for stereo video and designs GLED stereo rendering container for making a synchronous real-time rendering. The result of the research has been applied in the latest concept vehicle of XXX type vehicle series in Baic Group which is in integration testing stage and is selected as the example for stereo playing applications in domestic vehicle mounted field. The further job is to explore the automatic focus function of stereo playing.

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