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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) Title: MULTIPLE FORMAT VIDEO DISPLAY

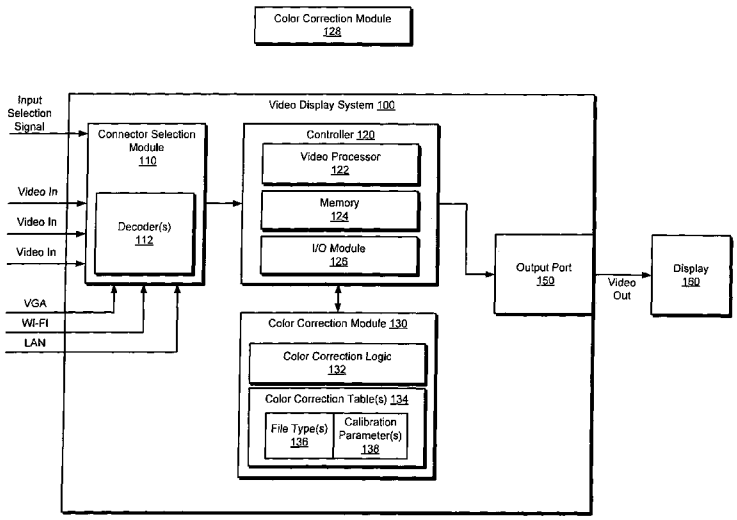

Fig. 1

(57) Abstract: In one embodiment a video display system (100) comprises a connector selection module (110) to receive a first video signal, a color correction module (130) comprising logic to select a color correction routine for the first video signal based on at least one of a video format identifier associated with the first video signal, an input connector associated with the first video signal, or a metadata tag associated with a data file containing the first video signal, applying the color correction routine to the first video signal; and presenting the first video signal on a video display (160).

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MULTIPLE FORMAT VIDEO DISPLAY

BACKGROUND

[0001] Given the convergence in video entertainment and computing technology, video display devices such as televisions, computers, digital video recorders, and the like receive inputs from multiple different sources in multiple different formats. Different file formats may require different color correction techniques in order for the video content to be displayed accurately on the video display device. Hence, techniques to implement format-specific color correction may find utility.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Fig. 1 is a schematic illustration of a multiple format video system in accordance with some embodiments.

[0003] Fig. 2 is a flowchart illustrating operations of a method of video buffer management in accordance with some embodiments.

[0004] Fig. 3 is a data table that depicts video format codewords for the MPEG2 video standard.

[0005] Fig. 4 is a schematic illustration of a data table that illustrates color primaries codewords.

[0006] Fig. 5 is a schematic depiction of a data table that stores gamma functions codes for the MPEG2 standard.

[0007] Fig. 6 is a schematic depiction of a data table that stores matrix coefficient codewords for the MPEG2 standard.

DETAILED DESCRIPTION

[0008] Fig. 1 is a schematic illustration of a multiple format video system 100 in accordance with some embodiments. The system 100 includes a connector selection module 110 coupled to a controller 120, and a color correction module 130. A display device 160 may be coupled to the output port 152. Display device 160 may be embodied as, e.g., a television, a cathode ray tube (CRT), a liquid crystal display (LCD) computer or television screen, or any other suitable display device. By way of illustration only, and not limitation, the system 100 will be described with reference to a multi-media entertainment system. However, it will be recognized by one of ordinary skill in the art that the disclosed invention may be employed as part of a personal video recorder (PVR), television, handheld Internet appliance or any other suitable device or system employing a display device.

[0009] Connector selection module 110 is operatively coupled to receive at least one incoming video signal. In some embodiments, the video display system 100 may comprise a plurality of connectors adapted to connector selection module may comprise an F-connector that may receive a video signal in a specific format such as broadcast formats, e.g., the National Television Standards Committee (NTSC) format commonly used to distribute television signals in North America, the Advanced Television Systems Committee (ATSC) format, or the Phase Alternating Line (PAL) format, an HDMI (High-Definition Multimedia Interface) to receive an HDTV (High Definition Television) input, an RCA connector(s) to receive a YPbPr signal or HDTV analog input, a VGA (Video Graphics Array) connector to receive an input from a personal computer or the like, a local area network (LAN) connector or a wireless connector (e.g., a WIFI) to receive a JPEG (Joint Photographic Experts Group) format or the MPEG (Moving Picture Experts Group) format, or an S-Video connector to receive an NTSC SD signal. Connector selection module 110 further receives an input selection signal, e.g., from a remote control device or the like. In

response to the input signal, the connector selection module selects one of the video input signals for processing.

[0010] The selected video input may be directed to a decoder 112, which comprises logic to decode the video input signal. For example, if the incoming signal is digital information, then decoder 112 may decompress the information and/or perform format conversion if necessary.

[0011] The selected video input is directed to controller 120. Controller 120 includes a processor 122, a memory module 124, and an input/output (I/O) module 126. The controller 120 may be, for example, one or more suitably programmed microprocessors, DSPs, discrete logic, state machines or any other suitable hardware, software, or suitable combination thereof to perform various operations described herein. Memory module 124 may be implemented as one or more of random access memory (RAM) or read-only memory (ROM). I/O module 126 may implement any suitable I/O interface such as, e.g., a serial interface.

[0012] In some embodiments, video system 100 comprises a color correction module 130 to apply color correction routines to received video signals. In the embodiment depicted in Fig. 1, color correction module 130 comprises color correction logic 132 and at least one color correction table 134, which includes entries that associated video file types 136 with color correction calibration parameters 138. In the embodiment depicted in Fig. 1 color correction module 130 is depicted as a stand-alone module, separate from but coupled to controller 120. For example, color correction module may be implemented as an application specific integrated circuit (ASIC) or as a programmable device such as a field programmable gate array (FPGA), which may be incorporated into system 100. In alternate embodiments, color correction module 130 may be integrated into controller 120.

[0013] Fig. 2 is a flowchart illustrating operations of in a method to implement a multiple format video display, according to embodiments. In some embodiments the operations depicted in Fig. 2 may be implemented by the color

correction module 130, alone or in combination with the controller 120. Referring to Fig. 2, at 210 a video input signal is received. For example, controller 120 may receive a video input signal from connector selection module 110.

[0014] At operation 215 it is determined whether the video signal format is available. In some embodiments, the video input signal(s) include information such as, e.g., one or more identifiers that identify the format of the video encoding. For example, Fig. 3 is a data table that depicts video format codewords for the MPEG2 video standard. Similarly, other encoding schemes include information about the format of the video content. If, at operation 215, the video format is available, then control passes to operation 220 and the video format identifier is obtained. For example, in some embodiments at least one of the controller 120 or the color correction module 130 extracts the video format codeword from the video signal.

[0015] By contrast, if at operation 215 the video format is not available, then control passes to operation 225 and the connector on which the video signal was received is obtained. In some embodiments, the identity of the connector may be obtained from the connector selection module 110. At operation 230 one or more pieces of meta data associated with the video stream are obtained. For example, if the video signal is encapsulated in a computer-executable file such as, e.g., a JPEG file or an MPEG file, then the meta data associated with the file is extracted from the file.

[0016] At operation 235 a color correction scheme is selected using the information obtained in operations 220-225. For example, in the event that the video format identifier is available, a color correction scheme is selected based at least in part on the video format identifier extracted from the video signal.

[0017] By contrast, in the event that the video format identifier was unavailable, a color correction scheme is selected based at least in part on the type of connector on which the video signal was received, alone or in combination with meta data associated with the video signal. For example, if

the signal was received in an F-connector on an RF tuner, then a color correction routine described by ITU-R BT.601 (International Telecommunications Union, ITU-R BT.601) may be implemented. If the video signal was received in an F-connector on an ATSC tuner, then a color correction routine described by ITU-R BT.709 (International Telecommunications Union, ITU-R BT.709) may be implemented. If the video signal was received on a VGA connector, a WIFI connector, or a LAN input, then an sRGB color correction routine may be implemented. If the video signal was received on a YPbPr connector then a color correction routine described by ITU-R BT.709 may be implemented. If the video signal was received on an S-video connector, then a color correction routine described by ITU-R BT.601 may be implemented.

[0018] In some embodiments meta data associated with the video signal may also be used to select a color correction routine. For example, if the video signal was received on an HDMI connector and meta data associated with the video signal indicates that the video format is 480i, then a color correction routine described by ITU-R BT.601 may be implemented. Similarly, if the meta data associated with the video signal indicates that the video is encoded in a JPEG file, then a color correction routine described by ITU-R BT.601 may be implemented.

[0019] Referring back to Fig. 2, at operation 240 a color correction scheme is implemented. Examples of color correction techniques are presented in commonly assigned U.S. Patents Nos. 6,862,029; 6,992,682; 7,046,255; and 7,106,344 to D'Souza et al., the disclosures of which are incorporated herein by reference in their entirety. Fig. 4 is a schematic illustration of a data table that illustrates color primaries codewords that may be stored in the color correction table(s) 134. In some embodiments, the color correction module may tag the video input with data from the table in Fig. 4 to illustrate which primaries were assumed. The color correction module may then calibrate to map the expected color space to the actual color space. This may be implemented as a linear transformation and RGB look up tables.

[0020] Most display modules map voltage-to-brightness on a scale (0 to 255 for digital, or 0 to 1 volt for analog) using a non-linear opto-electronic transfer function, commonly referred to as a gamma function. The video file may include one or more tags that identify which gamma function should be used. For example, Fig. 5 is a schematic depiction of a data table that stores gamma functions codes for the MPEG2 standard. In some embodiments, the color correction may be implemented by multiplying a RGB value, typically a 1x3 matrix by the 3x3 matrix coefficient to get a color-corrected 1x3 matrix. Fig. 6 is a schematic depiction of a data table that stores matrix coefficient codewords for the MPEG2 standard. In operation, the color correction module may use the codewords in Figs. 5 and 6 to retrieve from memory a color correction transfer function which may be applied to the video input.

[0021] Referring back to Fig. 2, at operation 245 the color-corrected video may be output to the display 160. For example, the controller 120 may direct the color corrected video to the display 160 via the output port 150.

[0022] In some embodiments the color correction tables 134 may include correction tables for multiple different video formats, and the color correction logic 132 may select a color correction scheme in response to the format of the video input selected by color selection module 110.

[0023] Thus, described herein are exemplary systems and methods to implement a multiple format video display. The methods described herein may be embodied as logic instructions on a computer-readable medium. When executed on a processor, the logic instructions cause a general purpose computing device to be programmed as a special-purpose machine that implements the described methods. The processor, when configured by the logic instructions to execute the methods recited herein, constitutes structure for performing the described methods.

[0024] Moreover, some embodiments may be provided as computer program products, which may include a machine-readable or computer-readable medium having stored thereon instructions used to program a computer (or

other electronic devices) to perform a process discussed herein. The machine-readable medium may include, but is not limited to, floppy diskettes, hard disks, optical disks, CD-ROMs, and magneto-optical disks, ROMs, RAMs, erasable programmable ROMs (EPROMs), electrically EPROMs (EEPROMs), magnetic or optical cards, flash memory, or other suitable types of media or computer-readable media suitable for storing electronic instructions and/or data. Moreover, data discussed herein may be stored in a single database, multiple databases, or otherwise in select forms (such as in a table).

[0025] Additionally, some embodiments discussed herein may be downloaded as a computer program product, wherein the program may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals embodied in a carrier wave or other propagation medium via a communication link (e.g., a modem or network connection).

[0026] Reference in the specification to "one embodiment" or "an embodiment" or "some embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least an implementation. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0027] The term "logic" as referred to herein relates to structure for performing one or more logical operations. For example, logic may comprise circuitry which provides one or more output signals based upon one or more input signals. Such circuitry may comprise a finite state machine which receives a digital input and provides a digital output, or circuitry which provides one or more analog output signals in response to one or more analog input signals. Such circuitry may be provided in an application specific integrated circuit (ASIC) or field programmable gate array (FPGA). Also, logic may comprise machine-readable instructions stored in a memory in combination with processing circuitry to execute such machine-readable instructions. However,

these are merely examples of structures which may provide logic and embodiments are not limited in this respect.

What is claimed is:

1. A video display system (100), comprising:

a connector selection module (110) to receive a first video signal

a color correction module (130) comprising logic to:

select a color correction routine for the first video signal based on at least one of:

a video format identifier associated with the first video signal;

an input connector associated with the first video signal; and

a metadata tag associated with a data file containing the first video signal;

applying the color correction routine to the first video signal; and

presenting the first video signal on a video display (160).

2. The video display system (100) of claim 1, wherein the first video signal comprises at least one video format identifier that identifies a format of the first video signal, and further comprising logic to extract the at least one video format identifier from the first video signal.

3. The video display system (100) of claim 2, further comprising logic to select at least one color correction scheme base at least in part on the at least one video format identifier.

4. The video display system (100) of claim 1, wherein the first video signal lacks an identifier that identifies a format of the first video signal, and further comprising logic to:

obtain an identity of a connector on which the video signal was received; and

obtain meta data associated with the video signal.

5. The video display system (100) of claim 4, further comprising logic to select at least one color correction scheme base at least in part on at least one of the connector on which the video signal was received and the meta data associated with the video signal.

6. The video display system (100) of claim 1, further comprising logic to:

receive a second video signal in a video display system (100);

select a color correction routine for the second video signal based on at least one of:

a video format identifier;

an input connector; and

a metadata tag associated with a data file containing the second video signal;

apply the color correction routine to the second video signal; and

present the second video signal on a video display (160).

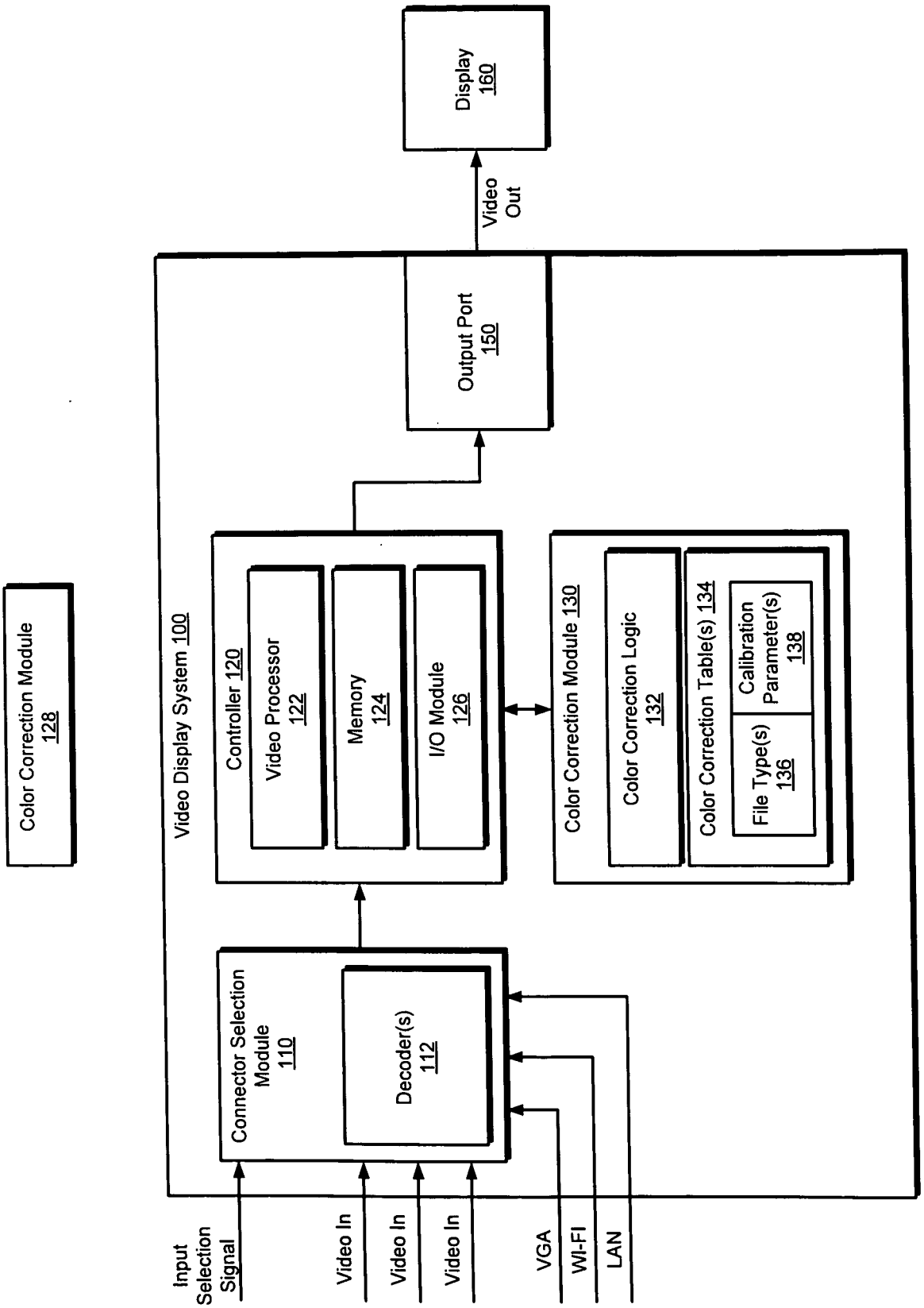
Color Correction Module 128
Video Display System 100
Controller 120
Video Processor 122
Memory 124
I/O Module 126
Color Correction Module 130
Color Correction Logic 132
Color Correction Table(s) 134
Calibration Parameter(s) 138
File Type(s) 136
Output Port 150
Video Out
Display 160
Connector Selection Module 110
Decoder(s) 112
Input Selection Signal
Video In
Video In
Video In
VGA
WI-FI
LAN

Fig. 1

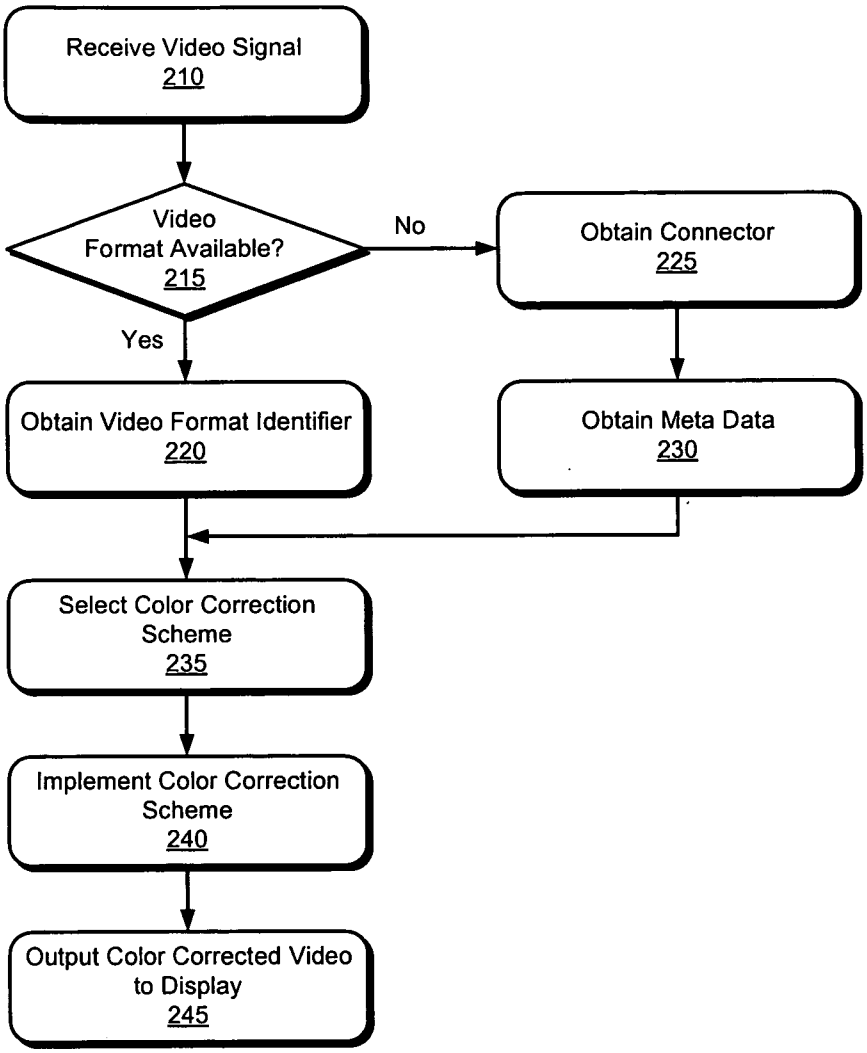
Receive Video Signal
210
Video Format Available?
215
No
Obtain Connector
225
Yes
Obtain Video Format Identifier
220
Obtain Meta Data
230
Select Color Correction Scheme
235
Implement Color Correction Scheme
240
Output Color Corrected Video to Display
245

Fig. 2

Video Format	Code
component	000
PAL	001
NTSC	010
SECAM	011
MAC	100
unspecified	101
reserved	110
reserved	111

Fig. 3

Color Primaries	Code	Application Default
forbidden	0000 0000	
BT.709, SMPTE 274M	0000 0001	MPEG 2, ATSC, DVB 25Hz HDTV, DVB 30Hz HDTV
unspecified	0000 0010	
reserved	0000 0011	
BT.470 system M	0000 0100	
BT.470 system B, G, I	0000 0101	DVB 25Hz SDTV
SMPTE 170M	0000 0110	DVB 30Hz SDTV
SMPTE 240M	0000 0111	
reserved	0000 1000	
:	:	:
reserved	1111 1111	

Fig. 4

Opto-Electronic Transfer Characteristics	Code	Application Default
forbidden	0000 0000	
BT.709, SMPTE 274M	0000 0001	MPEG 2, ATSC, DVB 25Hz HDTV, DVB 30Hz HDTV
unspecified	0000 0010	
reserved	0000 0011	
BT.470 system M	0000 0100	
BT.470 system B, G, I	0000 0101	DVB 25Hz SDTV
SMPTE 170M	0000 0110	DVB 30Hz SDTV
SMPTE 240M	0000 0111	
linear	0000 1000	
reserved	0000 1001	
:	:	:
reserved	1111 1111	

Fig. 5

Color Primaries	Code	Application Default
forbidden	0000 0000	
BT.709, SMPTE 274M	0000 0001	MPEG 2, ATSC, DVB 25Hz HDTV, DVB 30Hz HDTV
unspecified	0000 0010	
reserved	0000 0011	
FCC	0000 0100	
BT.470 system B, G, I	0000 0101	DVB 25Hz SDTV
SMPTE 170M	0000 0110	DVB 30Hz SDTV
SMPTE 240M	0000 0111	
reserved	0000 1000	
:	:	:
reserved	1111 1111	

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/005363

A. CLASSIFICATION OF SUBJECT MATTER

H04N 7/01(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) : video display; color correction; video format identifier; metatag

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/0137606 A1 (RUMREICH et al) 24 Jul. 2003. See abstract; Fig 1; Claim 1, 12, 13.	1-6
A	US 2005/0163369 A1 (JYOU et al) 28 Jul. 2005. See abstract; Fig 1, 4; Claims 1-3.	1-6
A	US 2004/0246537 A1 (OHYAMA et al) 09 Dec. 2004. See abstract; Fig 1; Claim 1, 4, 8.	1-6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 SEPTEMBER 2008 (08.09.2008)	**08 SEPTEMBER 2008 (08.09.2008)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2008/005363

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003-0137606 A1	24.07.2003	CN 1440205 A	03.09.2003
		EP 1330131 A3	19.05.2004
		EP 1330131 A2	23.07.2003
		JP 2003-308053 A2	31.10.2003
		KR 10-2003-0063221	28.07.2003
		PA 03000536 A	03.09.2004
		US 7253845	07.08.2007
		US 2003-137606 AA	24.07.2003
US 2005-0163369 A1	28.07.2005	AU 2004-324323 A1	15.06.2006
		CA 2553542 A1	30.04.2005
		EP 1544789 A1	22.06.2005
		EP 1544789 A4	07.03.2007
		EP 1727546 A2	06.12.2006
		KR 10-2005-0030897	31.03.2005
		KR 10-2007-0002104	04.01.2007
		US 2005-163369 AA	28.07.2005
		WO 2004-029876 A1	08.04.2004
		WO 2006-072809 A2	13.07.2006
		WO 2006-072809 A3	02.11.2006
		WO 2006-072809 C1	05.10.2006
US 2004-0246537 A1	09.12.2004	CN 1538759 A	20.10.2004
		GB 200400568 A0	11.02.2004
		GB 2400765 A	20.10.2004
		GB 2400765 B2	09.02.2005
		GB 2400765 A1	20.10.2004
		JP 2004-320632 A2	11.11.2004
		KR 2004090690 A	26.10.2004
		KR 2006020723 A	06.03.2006
		US 7265795	04.09.2007
		US 2004-246537 A1	09.12.2004