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(54) DIGITAL BROADCAST RECEIVER AND BROADCAST DATA DISPLAY METHOD FOR SIMULTANEOUS DISPLAY OF MULTI-CHANNEL VISUAL IMAGES

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(57) **ABSTRACT**

A broadcast data display method for a digital broadcast receiver is provided. In response to a broadcast reception request from a user, a channel list having identifiers of available channels is displayed. Broadcast data of a channel selected by the user from the channel list is displayed on a screen in a full-screen mode. In response to a request of all-channel view during channel list display or broadcast reception, the screen is divided into display areas corresponding to the individual available channels of the channel list. Real-time broadcast data of the selected channel is displayed in a corresponding display area of the screen. Still images of the remaining channels are displayed simultaneously or sequentially in their corresponding display areas.

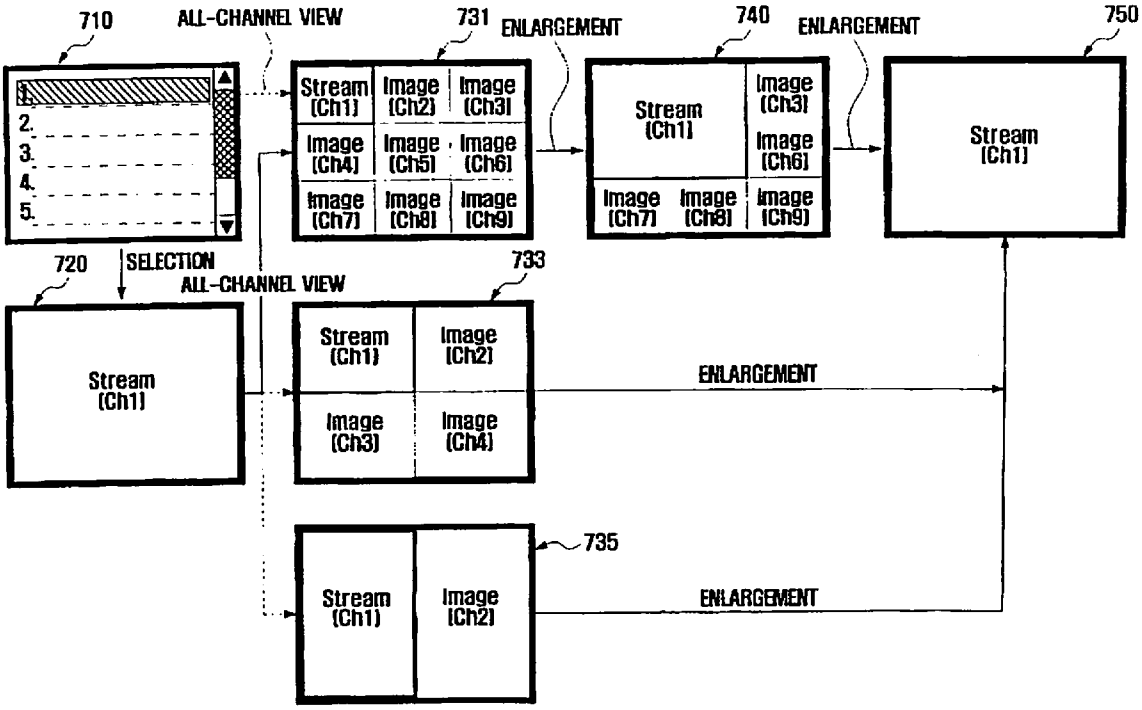


FIG. 1

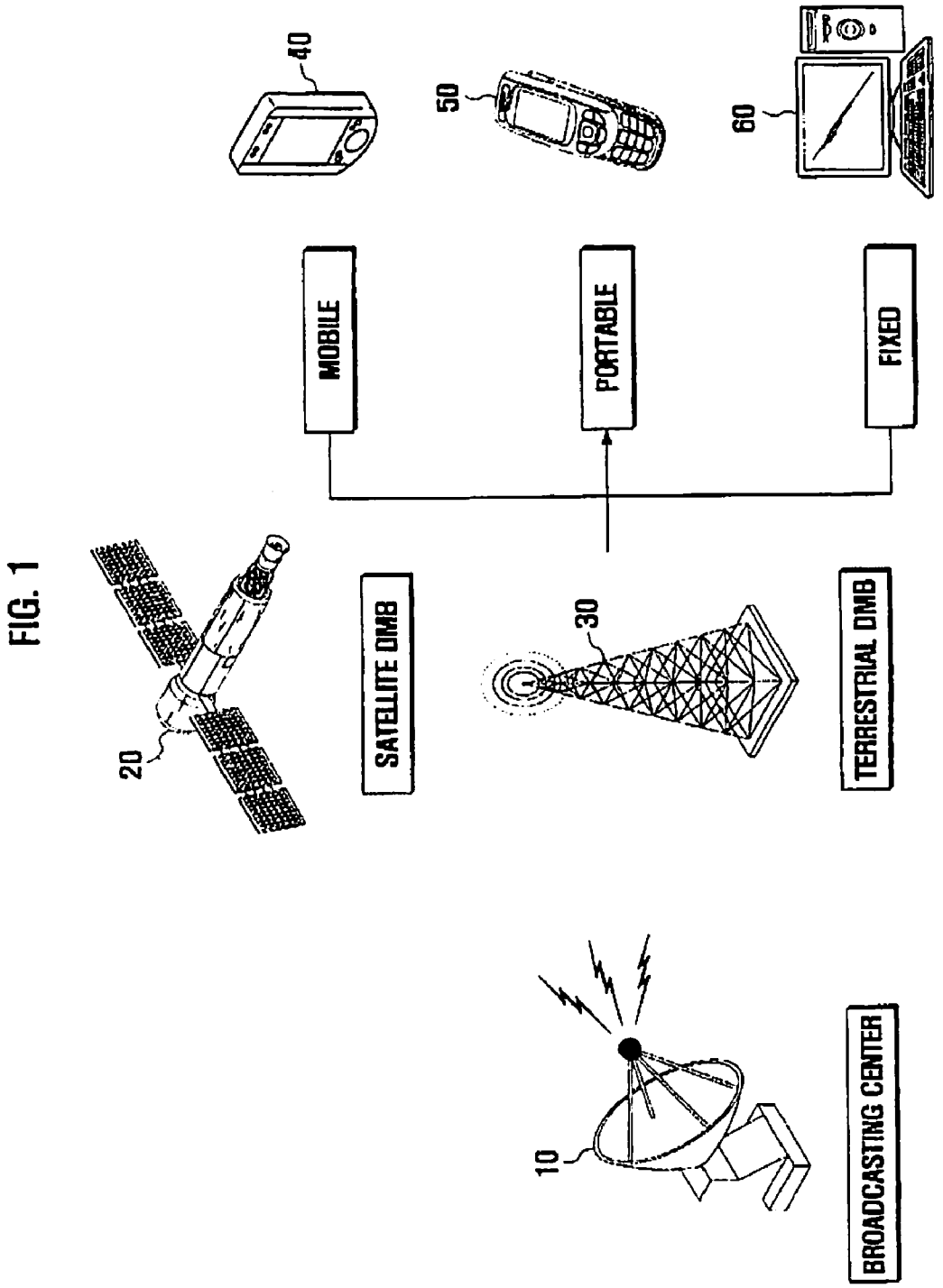

40
50
60
MOBILE
PORTABLE
FIXED
20
SATELLITE DMB
30
TERRESTRIAL DMB
10
BROADCASTING CENTER

FIG. 2

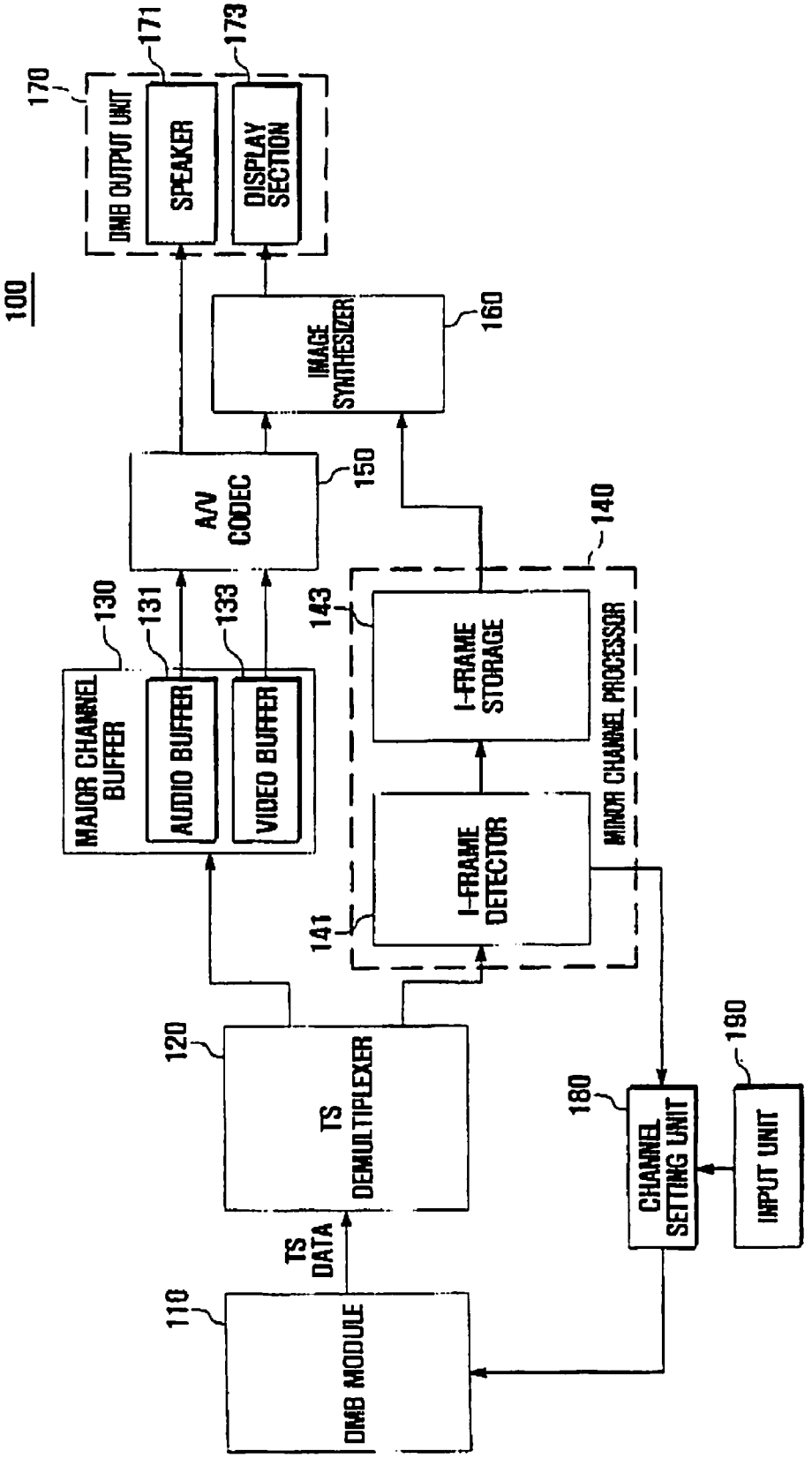

100
DMB MODULE
110
TS DATA
TS DEMULTIPLEXER
120
MAJOR CHANNEL BUFFER
130
AUDIO BUFFER
131
VIDEO BUFFER
133
A/V CODEC
150
IMAGE SYNTHESIZER
160
DMB OUTPUT UNIT
170
SPEAKER
171
DISPLAY SECTION
173
MINOR CHANNEL PROCESSOR
140
I-FRAME DETECTOR
141
I-FRAME STORAGE
143
CHANNEL SETTING UNIT
180
INPUT UNIT
190

FIG. 3

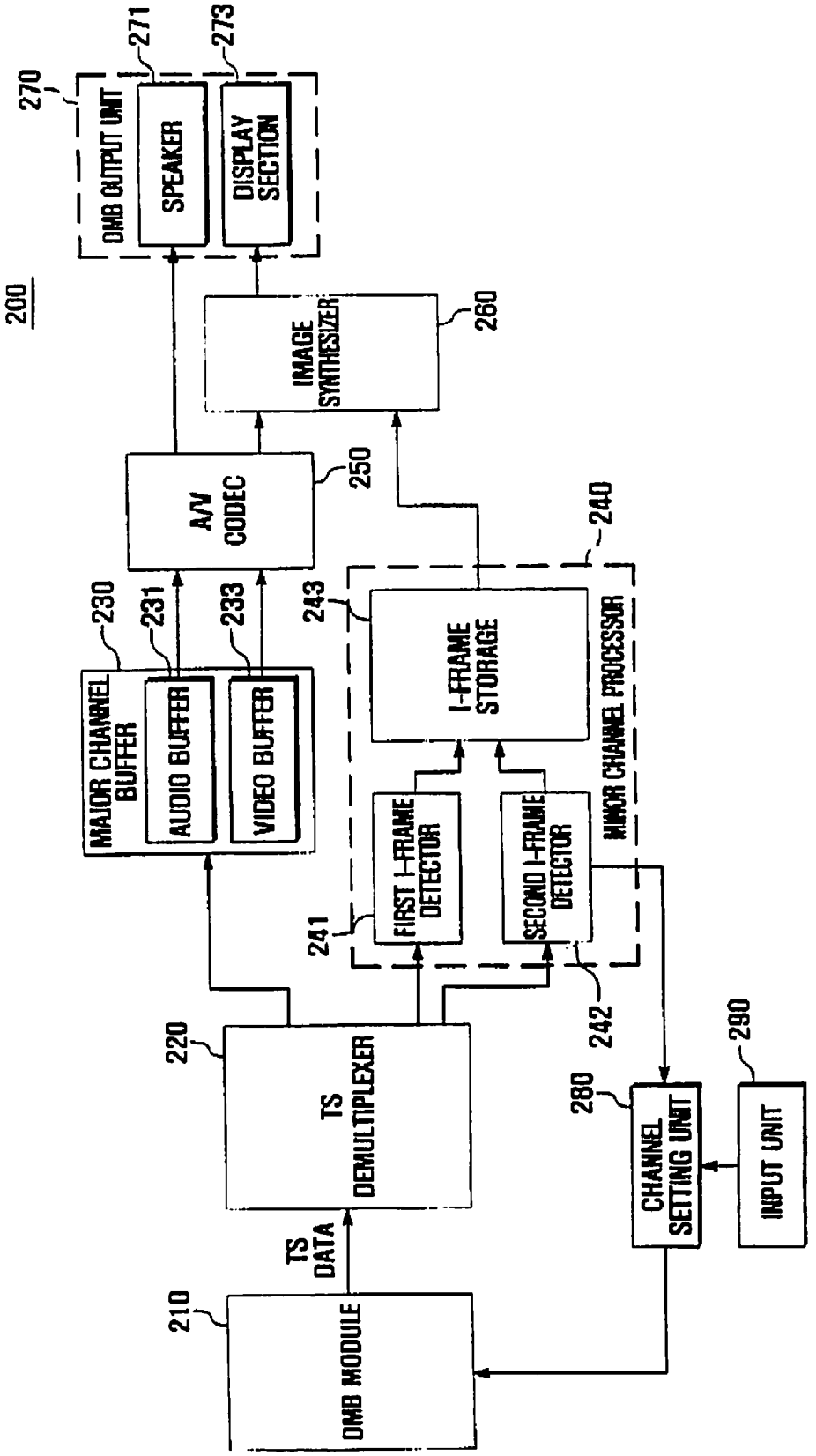

200
DMB MODULE
210
TS DATA
TS DEMULTIPLEXER
220
MAJOR CHANNEL BUFFER
230
AUDIO BUFFER
231
VIDEO BUFFER
233
A/V CODEC
250
IMAGE SYNTHESIZER
260
DMB OUTPUT UNIT
270
SPEAKER
271
DISPLAY SECTION
273
MINOR CHANNEL PROCESSOR
240
I-FRAME STORAGE
243
FIRST I-FRAME DETECTOR
241
SECOND I-FRAME DETECTOR
242
CHANNEL SETTING UNIT
280
INPUT UNIT
290

FIG. 4

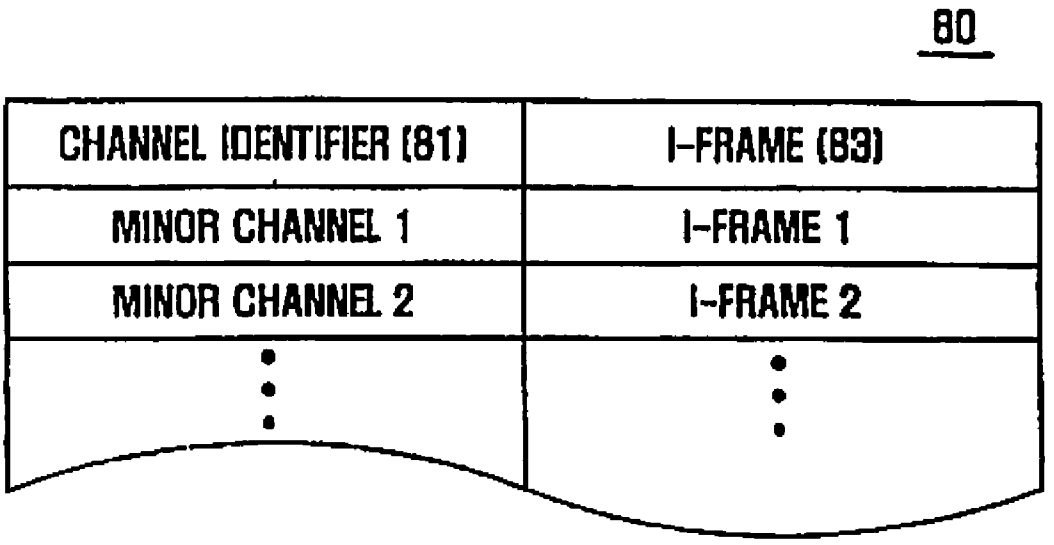

80
CHANNEL IDENTIFIER (81)
I-FRAME (83)
MINOR CHANNEL 1
I-FRAME 1
MINOR CHANNEL 2
I-FRAME 2

FIG. 5

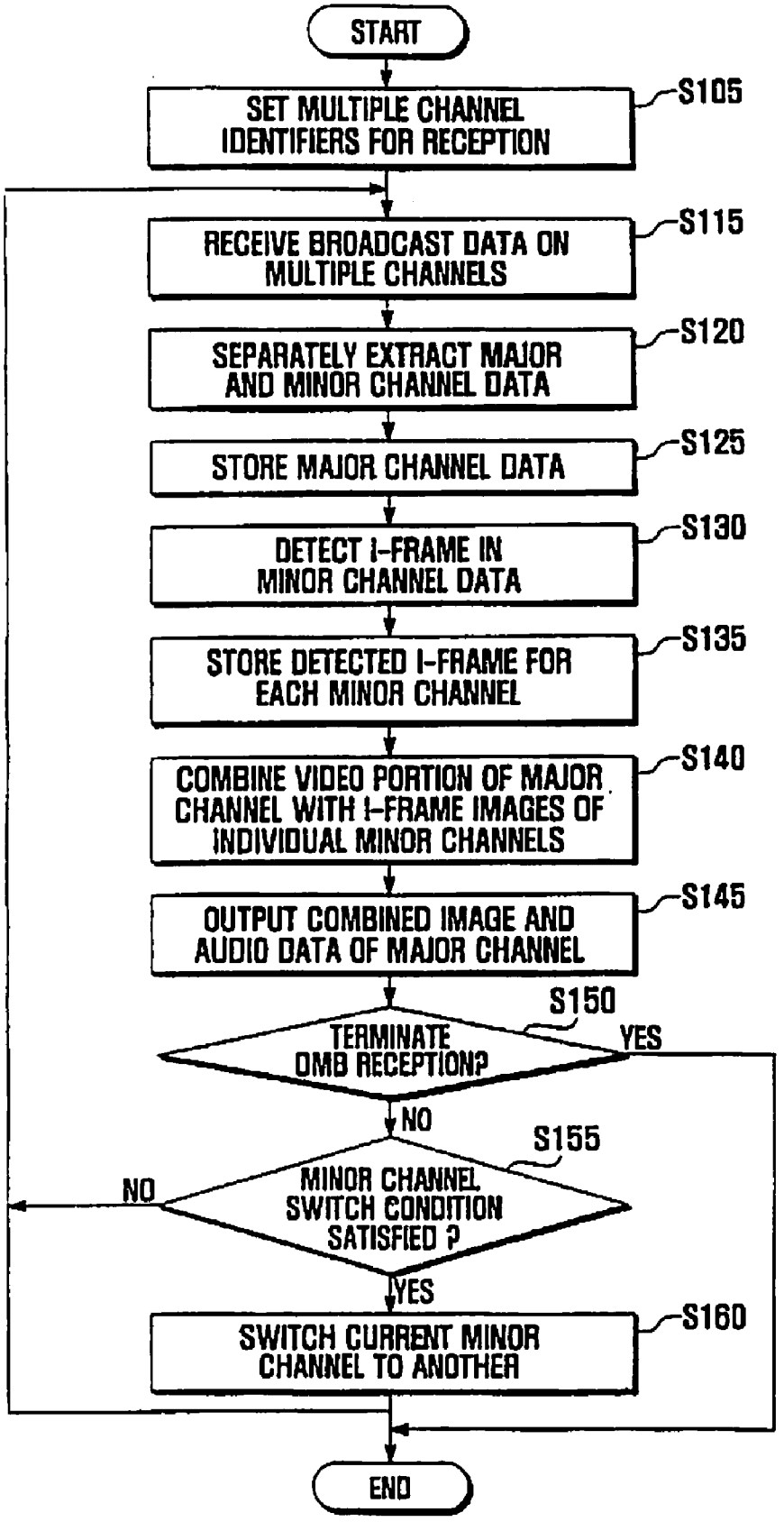
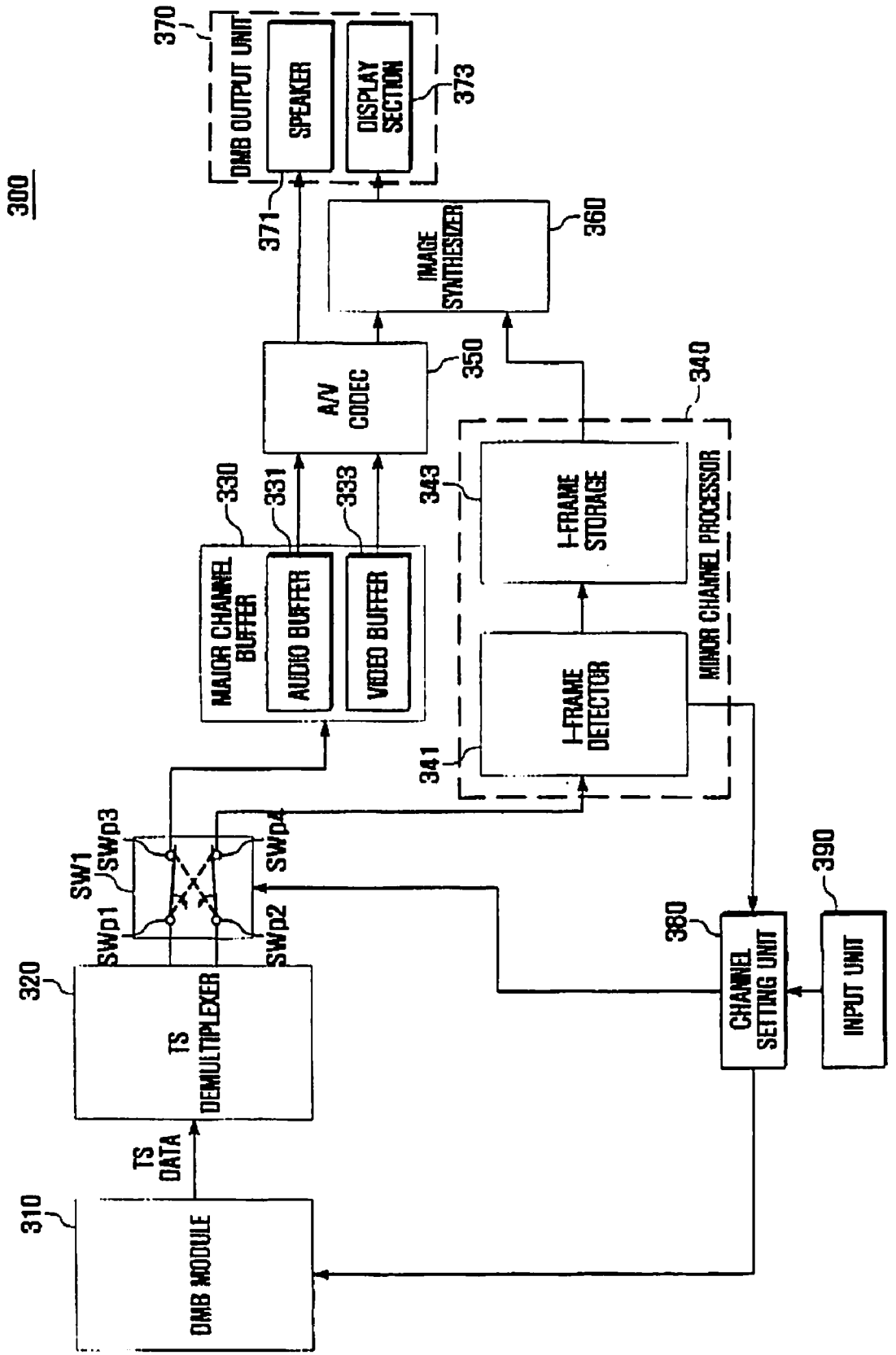

START
SET MULTIPLE CHANNEL IDENTIFIERS FOR RECEPTION
S105
RECEIVE BROADCAST DATA ON MULTIPLE CHANNELS
S115
SEPARATELY EXTRACT MAJOR AND MINOR CHANNEL DATA
S120
STORE MAJOR CHANNEL DATA
S125
DETECT I-FRAME IN MINOR CHANNEL DATA
S130
STORE DETECTED I-FRAME FOR EACH MINOR CHANNEL
S135
COMBINE VIDEO PORTION OF MAJOR CHANNEL WITH I-FRAME IMAGES OF INDIVIDUAL MINOR CHANNELS
S140
OUTPUT COMBINED IMAGE AND AUDIO DATA OF MAJOR CHANNEL
S145
S150
TERMINATE OMB RECEPTION?
YES
NO
S155
MINOR CHANNEL SWITCH CONDITION SATISFIED ?
NO
YES
SWITCH CURRENT MINOR CHANNEL TO ANOTHER
S160
END

FIG. 6


300
310
DMB MODULE
TS DATA
320
TS DEMULTIPLEXER
SW1
SWp1
SWp2
SWp3
SWp4
330
MAJOR CHANNEL BUFFER
331
AUDIO BUFFER
333
VIDEO BUFFER
340
MINOR CHANNEL PROCESSOR
341
I-FRAME DETECTOR
343
I-FRAME STORAGE
350
A/V CODEC
360
IMAGE SYNTHESIZER
370
DMB OUTPUT UNIT
371
SPEAKER
373
DISPLAY SECTION
380
CHANNEL SETTING UNIT
390
INPUT UNIT

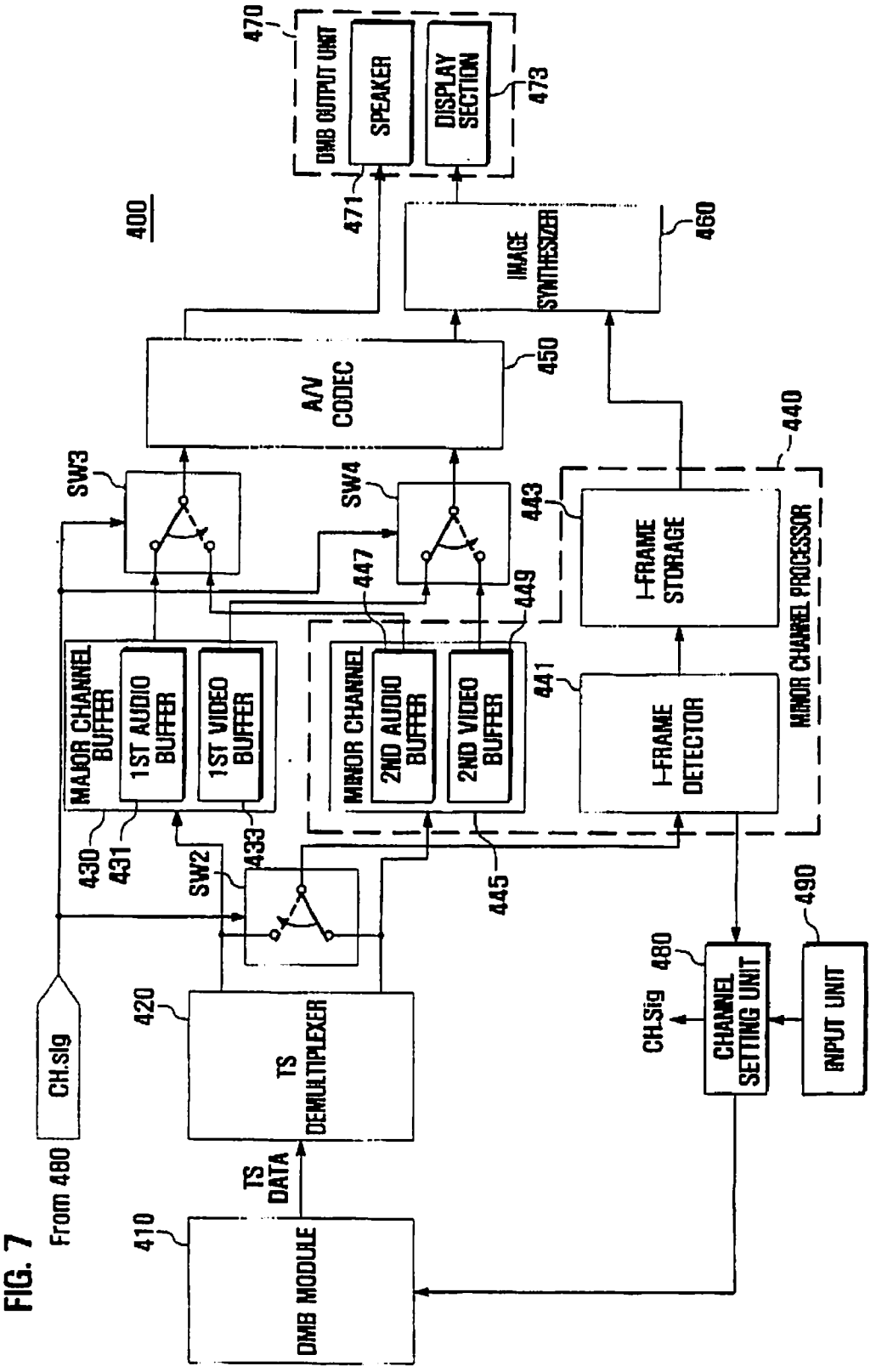

400
470
DMB OUTPUT UNIT
SPEAKER
DISPLAY SECTION
473
471
IMAGE SYNTHESIZER
460
A/V CODEC
450
440
SW3
SW4
443
I-FRAME STORAGE
447
449
MAJOR CHANNEL BUFFER
1ST AUDIO BUFFER
1ST VIDEO BUFFER
MINOR CHANNEL
2ND AUDIO BUFFER
2ND VIDEO BUFFER
441
I-FRAME DETECTOR
MINOR CHANNEL PROCESSOR
430
431
433
SW2
445
490
480
CH.Sig
CHANNEL SETTING UNIT
INPUT UNIT
420
TS DEMULTIPLEXER
CH.sig
From 480
TS DATA
410
DMB MODULE

FIG. 7

FIG. 8

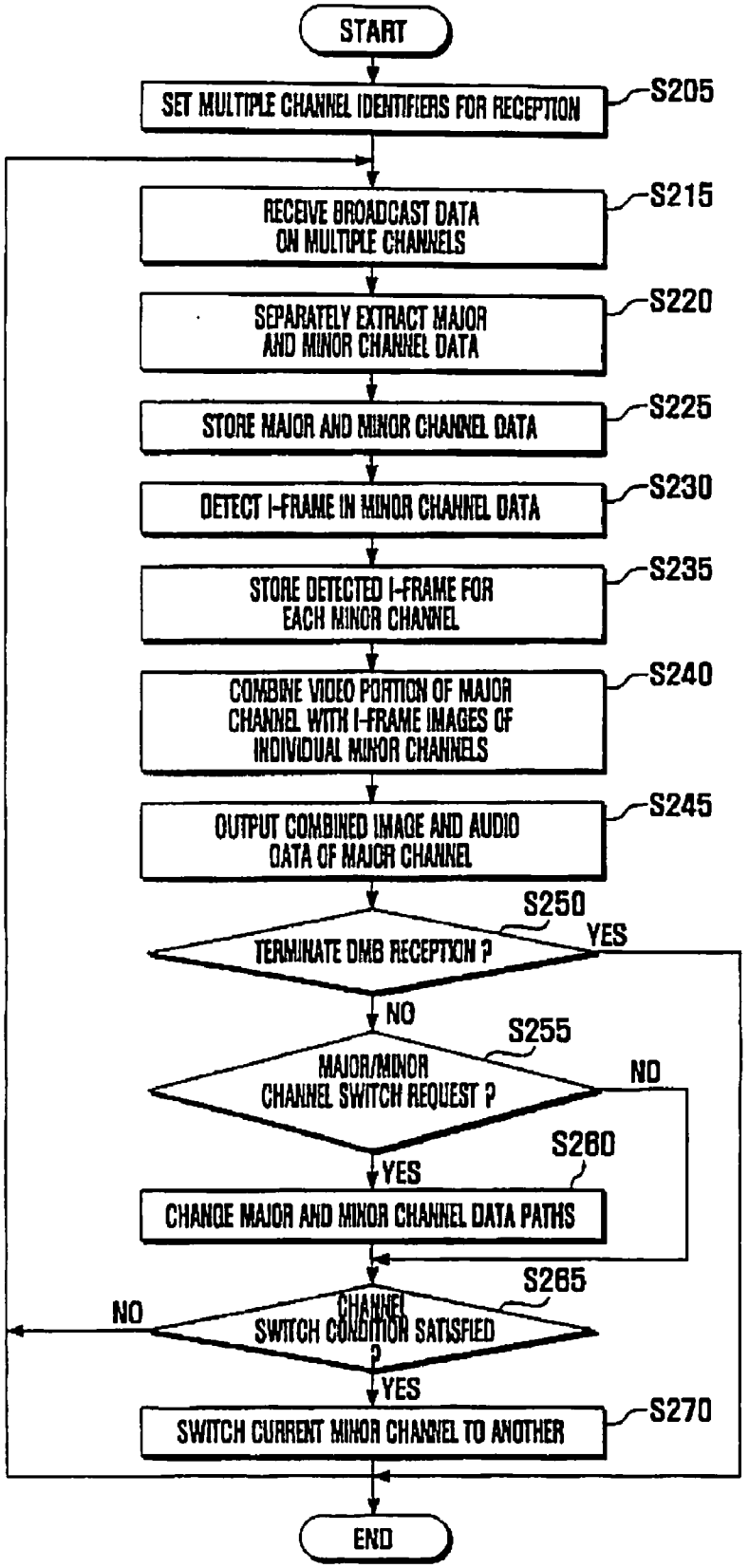

START
SET MULTIPLE CHANNEL IDENTIFIERS FOR RECEPTION
S205
RECEIVE BROADCAST DATA ON MULTIPLE CHANNELS
S215
SEPARATELY EXTRACT MAJOR AND MINOR CHANNEL DATA
S220
STORE MAJOR AND MINOR CHANNEL DATA
S225
DETECT I-FRAME IN MINOR CHANNEL DATA
S230
STORE DETECTED I-FRAME FOR EACH MINOR CHANNEL
S235
COMBINE VIDEO PORTION OF MAJOR CHANNEL WITH I-FRAME IMAGES OF INDIVIDUAL MINOR CHANNELS
S240
OUTPUT COMBINED IMAGE AND AUDIO DATA OF MAJOR CHANNEL
S245
S250
TERMINATE DMB RECEPTION ?
YES
NO
S255
MAJOR/MINOR CHANNEL SWITCH REQUEST ?
NO
YES
S260
CHANGE MAJOR AND MINOR CHANNEL DATA PATHS
S265
CHANNEL SWITCH CONDITION SATISFIED ?
NO
YES
S270
SWITCH CURRENT MINOR CHANNEL TO ANOTHER
END

FIG. 9

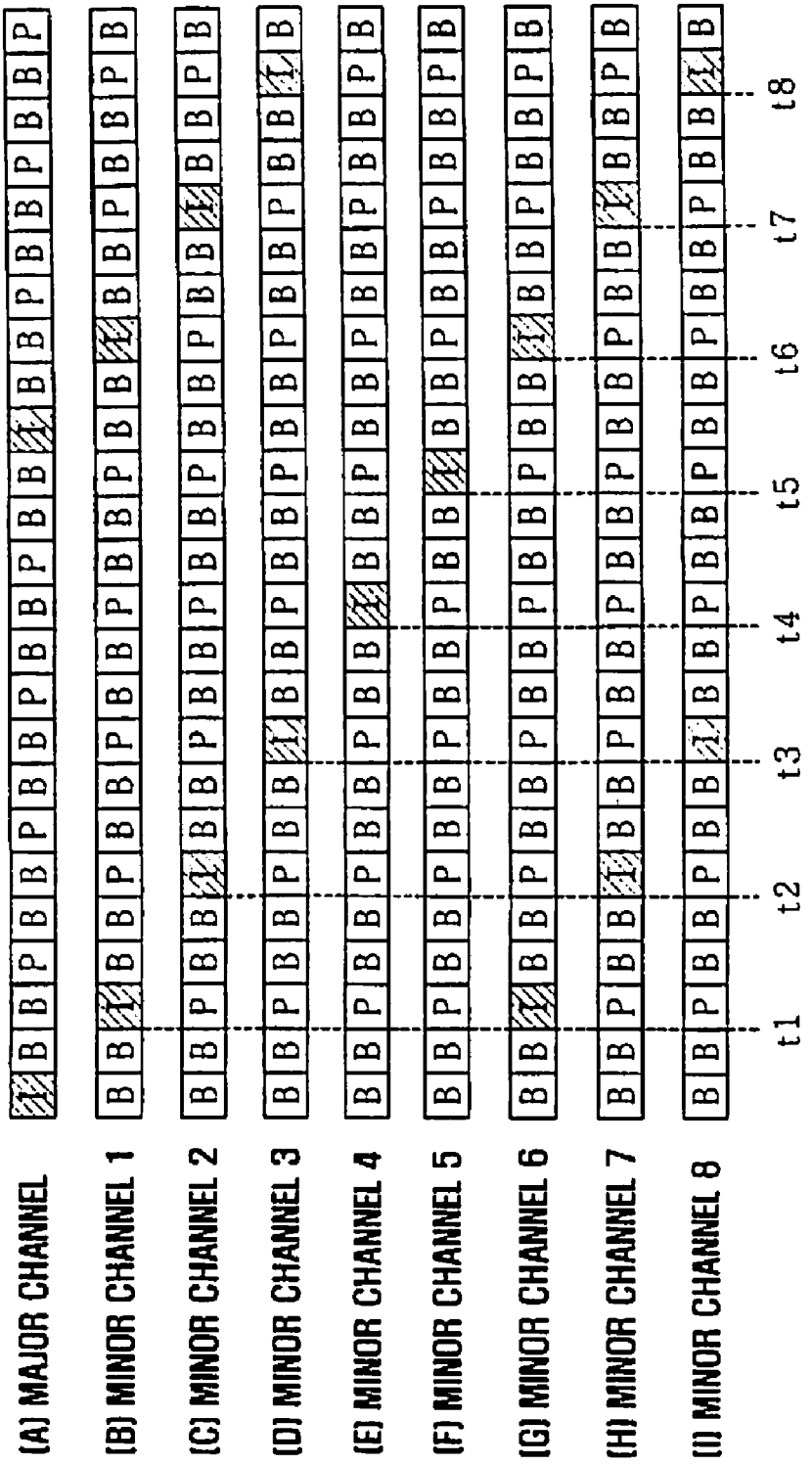

(A) MAJOR CHANNEL
(B) MINOR CHANNEL 1
(C) MINOR CHANNEL 2
(D) MINOR CHANNEL 3
(E) MINOR CHANNEL 4
(F) MINOR CHANNEL 5
(G) MINOR CHANNEL 6
(H) MINOR CHANNEL 7
(I) MINOR CHANNEL 8
t1
t2
t3
t4
t5
t6
t7
t8

FIG. 10A

MINOR CHANNEL 1	MINOR CHANNEL 2	MINOR CHANNEL 3
MINOR CHANNEL 4	MAJOR CHANNEL	MINOR CHANNEL 5
MINOR CHANNEL 6	MINOR CHANNEL 7	MINOR CHANNEL 8

FIG. 10B

MAJOR CHANNEL	MINOR CHANNEL 1	MINOR CHANNEL 2
	MINOR CHANNEL 3	MINOR CHANNEL 4

FIG. 11

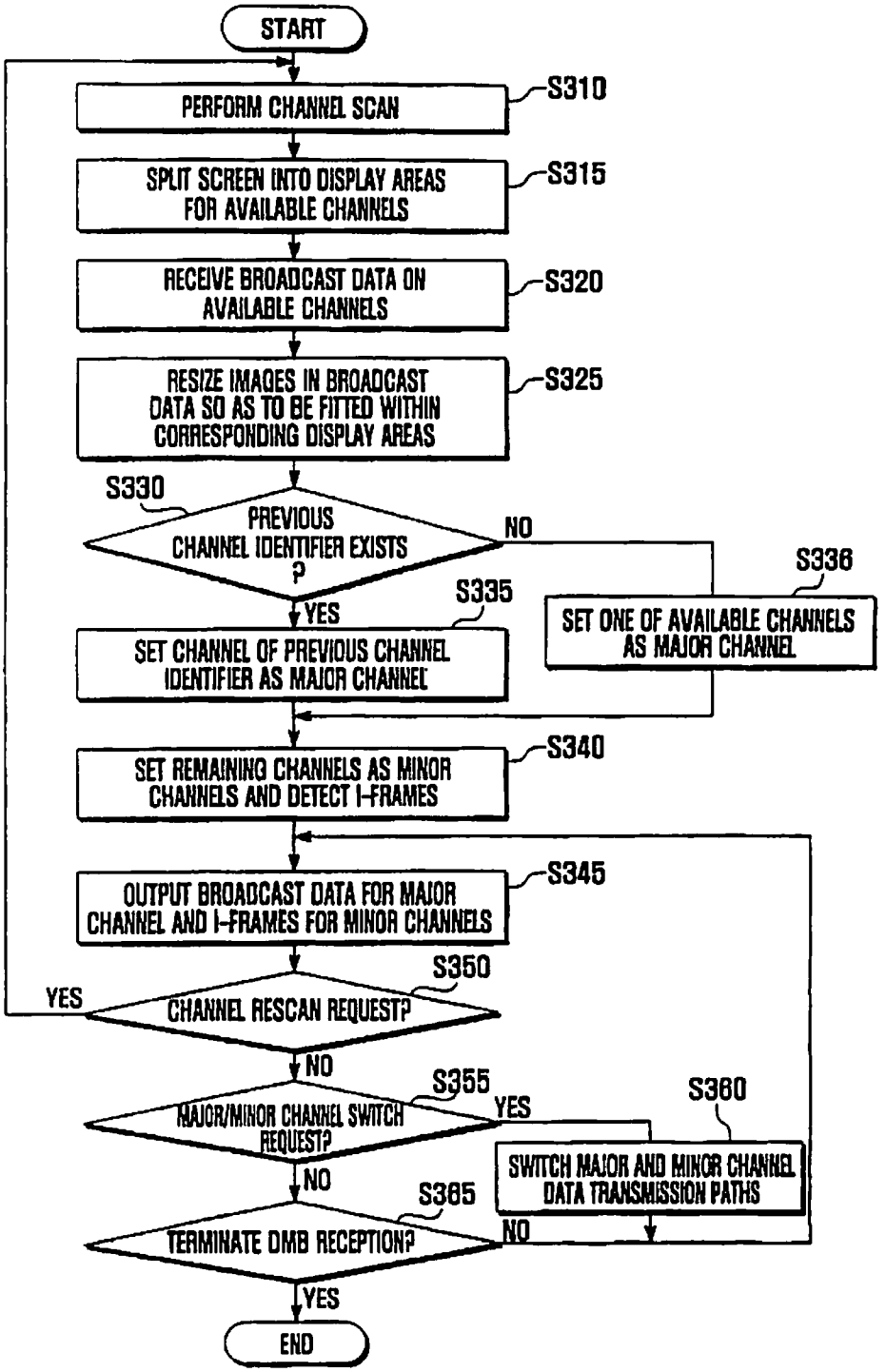

START
PERFORM CHANNEL SCAN
S310
SPLIT SCREEN INTO DISPLAY AREAS FOR AVAILABLE CHANNELS
S315
RECEIVE BROADCAST DATA ON AVAILABLE CHANNELS
S320
RESIZE IMAGES IN BROADCAST DATA SO AS TO BE FITTED WITHIN CORRESPONDING DISPLAY AREAS
S325
S330
PREVIOUS CHANNEL IDENTIFIER EXISTS ?
NO
S336
SET ONE OF AVAILABLE CHANNELS AS MAJOR CHANNEL
YES
S335
SET CHANNEL OF PREVIOUS CHANNEL IDENTIFIER AS MAJOR CHANNEL
S340
SET REMAINING CHANNELS AS MINOR CHANNELS AND DETECT I-FRAMES
S345
OUTPUT BROADCAST DATA FOR MAJOR CHANNEL AND I-FRAMES FOR MINOR CHANNELS
S350
YES
CHANNEL RESCAN REQUEST?
NO
S355
MAJOR/MINOR CHANNEL SWITCH REQUEST?
YES
S360
SWITCH MAJOR AND MINOR CHANNEL DATA TRANSMISSION PATHS
NO
S365
TERMINATE DMB RECEPTION?
NO
YES
END

FIG. 12

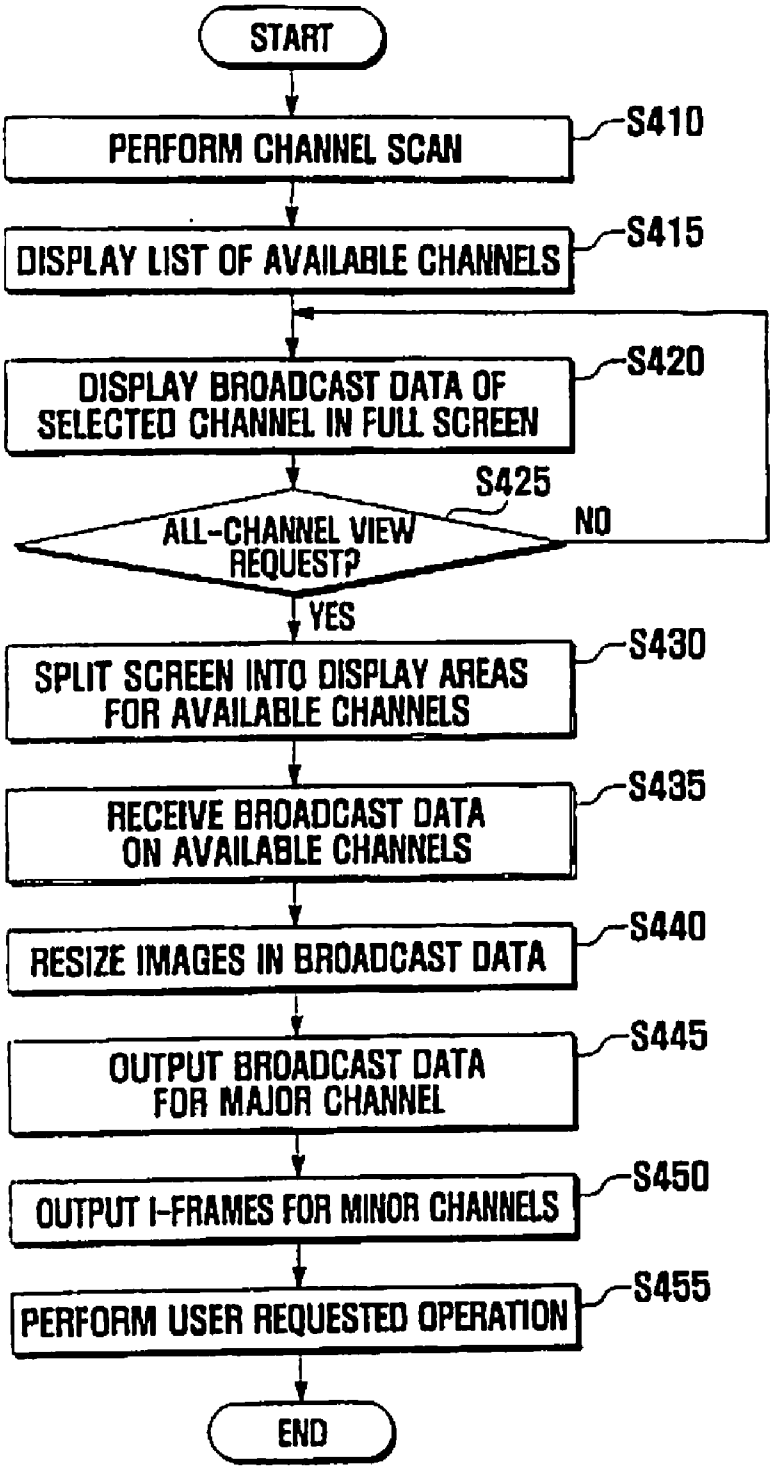

START
PERFORM CHANNEL SCAN
S410
DISPLAY LIST OF AVAILABLE CHANNELS
S415
DISPLAY BROADCAST DATA OF SELECTED CHANNEL IN FULL SCREEN
S420
S425
ALL-CHANNEL VIEW REQUEST?
NO
YES
SPLIT SCREEN INTO DISPLAY AREAS FOR AVAILABLE CHANNELS
S430
RECEIVE BROADCAST DATA ON AVAILABLE CHANNELS
S435
RESIZE IMAGES IN BROADCAST DATA
S440
OUTPUT BROADCAST DATA FOR MAJOR CHANNEL
S445
OUTPUT I-FRAMES FOR MINOR CHANNELS
S450
PERFORM USER REQUESTED OPERATION
S455
END

FIG. 13

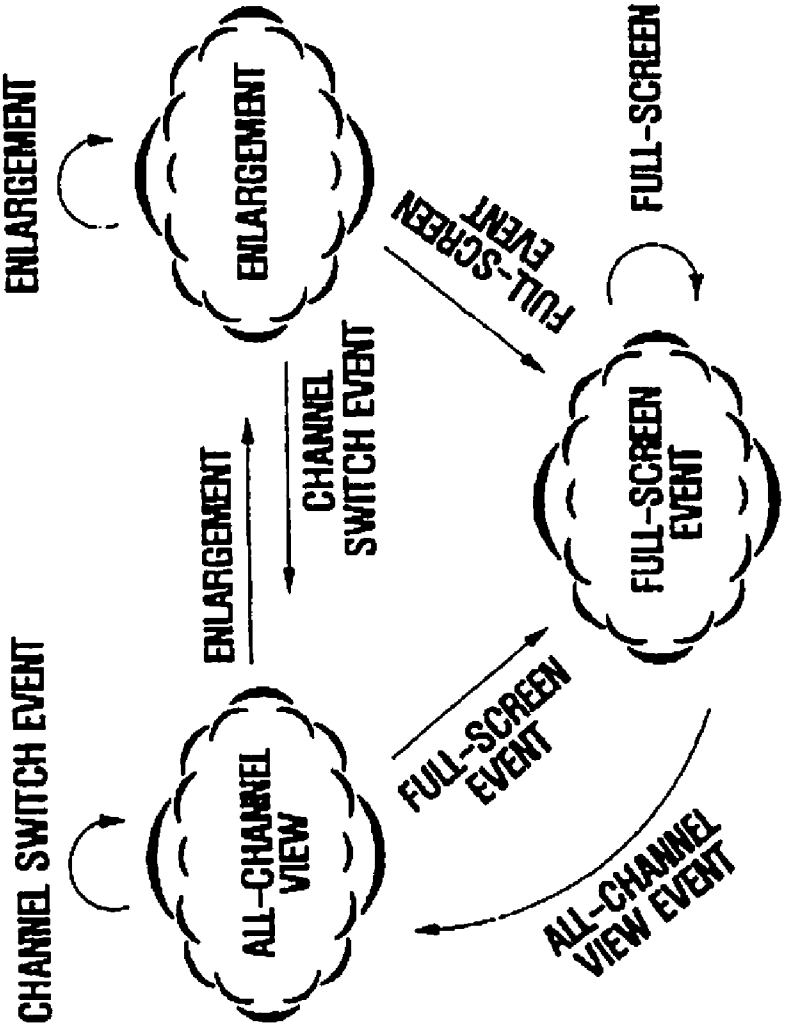

ENLARGEMENT
ENLARGEMENT
FULL-SCREEN EVENT
FULL-SCREEN
CHANNEL SWITCH EVENT
ENLARGEMENT
FULL-SCREEN EVENT
CHANNEL SWITCH EVENT
ALL-CHANNEL VIEW
FULL-SCREEN EVENT
ALL-CHANNEL VIEW EVENT

FIG. 14

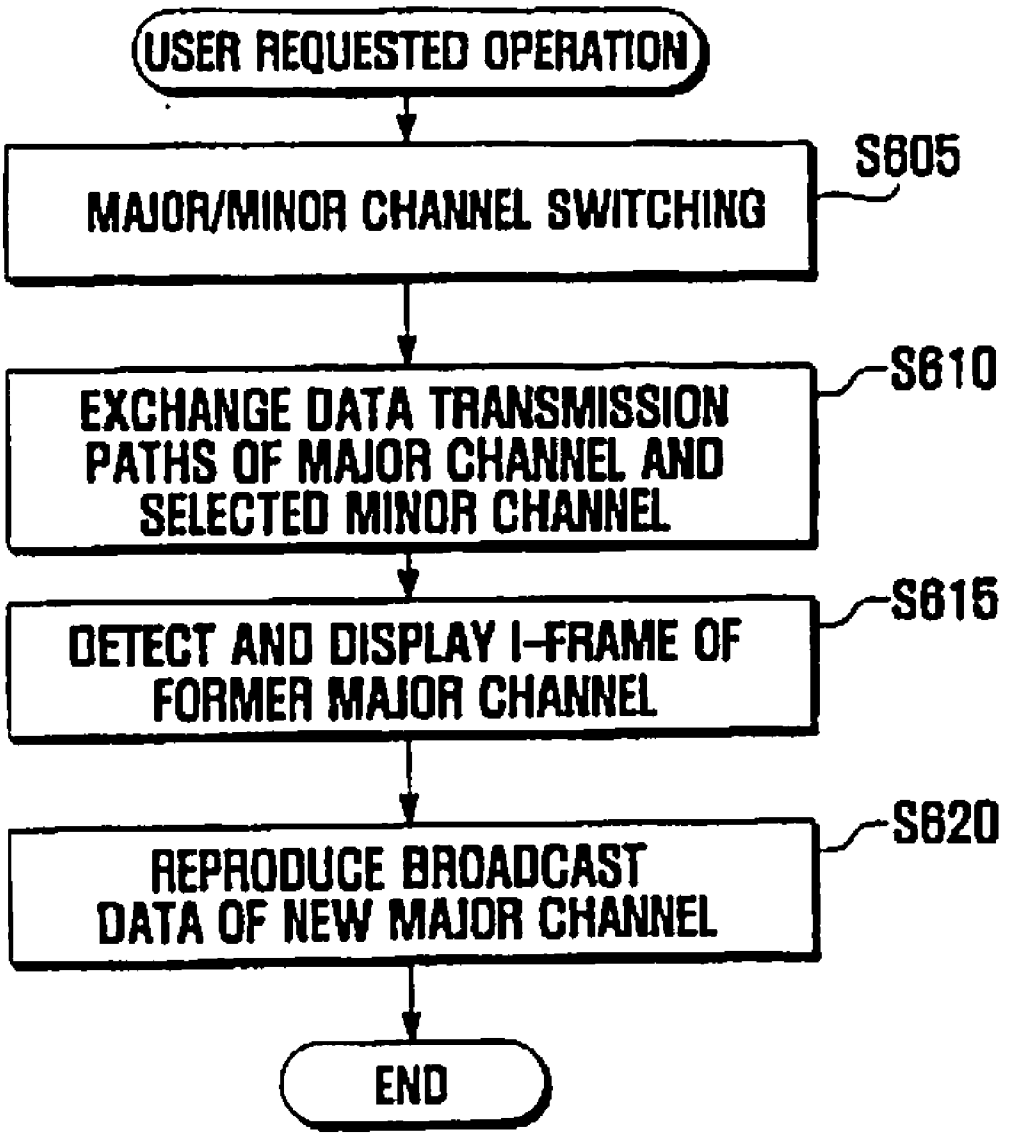

USER REQUESTED OPERATION
MAJOR/MINOR CHANNEL SWITCHING
S605
EXCHANGE DATA TRANSMISSION PATHS OF MAJOR CHANNEL AND SELECTED MINOR CHANNEL
S610
DETECT AND DISPLAY I-FRAME OF FORMER MAJOR CHANNEL
S615
REPRODUCE BROADCAST DATA OF NEW MAJOR CHANNEL
S620
END

FIG. 15

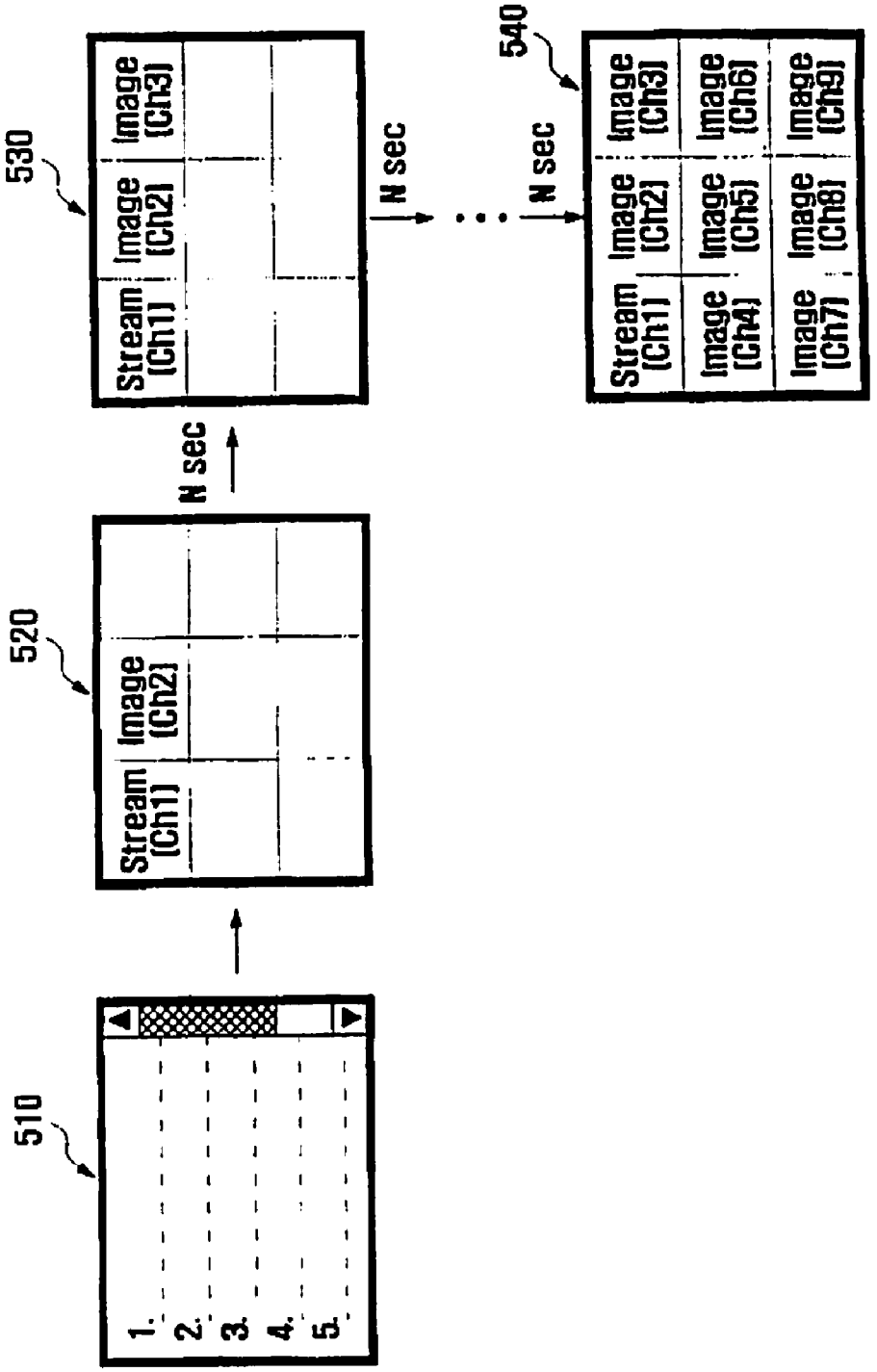

510
1.
2.
3.
4.
5.
520
Stream [Ch1]
Image [Ch2]
N sec
530
Stream [Ch1]
Image [Ch2]
Image [Ch3]
N sec
540
Stream [Ch1]
Image [Ch4]
Image [Ch7]
Image [Ch2]
Image [Ch5]
Image [Ch8]
Image [Ch3]
Image [Ch6]
Image [Ch9]

FIG. 16

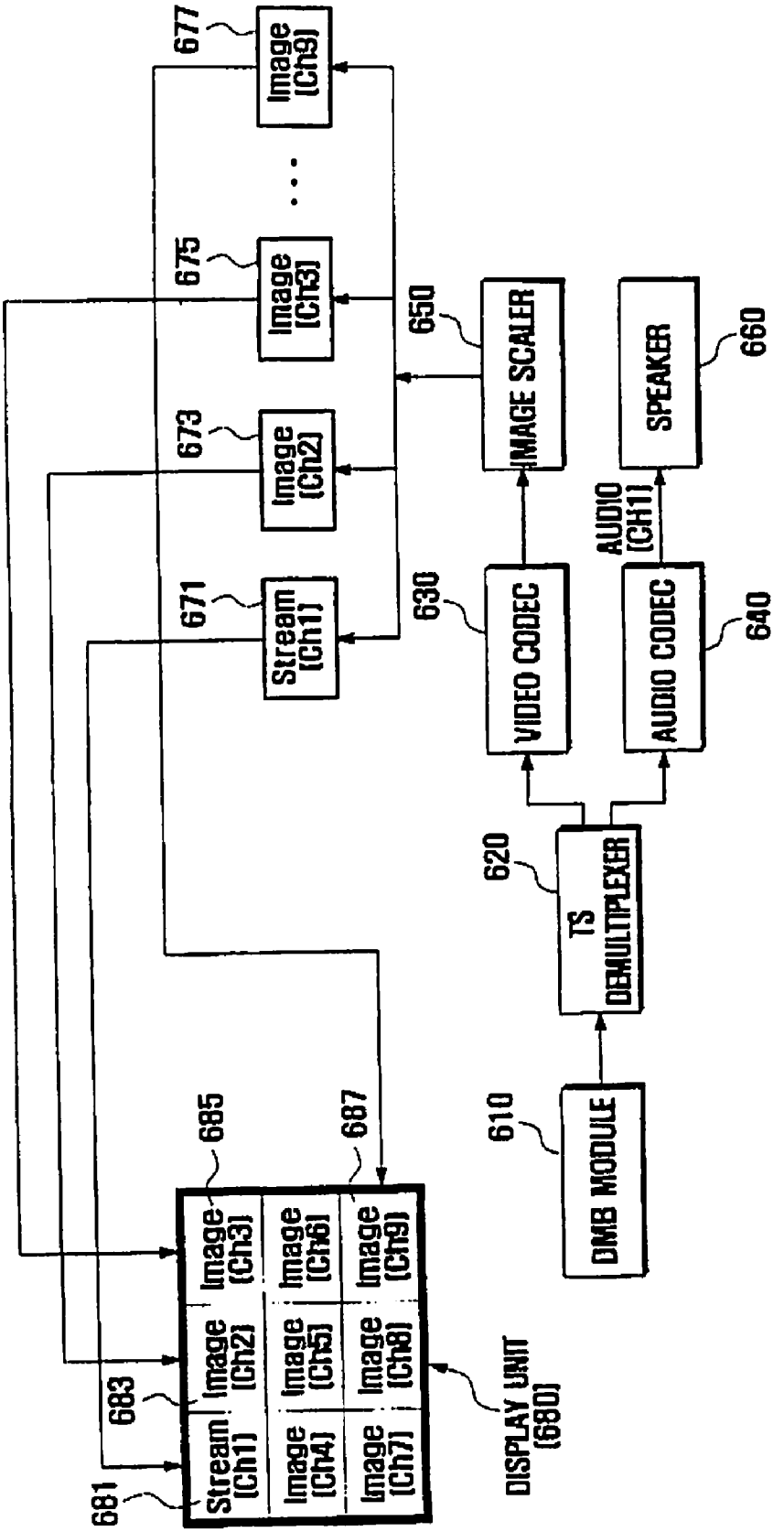
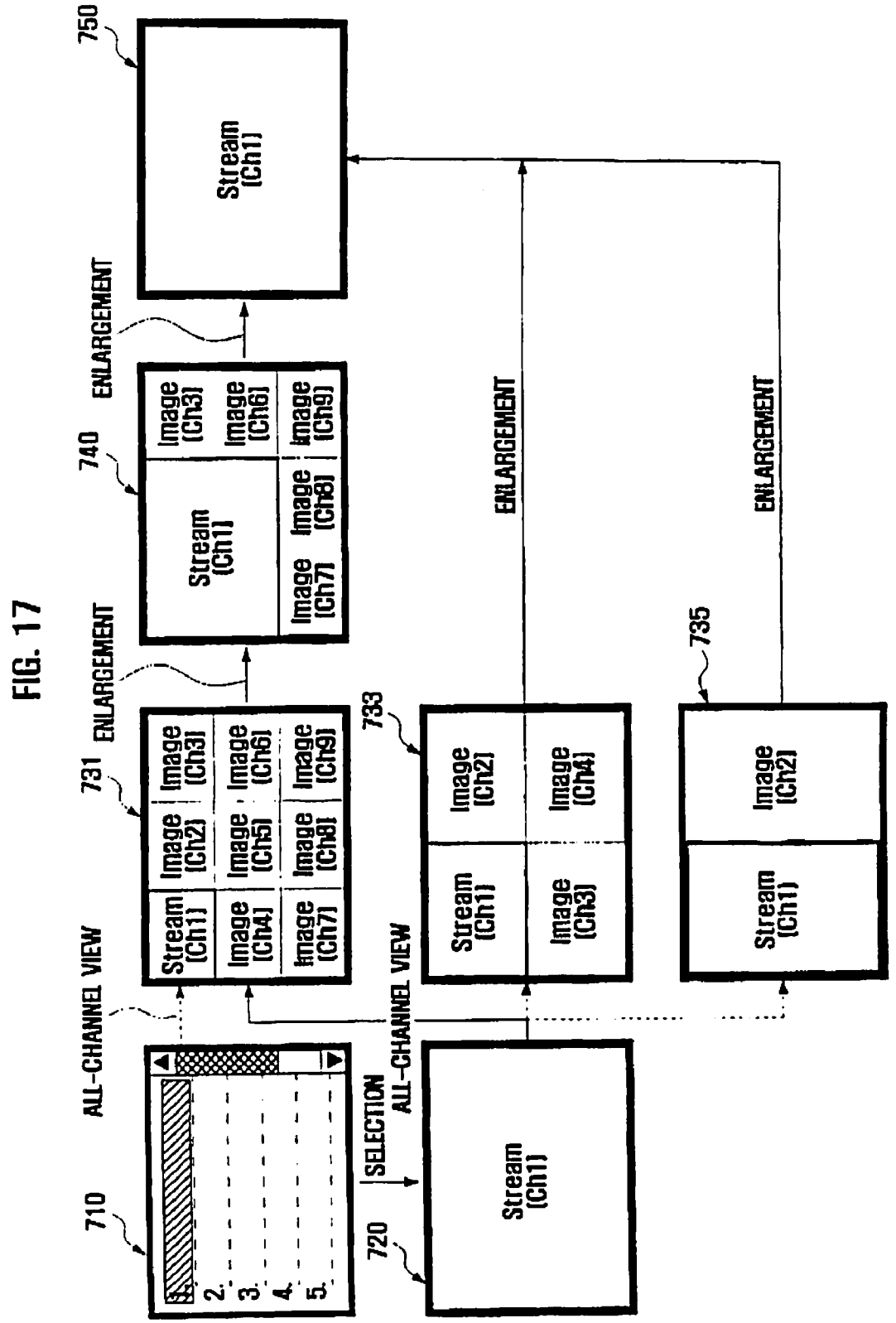

677
Image [Ch9]
675
Image [Ch3]
673
Image [Ch2]
671
Stream [Ch1]
650
IMAGE SCALER
630
VIDEO CODEC
640
AUDIO CODEC
660
SPEAKER
AUDIO [CH1]
620
TS DEMULTIPLEXER
610
DMB MODULE
685
687
683
681
Stream [Ch1]
Image [Ch2]
Image [Ch3]
Image [Ch4]
Image [Ch5]
Image [Ch6]
Image [Ch7]
Image [Ch8]
Image [Ch9]
DISPLAY UNIT [680]

FIG. 17


710
ALL-CHANNEL VIEW
1.
2.
3.
4.
5.
SELECTION
720
Stream (Ch1)
ALL-CHANNEL VIEW
731
Stream (Ch1)
Image (Ch4)
Image (Ch7)
Image (Ch2)
Image (Ch5)
Image (Ch8)
Image (Ch3)
Image (Ch6)
Image (Ch9)
ENLARGEMENT
740
Stream (Ch1)
Image (Ch7)
Image (Ch8)
Image (Ch3)
Image (Ch6)
Image (Ch9)
ENLARGEMENT
750
Stream (Ch1)
733
Stream (Ch1)
Image (Ch3)
Image (Ch2)
Image (Ch4)
ENLARGEMENT
735
Stream (Ch1)
Image (Ch2)
ENLARGEMENT

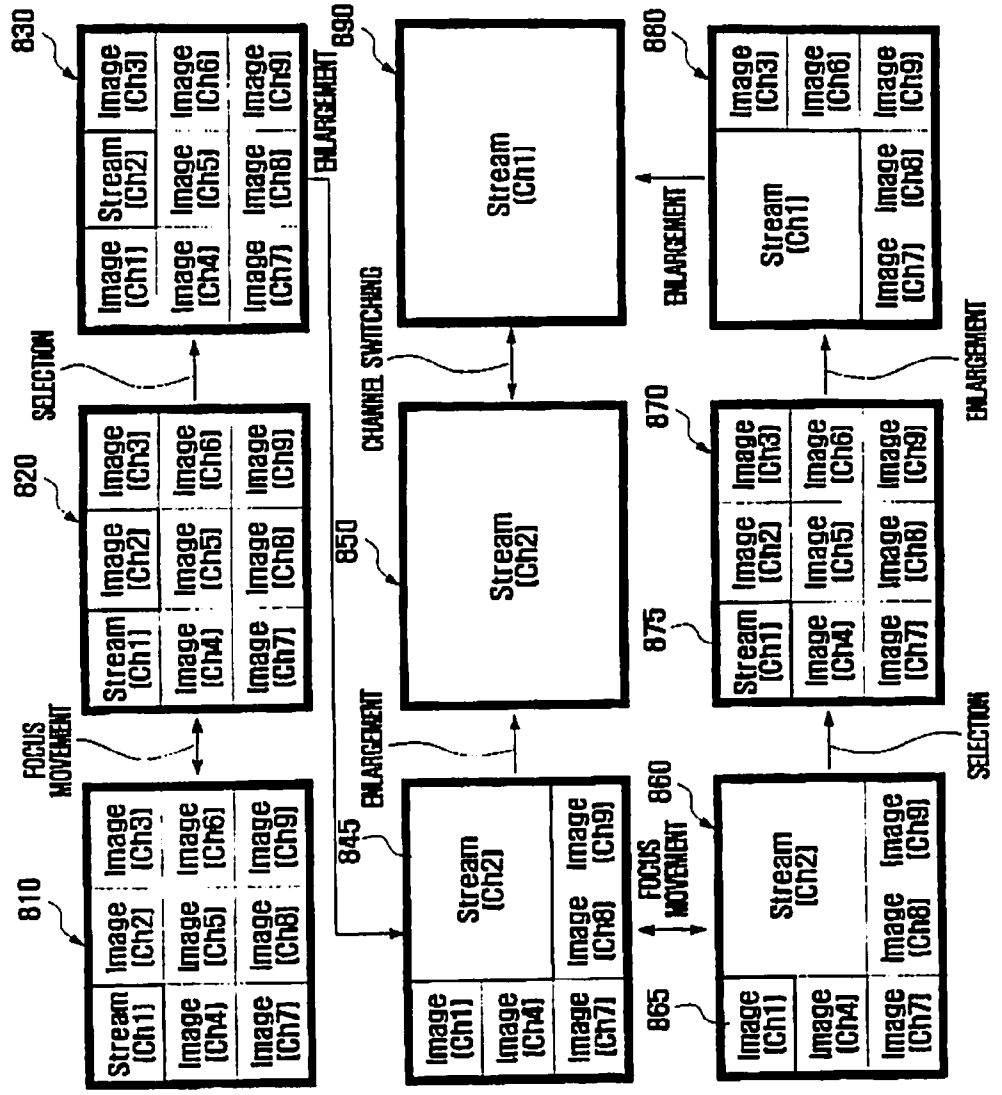

810
820
830
840
850
860
870
880
890
FOCUS MOVEMENT
SELECTION
ENLARGEMENT
CHANNEL SWITCHING
Stream (Ch1)
Stream (Ch2)
Image (Ch1)
Image (Ch2)
Image (Ch3)
Image (Ch4)
Image (Ch5)
Image (Ch6)
Image (Ch7)
Image (Ch8)
Image (Ch9)

FIG. 18

DIGITAL BROADCAST RECEIVER AND BROADCAST DATA DISPLAY METHOD FOR SIMULTANEOUS DISPLAY OF MULTI-CHANNEL VISUAL IMAGES

PRIORITY

[0001] This application is a Divisional Application of U.S. patent application Ser. No. 11/710,682, filed in the U.S. Patent and Trademark Office on Feb. 23, 2007, which claims priority under 35 U.S.C. §119(a) to applications filed in the Korean Intellectual Property Office on Feb. 23, 2006, and Sep. 15, 2006, and assigned Serial Nos. 2006-17793, and 2006-89505 respectively, the contents of each of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to a digital broadcast receiver and, more particularly, to a digital broadcast receiver and broadcast data display method wherein multi-channel visual images are simultaneously displayed to support easy channel selection and switching.

[0004] 2. Description of the Related Art

[0005] In digital multimedia broadcasting (DMB), various multimedia signals including audios and videos are digitally modulated and delivered to users. Particularly, users in motion can receive various multimedia programs through portable personal or in-vehicle receivers equipped with an omni directional receiving antenna.

[0006] Advances in memories capable of storing vast amounts of digital multimedia data such as moving pictures and music videos, and popularization of mobile communication terminals, have enabled recent development and commercialization of mobile communication terminals having DMB reception capabilities, for example DMB phones. While in motion, users can watch or listen to DMB programs through DMB phones.

[0007] When a user receiving DMB desires to obtain information on channels other than the current reception channel or desires to switch the current reception channel to a different channel, the user may have to scan all available channels in sequence. In addition, because information on broadcast programs or channels is provided as text-based information including channel names and associated program schedules, the user may have difficulty in intuitively understanding program guide information of a particular channel.

[0008] To solve the above problem, an image-based broadcast information providing method has recently been developed. In this image-based method, visual images are preassigned to corresponding programs on individual channels or visual images are extracted on demand from video broadcasts on individual channels, to provide program information on a particular channel using the prepared visual images.

[0009] However, in such a conventional image-based approach, program information is provided using a fixed image for each program on a channel. Thus, program information that changes with the passage of time cannot be provided. Because up-to-date image information regarding broadcast programs of individual channels cannot be obtained, the user cannot utilize up-to-date image information to select a desired channel.

SUMMARY OF THE INVENTION

[0010] The present invention has been made in view of the above problems, and an object of the present invention is to provide a digital broadcast receiver and broadcast data display method that can simultaneously display up-to-date multi-channel visual images and facilitate channel selection of the user.

[0011] Another object of the present invention is to provide a digital broadcast receiver and broadcast data display method that can simultaneously display thumbnail images representing digital broadcasts of individual channels in corresponding display areas of a single screen and to facilitate channel selection and switching.

[0012] Another object of the present invention is to provide a digital broadcast receiver and broadcast data display method that can simultaneously display real-time broadcast of a major channel and up-to-date informational images of other remaining channels.

[0013] Another object of the present invention is to provide a digital broadcast receiver and broadcast data display method wherein a major channel display area for a real-time broadcast and multiple minor channel display areas for up-to-date visual images are simultaneously presented and selection of both the major channel display area and one of the minor channel display areas resulting in major/minor channel switching.

[0014] In accordance with the present invention, a broadcast data display method for a digital broadcast receiver is provided. In response to a broadcast reception request from a user, a channel list having identifiers of available channels is displayed. Broadcast data of a channel selected by the user from the channel list is displayed on a screen in a full-screen mode. In response to a request of all-channel view during channel list display or broadcast reception, the screen is divided into display areas corresponding to the individual available channels of the channel list. Real-time broadcast data of the selected channel is displayed in a corresponding display area of the screen. Still images of the remaining channels are displayed simultaneously or sequentially in their corresponding display areas.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description in conjunction with the accompanying drawings, in which:

[0016] FIG. **1** is an overview of a digital multimedia broadcasting (DMB) system;

[0017] FIG. **2** is a block diagram of a DMB receiver according to the present invention;

[0018] FIG. **3** is a block diagram of a DMB receiver according to another embodiment of the present invention;

[0019] FIG. **4** illustrates an I-frame information table for managing information on I-frames of minor channels in the receiver of FIG. **2** or FIG. **3**;

[0020] FIG. **5** is a flow chart of a method of simultaneously displaying multi-channel visual images for the receiver of FIG. **2** or FIG. **3**;

[0021] FIG. **6** is a block diagram of a DMB receiver according to another embodiment of the present invention;

[0022] FIG. **7** is a block diagram of a DMB receiver according to another embodiment of the present invention;

[0023] FIG. **8** is a flow chart of a method for simultaneously displaying multi-channel visual images for the receiver of FIG. **6** or FIG. **7**;

[0024] FIG. **9** illustrates structures of MPEG video data processed by the receivers of FIGS. **2**, **3**, **6** and **7**;

[0025] FIGS. **10**A and **10**B illustrate display screen layouts for presenting multi-channel visual images output by the receivers of FIGS. **2**, **3**, **6** and **7**;

[0026] FIG. **11** is a flow chart of a method for simultaneously displaying multi-channel visual images according to another embodiment of the present invention;

[0027] FIG. **12** is a flow chart of a method for simultaneously displaying multi-channel visual images according to another embodiment of the present invention;

[0028] FIG. **13** is the state transition diagram illustrating transitions in screen display mode in response to user events in the method of FIG. **12**;

[0029] FIG. **14** is the flow chart of a channel switching procedure in the method of FIG. **12**;

[0030] FIG. **15** illustrates the sequence of screen layouts for multi-channel visual images in response to user events;

[0031] FIG. **16** is a configuration of a DMB receiver for illustrating multi-channel visual image processing;

[0032] FIG. **17** illustrates the sequence of screen layouts for multi-channel visual images in response to user events; and

[0033] FIG. **18** illustrates the sequence of screen layouts for multi-channel visual images in response to user events.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0034] Hereinafter, preferred embodiments of the present invention are described in detail with reference to the accompanying drawings. The same reference symbols identify the same or corresponding elements in the drawings. Detailed descriptions of constructions or processes known in the art may be omitted to avoid obscuring the invention in unnecessary detail.

[0035] First, a brief introduction to digital multimedia broadcasting (DMB) is provided. Although the present invention is applied to DMB, it may also be applied to any digital broadcasting, such as digital video broadcasting (DVB), and MediaFLO.

[0036] DMB services are based on digital audio broadcasting (DAB) technologies for digital radios, and further include multimedia broadcasting concepts to additionally deliver moving images and information services such as weather, news and location services. DMB services can provide compact disc (CD) or digital versatile disc (DVD)-like high quality audio and video broadcast data to users in motion through mobile or in-vehicle receivers, and they are attracting attention as next generation broadcasting services.

[0037] That is, DMB services enable users in motion to receive various multimedia broadcast data on multiple channels through mobile or in-vehicle terminals having an omni directional receiving antenna.

[0038] Compared with existing broadcasting services, DMB services can be characterized by mobility. DMB systems are divided by signal transmission mechanisms into terrestrial and satellite systems. DMB systems are compared with existing broadcasting systems and comparison results are summarized in Table 1.

TABLE 1

	Mobility		
	Fixed	Mobile	Comparison
Transmission mechanism	Existing public broadcasting	Terrestrial DMB	Ground station
	Existing satellite broadcasting	Satellite DMB	Artificial satellite
Comparison	Middle to large receiver	Very small receiver	

[0039] As shown in Table 1, compared with existing broadcasting services, DMB services can be characterized by mobility and small size of receivers. Broadcasting services are provided though ground stations in terrestrial DMB systems, and are provided through artificial satellites in satellite DMB systems.

[0040] In a satellite DMB system as a new broadcast medium, programs are transmitted from a DMB broadcast center to a satellite, which then retransmits the programs to mobile DMB terminals in the wide coverage area of the satellite. Owing to the use of satellite, satellite DMB services are available in outdoor environments across a large area. Gap fillers or repeaters may be required to receive DMB signals and retransmit the received DMB signals in order to provide services to users in shadow areas such as underground or indoor regions.

[0041] In a terrestrial DMB system, programs are transmitted through spectrum suitable for terrestrial propagation. Unlike the satellite DMB system, broadcast signals are transmitted through base stations, which are similar to those for mobile terminals, on the ground. A terrestrial DMB service is a multimedia service combining video, audio and data broadcasting that is provided through terrestrial waves to users in motion.

[0042] Referring to FIG. **1**, the DMB system includes a broadcasting center **10**, one or more satellites **20**, one or more base stations **30**, and a plurality of mobile, portable and fixed receivers such as vehicle receivers **40**, mobile terminals **50** and home receivers **60**.

[0043] The broadcasting center **10** compresses and modulates DMB signals representing audio, video and data signals, and transmits the modulated DMB signals to corresponding satellites **20** or base stations **30**.

[0044] Each satellite **20** or base station **30** receiving the DMB signals from broadcasting center **10** amplifies the received DMB signals, and retransmits the amplified DMB signals at different frequencies to receivers **40**, **50** and **60**.

[0045] Each receiver **40**, **50** or **60** receives the DMB signals from corresponding satellite **20** or base station **30**, and demodulates and decompresses the received DMB signals to output uncompressed audio, video and data signals.

[0046] Rapidly advancing digital broadcasting technologies have enabled users in fast motion to receive noise-free digital broadcast programs, and have demanded development of new added functions and services for greater user convenience.

[0047] A digital broadcast receiver of the present invention maintains one broadcast channel ('major channel') to continuously deliver a digital broadcast, and at least one broadcast channel ('minor channel') to deliver digital broadcasts in an alternating manner according to a preset channel switch condition. The channel switch condition is preferably one of

a change request by the user, a preset change period, and detection of I-frames on minor channels, and is described later.

[0048] Referring to FIG. **2**, DMB receiver **100** includes a DMB module **110**, a TS demultiplexer **120**, a major channel buffer **130**, a minor channel processor **140**, an A/V codec **150**, an image synthesizer **160**, a DMB output unit **170**, a channel setting unit **180**, and an input unit **190**.

[0049] DMB module **110** receives a multi-channel broadcast signal corresponding to broadcast channels selected by the user, and outputs transport stream (TS) data of the selected broadcast channels. In satellite DMB, DMB module **110** sets Walsh codes (a Walsh code is a code used to extract TS packets of a particular channel from broadcast data transmitted over an MPEG-2 transport stream) associated with a major channel and a minor channel on the basis of reception channel information from channel setting unit **180**, extracts TS data of the major and minor channels using the Walsh codes, and outputs the extracted TS data. Before output of the extracted TS data, DMB module **110** deinterleaves the extracted TS data using associated channel information.

[0050] TS demultiplexer **120** demultiplexes the TS data from DMB module **110** into major channel data and minor channel data, detects MPEG-4 format data from the major channel data and minor channel data, and outputs the major channel MPEG-4 data and minor channel MPEG-4 data to the major channel buffer **130** and minor channel processor **140** respectively.

[0051] Major channel buffer **130** stores broadcast data of the major channel from TS demultiplexer **120**. To separately store the audio portion and visual portion of the broadcast data, major channel buffer **130** preferably includes an audio buffer **131** for storing audio data in a digital form and video buffer **133** for storing video data in a digital form.

[0052] Minor channel processor **140** detects video data from the minor channel broadcast data from TS demultiplexer **120**, detects an I-frame from the detected video data, and stores the detected I-frame. Minor channel processor **140** preferably includes an I-frame detector **141** for detecting I-frames, and an I-frame storage **143** for storing detected I-frames and associated minor channel identifiers.

[0053] An MPEG-compressed video data stream includes intra-coded frames or I-frames, predictive frames or P-frames, and bidirectional frames or B-frames. I-frames are reference frames for MPEG compression and decompression, and are repeated in an MPEG-compressed video data stream by a preset period of time (0.5 seconds for the satellite DMB system). In addition, the size of an I-frame is greater than that of a P-frame or B-frame. For example, the P-frame size is about 1/10 of the I-frame size.

[0054] I-frame detector **141** detects an I-frame at each I-frame period in the minor channel broadcast data from TS demultiplexer **120**. The minor channel broadcast data fed to minor channel processor **140** can include both video data and audio data. Hence, I-frame detector **141** preferably detects video data in the minor channel broadcast data then detects an I-frame from the detected video data.

[0055] Preferably, I-frame detector **141** pre-stores I-frame periods to detect an image frame received at each I-frame period as an I-frame, or compares sizes of received image frames to detect a relatively large image frame as an I-frame.

[0056] I-frame storage **143** stores I-frames detected by I-frame detector **141** and associated minor channel identifiers. The stored I-frame of a current minor channel is updated at each I-frame period.

[0057] This is because image synthesizer **160** uses stored I-frames of minor channels (in particular, the previous minor channel) to display on a single screen I-frame images of the minor channels, which alternate with one another at a predetermined channel switch period. I-frame storage **143** preferably stores a quantity of I-frames greater than or equal to the quantity of preset minor channels to be received simultaneously with the major channel. I-frames arranged in a tabular format are illustrated in FIG. **4**. Referring to FIG. **4**, an I-frame information table **80** includes channel identifier fields **81** and I-frame fields **83** to store I-frames according to their corresponding channels.

[0058] A/V codec **150** decodes digital audio data and video data from major channel buffer **130**, and outputs decoded data as an audio signal and video signal.

[0059] Image synthesizer **160** combines major channel video data decoded by A/V codec **150** with multiple minor channel images from minor channel processor **140**. That is, the major channel video data is combined with I-frames of minor channels stored in I-frame storage **143**. Preferably, image synthesizer **160** stores the preset quantity of minor channels, and selects in sequence from I-frame storage **143** a quantity of I-frames for image synthesis equal to the preset quantity of minor channels.

[0060] DMB output unit **170** includes a speaker **171** for outputting an audio signal from A/V codec **150**, and a display section **173** for displaying a video signal from image synthesizer **160**. Display section **173** preferably simultaneously displays major channel video data and minor channel video data on a single screen using the output signal from image synthesizer **160**.

[0061] Channel setting unit **180** sets identifiers of major and minor channels to be received according to user selections through input unit **190**, and transmits the channel identifiers to DMB module **110**. Preferably, channel setting unit **180** pre-stores a channel ID list having a plurality of identifiers of minor channels selected by the user or a plurality of favorite channel identifiers automatically collected from channel reception histories, selects a channel identifier from the channel ID list in sequence according to a channel switch condition set in advance, and transmits the selected channel identifier to DMB module **110**. The channel ID list preferably includes a quantity of channel identifiers greater than or equal to the preset quantity of minor channels to be simultaneously output to a single screen.

[0062] The channel switch condition may be a change request by the user, a preset change period, or detection of an I-frame on the current minor channel. If the channel switch condition is a change request by the user, channel setting unit **180** preferably sets the current minor channel to a channel of a channel identifier accompanied by the change request.

[0063] If the channel switch condition is a change request by the user or a preset change period, channel setting unit **180** maintains the current minor channel until the channel switch condition is satisfied, and minor channel processor **140** updates the I-frame of the current minor channel stored in I-frame storage **143** at each I-frame period.

[0064] Accordingly, DMB output unit **170** both outputs broadcast data of the major channel fed via major channel buffer **130** and displays a preset quantity of minor channel

images using minor channel I-frames stored in I-frame storage **143**, wherein the image of the current minor channel is updated and newly displayed at each I-frame period until the current minor channel is switched to another channel.

[0065] For a minor channel switch through I-frame detection, I-frame detector **141** preferably informs channel setting unit **180** of detection of an I-frame of a particular minor channel. Because an I-frame contains a reference image for MPEG compression and decompression, it is possible to create a visual image of the particular minor channel. That is, if an I-frame of the current minor channel is detected, a visual image of the current minor channel is updated with the detected I-frame image, and the current minor channel is switched to a next minor channel for video data reception.

[0066] Accordingly, in the present invention, while broadcast data of a major channel is being output, newly updated visual images of multiple minor channels can be delivered.

[0067] Instead of using such a channel ID list for a minor channel switch, channel setting unit **180** may directly set or modify minor channel identifiers according to information supplied by each user selection, and transmit the minor channel identifiers to DMB module **110**.

[0068] When a major channel change request is input through input unit **190**, channel setting unit **180** changes the major channel identifier according to information accompanied by the change request. That is, channel setting unit **180** sets identifiers of major and minor channels to be received by DMB module **110**, and controls DMB module **110** to alternate multiple minor channels while the major channel is fixed.

[0069] Referring to FIG. **3**, DMB receiver **200** includes a DMB module **210**, a TS demultiplexer **220**, a major channel buffer **230**, a minor channel processor **240**, an A/V codec **250**, an image synthesizer **260**, a DMB output unit **270**, a channel setting unit **280**, and an input unit **290**. Compared with DMB receiver **100** of FIG. **2**, DMB receiver **200** can simultaneously receive broadcast data of two minor channels if available channels exist.

[0070] Elements of DMB receiver **200** are similar in function to corresponding elements of DMB receiver **100** of FIG. **2**. That is, DMB module **210**, TS demultiplexer **220**, major channel buffer **230**, minor channel processor **240**, A/V codec **250**, image synthesizer **260**, DMB output unit **270**, channel setting unit **280**, and input unit **290** of DMB receiver **200** shown in FIG. **3** are similar in function, respectively, to DMB module **110**, TS demultiplexer **120**, major channel buffer **130**, minor channel processor **140**, A/V codec **150**, image synthesizer **160**, DMB output unit **170**, channel setting unit **180**, and input unit **190** of the DMB receiver **100** shown in FIG. **2**.

[0071] However, with an increased number of minor channels to be received, operations of the elements in FIG. **3** related to minor channel processing are different from those of corresponding elements in FIG. **2**.

[0072] Channel setting unit **280** sets one major channel identifier and two minor channel identifiers, and transmits the three channel identifiers to DMB module **210**. In satellite DMB, DMB module **210** sets three Walsh codes on the basis of the major and minor channel identifiers, and extracts TS data corresponding to one major channel and two minor channels using the Walsh codes and outputs the extracted TS data. TS demultiplexer **220** separates major channel data, first minor channel data and second minor channel data from the TS data output from DMB module **210**, detects MPEG-4 data from the separated data, and outputs the detected MPEG-4 data.

[0073] To simultaneously process video broadcasts on multiple minor channels, minor channel processor **240** includes an I-frame detector for each minor channel. Minor channel processor **240** includes a first I-frame detector **241** for detecting an I-frame of a first minor channel, a second I-frame detector **242** for detecting an I-frame of a second minor channel, and an I-frame storage **243** for storing I-frames output from the first and second I-frame detectors **241** and **242**.

[0074] As described above, with an increased number of minor channels, operations of DMB module **210**, TS demultiplexer **220**, minor channel processor **240** and channel setting unit **280** in FIG. **3** are different from those of corresponding elements in FIG. **2**. Elements in FIG. **3** other than those listed above are similar in operation to corresponding elements in FIG. **2**, and a repeated description thereof is omitted.

[0075] FIG. **2** is a block diagram of a DMB receiver having one minor channel simultaneously received with a major channel, and FIG. **3** is a block diagram of a DMB receiver having two minor channels. However, the present invention is not limited to a DMB receiver having one minor channel or two minor channels. The present invention relates to a DMB receiver that can simultaneously display visual images of a major channel and multiple minor channels, wherein each minor channel is selected in sequence according to a channel switch condition described above and the displayed image of the selected minor channel is continuously updated with a newly received image. The present invention is not limited by the quantity of minor channels simultaneously receivable with a major channel, and the quantity of minor channels can increase along with performance improvement of the DMB module.

[0076] Referring to FIG. **5**, the method is described as follows.

[0077] The DMB receiver sets multiple channel identifiers for DMB reception in step **S105**. At this step, the DMB receiver sets a major channel identifier and a quantity of minor channel identifiers. Preferably, the DMB receiver prestores a channel ID list having a plurality of identifiers of minor channels selected by the user or a plurality of favorite channel identifiers automatically collected from channel reception histories, and selects a channel identifier from the channel ID list in sequence according to a preset channel switch condition to set the current minor channel to a channel of the selected channel identifier. The channel switch condition is described above in relation to FIG. **2**.

[0078] When DMB reception is initiated in step **S115**, the DMB receiver receives broadcast data on multiple channels of the channel identifiers set at step **S105**, and separately extracts major channel data and minor channel data from the received broadcast data in step **S120** because the major channel data and minor channel data in the broadcast data received at step **S115** are in an interleaved form. This separate extraction operation is similar to the operation of TS demultiplexer **120** described in relation to FIG. **2**.

[0079] After separate extraction of the major channel data and minor channel data at step **S120**, the DMB receiver stores the major channel data at step **S125**. An I-frame of the current minor channel is detected from the minor channel data at step **S130**, and the detected I-frame is stored according to its corresponding channel in step **S135**. Steps **S130** and **S135** for

minor channel processing are similar to the operation of minor channel processor **140** described in relation to FIG. **2**.

[0080] After storing the major channel data and I-frame detection, the DMB receiver combines the video portion of the major channel with a quantity of I-frame images equal to the preset quantity of the minor channels in step S**140**, and outputs the combined major/minor channel visual image with the audio data of the major channel in step S**145**.

[0081] While in DMB reception, namely, if reception of the fixed major channel is not terminated in step S**150**, if the channel switch condition is satisfied in step S**155**, the DMB receiver switches the current minor channel to another minor channel in step S**160**, and repeats steps S**115** through S**155** for continued DMB reception.

[0082] The condition to switch channels is preferably one of a change request by the user, a preset change period and detection of an I-frame on the current minor channel. The condition to switch channels at step S**160** to switch between minor channels are described in relation to channel setting unit **180** in FIG. **2**.

[0083] Through steps described above, the DMB receiver of FIG. **2** or **3** simultaneously displays up-to-date multi-channel visual images. In particular, up-to-date visual images of multiple minor channels are displayed during reception of a major channel, thereby facilitating channel selections of the user.

[0084] FIG. **6** illustrates a configuration of a DMB receiver according to another embodiment of the present invention.

[0085] Referring to FIG. **6**, DMB receiver **300** includes a DMB module **310**, a TS demultiplexer **320**, a major channel buffer **330**, a minor channel processor **340**, an A/V codec **350**, an image synthesizer **360**, a DMB output unit **370**, a channel setting unit **380**, an input unit **390**, and a first switch SW**1**. Compared with DMB receiver **100** of FIG. **2**, DMB receiver **300** performs switching between major and minor channels in response to a major/minor channel switch request, and further includes the first switch SW**1** to perform switching between major and minor channel data transmission paths.

[0086] Elements of DMB receiver **300** are similar in function to corresponding elements of DMB receiver **100** of FIG. **2**. That is, DMB module **310**, TS demultiplexer **320**, major channel buffer **330**, minor channel processor **340**, A/V codec **350**, image synthesizer **360**, DMB output unit **370**, channel setting unit **380**, and input unit **390** of the DMB receiver **300** shown in FIG. **6** are similar in function, respectively, to DMB module **110**, TS demultiplexer **120**, major channel buffer **130**, minor channel processor **140**, A/V codec **150**, image synthesizer **160**, DMB output unit **170**, channel setting unit **180**, and input unit **190** of DMB receiver **100** shown in FIG. **2**.

[0087] Elements in FIG. **6** other than channel setting unit **380** are similar in operation to corresponding elements in FIG. **2**, and a repeated description thereof is omitted. In the case of channel setting unit **380**, it transmits a control signal for switching between major and minor channel data transmission paths to the first switch SW**1**.

[0088] Channel setting unit **380** outputs a control signal to the first switch SW**1** for switching data transmission paths on the basis of a user selection through input unit **390** or a major/minor channel switch condition set in advance. The major/minor channel switch condition is preferably a major/minor channel switch period or a major/minor channel switch time. If the condition to switch the major/minor channel is a major/minor channel switch period, channel setting unit **380** repeatedly outputs a control signal at regular intervals for switching between major and minor channels. If the condition to switch the major/minor channel is a major/minor channel switch time, channel setting unit **380** outputs a control signal at a specified time for switching between major and minor channels.

[0089] In response to a control signal from channel setting unit **380**, the first switch SW**1** changes current transmission paths. For example, before reception of a control signal by the first switch SW**1**, it is assumed that a first contact point SWp**1** and third contact point SWp**3** are interconnected to form a major channel data transmission path and a second contact point SWp**2** and fourth contact point SWp**4** are interconnected to form a minor channel data transmission path. After reception of the control signal, the first switch SW**1** forms a major channel data transmission path by interconnecting the first contact point SWp**1** and fourth contact point SWp**4**, and also forms a minor channel data transmission path by interconnecting the second contact point SWp**2** and third contact point SWp**3**.

[0090] As a result, before reception of the control signal, broadcast data passed through the first contact point SWp**1** and third contact point SWp**3** was processed as major channel data, and, after reception of the control signal, the broadcast data is directed to pass through the first contact point SWp**1** and fourth contact point SWp**4** and is processed as minor channel data; while broadcast data passed through the second contact point SWp**2** and fourth contact point SWp**4** was processed as minor channel data before reception of the control signal, and after reception of the control signal the broadcast data is directed to pass through the second contact point SWp**2** and third contact point SWp**3** and is processed as major channel data.

[0091] Accordingly, DMB receiver **300** of FIG. **6** can perform switching between major and minor channel data transmission paths in response to a control signal from channel setting unit **380**.

[0092] Referring to FIG. **7**, DMB receiver **400** includes a DMB module **410**, a TS demultiplexer **420**, a major channel buffer **430**, a minor channel processor **440**, an A/V codec **450**, an image synthesizer **460**, a DMB output unit **470**, a channel setting unit **480**, an input unit **490**, a second switch SW**2**, a third switch SW**3**, and a fourth switch SW**4**. Compared with DMB receiver **100** of FIG. **2**, DMB receiver **400** performs switching between major and minor channels in response to a major/minor channel switch request, and stores minor channel data to minimize a major/minor channel switch time, and further includes a minor channel buffer **445** within minor channel processor **440** and the second to fourth switches SW**2** to SW**4** for changing transmission paths.

[0093] Elements in FIG. **7** other than those related to a change of transmission paths and storage of minor channel data (the minor channel processor **440**, channel setting unit **480** and second to fourth switches SW**2** to SW**4**) are similar in function to corresponding elements in FIG. **2**. That is, DMB module **410**, TS demultiplexer **420**, major channel buffer **430**, A/V codec **450**, image synthesizer **460**, DMB output unit **470**, channel setting unit **480**, and input unit **490** of the DMB receiver **400** shown in FIG. **7** are similar in function as DMB module **110**, TS demultiplexer **120**, major channel buffer **130**, A/V codec **150**, image synthesizer **160**, DMB output unit **170**, channel setting unit **180**, and input unit **190** of DMB receiver **100** shown in FIG. **2**.

[0094] Compared with channel setting unit **180** in FIG. **2**, channel setting unit **480** additionally outputs a control signal

to the second to fourth switches SW2 to SW4 to change major and minor channel data transmission paths.

[0095] Channel setting unit **480** outputs a control signal CH.sig to the second, third and fourth switches SW2, SW3 and SW4 for switching transmission paths thereof on the basis of a user selection through input unit **490** or a major/minor channel switch condition set in advance.

[0096] In response to the control signal CH.sig, the second, third and fourth switches SW2, SW3 and SW4 toggle to new transmission paths. In FIG. **7**, paths shown inside the switches with solid lines constitute initial transmission paths, and paths shown inside the switches with dotted lines constitute transmission paths to be formed in response to a major/minor channel switch request.

[0097] In DMB receiver **400** of FIG. **7**, transmission path switching is performed at an input terminal of an I-frame detector **441** and output terminals of major channel buffer **430** and minor channel buffer **445**.

[0098] The second switch SW2 makes an initial connection between the input terminal of I-frame detector **441** and the input terminal of minor channel buffer **445**. When channel setting unit **480** outputs a control signal in response to a major/minor channel switch request, the second switch SW2 removes the connection between the input terminal of I-frame detector **441** and the input terminal of minor channel buffer **445** then makes a connection between the input terminal of I-frame detector **441** and the input terminal of major channel buffer **430**. That is, broadcast data fed to major channel buffer **430** before the occurrence of the major/minor channel switch request is now directed to I-frame detector **441** for I-frame detection.

[0099] At the same time, the third switch SW3 and fourth switch SW4 remove initial connections for audio and video outputs respectively from major channel buffer **430**, and make new connections for audio and video outputs respectively from minor channel buffer **445**. That is, the third switch SW3 disconnects an initial transmission path from an audio buffer **431** of major channel buffer **430** to a speaker **471**, and then makes a new connection to form a transmission path from an audio buffer **447** of minor channel buffer **445** to speaker **471**. The fourth switch SW4 disconnects an initial transmission path from a video buffer **433** of major channel buffer **430** to A/V codec **450**, and then makes a new connection to form a transmission path from a video buffer **449** of minor channel buffer **445** to A/V codec **450**.

[0100] As described above, the DMB receiver of FIG. **7** buffers minor channel broadcast data in addition to buffering major channel broadcast data, and switches output of the buffered minor channel broadcast data and input to the I-frame detector in response to a major/minor channel switch request, thereby minimizing a time delay due to major/minor channel switching.

[0101] FIG. **8** is a flow chart of a method for simultaneously displaying multi-channel visual images for the DMB receiver of FIG. **6** or FIG. **7**. In particular, the flow chart of FIG. **8** illustrates a method to perform switching between major and minor channels during simultaneous display of multi-channel visual images. Referring to FIG. **8**, the method is described as follows.

[0102] The DMB receiver sets multiple channel identifiers for DMB reception in step S**205**. At this step, the DMB receiver sets a major channel identifier and a quantity of minor channel identifiers. Preferably, the DMB receiver prestores a channel ID list having a plurality of identifiers of minor channels selected by the user or a plurality of favorite channel identifiers automatically collected from channel reception histories, and selects a channel identifier from the channel ID list in sequence according to a preset channel switch condition to set the current minor channel to a channel of the selected channel identifier. The condition to switch the channel is described in relation to FIG. **2**.

[0103] The DMB receiver receives broadcast data on multiple channels associated with the channel identifiers set at step S**205** and step S**215**, and the receiver separately extracts major channel data and minor channel data from the received broadcast data in step S**220** because the major channel data and minor channel data in the broadcast data received at step S**215** are in an interleaved form. This separate extraction operation is similar to the operation of TS demultiplexer **120** described in relation to FIG. **2**.

[0104] After separate extraction of the major channel data and minor channel data at step S**220**, the DMB receiver stores the major channel data and minor channel data in a major channel buffer and minor channel buffer, respectively in step S**225**.

[0105] An I-frame of the current minor channel is detected from the minor channel data in step S**230**, and the detected I-frame is stored according to its corresponding minor channel in step S**235**. Steps S**230** and S**235** for minor channel processing are similar to the operation of the minor channel processor **140** described in relation to FIG. **2**.

[0106] After I-frame detection from the minor channel data, the DMB receiver combines the video portion of the major channel with a quantity of I-frame images equal to the preset quantity of minor channels in step S**240**, and outputs the combined major/minor channel visual image with the audio data of the major channel in step S**245**.

[0107] While in DMB reception, namely, if reception of the fixed major channel is not terminated in step S**250**, if a major/minor channel switch request is input or a preset major/minor channel switch condition is satisfied in step S**255**, the DMB receiver performs switching between major and minor channel data transmission paths in step S**260**. That is, the DMB receiver of FIG. **6** operates the first switch SW1 as described with reference to FIG. **6**, and the DMB receiver of FIG. **7** operates the second to fourth switches SW2 to SW4 as described with reference to FIG. **7**.

[0108] While in DMB reception, namely, major channel reception, if the condition to switch the channel is satisfied in step S**265**, the DMB receiver switches the current minor channel to another minor channel in step S**270**, and repeats steps S**215** through S**265** for continued DMB reception.

[0109] The condition to switch the channel is preferably one of a change request by the user, a preset change period and detection of an I-frame on the current minor channel. The condition to switch the channel and step S**270** of switching between major/minor channels are described in relation to channel setting unit **280** in FIG. **2**.

[0110] Through steps described above, the DMB receiver of FIG. **6** or **7** can both simultaneously display up-to-date multi-channel visual images and perform, in response to a major/minor channel switch request, switching between the major channel and a minor channel selected at the time of the request. In particular, the DMB receiver of FIG. **7** can minimize the time delay due to major/minor channel switching.

[0111] FIG. **9** illustrates structures of MPEG video data processed by the receiver of FIG. **2**, **3**, **6** or **7**. That is, FIG. **9** shows examples of video streams composing typical MPEG

video broadcasts receivable by the DMB receiver: a video stream (A) of a major channel, a video stream B) of a minor channel-**1**, a video stream (C) of a minor channel-**2**, a video stream (D) of a minor channel-**3**, a video stream (E) of a minor channel-**4**, a video stream (F) of a minor channel-**5**, a video stream (G) of a minor channel-**6**, a video stream (H) of a minor channel-**7**, and a video stream (J) of a minor channel-**8**.

[0112] As described above, the DMB receiver of the present invention receives video streams on multiple channels. In the case of minor channels, one of the minor channels is selected at a time, and only I-frames, which serve as reference image frames, are detected from broadcast data on the currently selected minor channel and stored. Referring to FIG. **9**, if the condition to switch a channel is detection of an I-frame on the current minor channel, the DMB receiver continuously receives a video stream such as (A) on the major channel. During continuous reception on the major channel, the current minor channel is switched from 'minor channel-**1**' to 'minor channel-**2**' after detection of an I-frame on 'minor channel-**1**' at time t**1**; from 'minor channel-**2**' to 'minor channel-**3**' after detection of an I-frame on 'minor channel-**2**' at time t**2**; from 'minor channel-**3**' to 'minor channel-**4**' after detection of an I-frame on 'minor channel-**3**' at time t**3**; from 'minor channel-**4**' to 'minor channel-**5**' after detection of an I-frame on 'minor channel-**4**' at time t**4**; from 'minor channel-**5**' to 'minor channel-**6**' after detection of an I-frame on 'minor channel-**5**' at time t**5**; from 'minor channel-**6**' to 'minor channel-**7**' after detection of an I-frame on 'minor channel-**6**' at time t**6**; from 'minor channel-**7**' to 'minor channel-**8**' after detection of an I-frame on 'minor channel-**7**' at time t**7**; and from 'minor channel-**8**' back to 'minor channel-**1**' after detection of an I-frame on 'minor channel-**8**' at time t**8**. Then, this process is repeated. Although an I-frame is received on 'minor channel-**1**' and 'minor channel-**6**', 'minor channel-**2**' and 'minor channel-**7**', and 'minor channel **3**' and 'minor channel **8**' at a same time, respectively, each minor channel is selected in order of precedence during updating an I-frame. Accordingly, the 'minor channel-**1**', 'minor channel-**2**' and 'minor channel-**3**' are selected in sequence and the updated I-frame on the 'minor channel-**6**', 'minor channel-**7**' and 'minor channel-**8**' is disregarded.

[0113] As a result, during output of major channel broadcast data, whenever broadcast data of a minor channel selected from the eight minor channels is output, an I-frame of the selected minor channel is updated, thereby enabling output of up-to-date visual images of minor channels.

[0114] FIGS. **10**A and **10**B illustrate display screen layouts for presenting multi-channel visual images output by the DMB receivers of FIGS. **2**, **3**, **6** and **7**. The DMB receiver outputs broadcast data received on multiple channels in screen layouts illustrated in FIGS. **10**A and **10**B. As described with reference to FIGS. **2** to **8**, broadcast data of minor channels is updated with associated I-frame images, thereby enabling delivery of up-to-date visual images of the minor channels. Switching between the major channel and a selected minor channel can be performed according to a user request. For example, if the user selects a display area associated with a minor channel, switching between the major channel and minor channel is performed. If the user selects a display area associated with the major channel, the selected display area is preferably enlarged. Preferably, the DMB receiver pre-stores display information for enlargement (for example, enlargement ratios and display locations), and enlarges the display area associated with the major channel using the display information.

[0115] In the description, although a DMB receiver simultaneously receives one major and one minor channel or one major and two minor channels, the DMB receiver may also simultaneously receive one major channel and two or more minor channels. Although the present invention addresses a DMB receiver, it may also be applied to a receiver for any digital broadcasting, such as DMB, digital video broadcasting—handheld (DVB-H), and MediaFLO.

[0116] A broadcast data display method according to another embodiment of the present invention is described. In the method, a single screen is divided into display areas corresponding to broadcast channels available in a DMB receiver; one of the available channels is automatically set as a major channel and the remaining channels are set as minor channels, on the basis of a channel reception history or a preset channel list; and broadcast data of the major channel is displayed in an associated display area and visual images of the minor channels are displayed in associated display areas, in the form of thumbnail images.

[0117] For example, in the case where two broadcast channels are available in a DMB receiver, the display screen is divided into two display areas, and broadcast data of one major channel is displayed in one of the display areas and an up-to-date visual image of one minor channel is displayed in the other display area. In the case where four broadcast channels are available in a DMB receiver, the display screen is divided into four display areas, and broadcast data of one major channel is displayed in one of the display areas and up-to-date visual images of the remaining three minor channels are displayed in their corresponding display areas, in the form of thumbnail images.

[0118] The broadcast data of a major channel may include video data and audio data. An up-to-date visual image of a minor channel may be a still image corresponding to an I-frame detected in the broadcast data of the minor channel. In the case of channel switching, the still image may also correspond to a raw image captured from the most recently decoded broadcast data of the former major channel. Preferably, the broadcast data of a major channel and up-to-date visual images of minor channels are resized according to positions and sizes of corresponding display areas in a single screen, and displayed in the form of thumbnail images.

[0119] Referring to FIG. **11**, the method is described as follows.

[0120] When DMB reception is initiated by a user, a DMB receiver performs channel scan to identify available broadcast channels in step S**310**, and divides the screen into display areas corresponding to the individual available channels in step S**315**. The DMB receiver simultaneously receives broadcast data on the available channels in step S**320**, and resizes video images in the received broadcast data so that the video images can fit within their corresponding display areas in step S**325**.

[0121] The DMB receiver checks if a previous channel identifier exists in step S**330**. If a previous channel identifier exists, the DMB receiver sets a channel of the previous channel identifier as a major channel in step S**335**. If a previous channel identifier does not exist, the DMB receiver sets one of the available channels as a major channel in step S**336**. The DMB receiver sets the remaining available channels as minor channels, and detects I-frames in broadcast data of the minor channels in step S**340**.

[0122] The DMB receiver combines the detected I-frames with a video signal of the major channel into a screen output image, and displays the screen output image in step S**345**. That is, whereas video and audio signals of the major channel are reproduced as a broadcast stream, detected I-frames of the individual minor channels are displayed as up-to-date visual images.

[0123] The DMB receiver checks if the user requests to rescan broadcast channels in step S**350**. If the user requests to rescan, the DMB receiver repeats step S**310** and subsequent steps. If the user requests to switch major/minor channels in step S**355**, the DMB receiver exchanges the major channel and a minor channel selected by the user with each other in step S**360**, and repeats step S**345** and subsequent steps. That is, after step S**360**, video and audio signals of the new major channel are reproduced as a broadcast stream and a detected I-frame of the former major channel is displayed in the corresponding display area as an up-to-date visual image. If the user requests to terminate DMB reception in step S**365**, the DMB reception is terminated, otherwise the DMB receiver returns to step S**345** to continue display of the screen output image.

[0124] As described above, the DMB receiver of the present invention simultaneously displays up-to-date multi-channel images on a single screen. Broadcast data of one major channel and I-frames extracted from broadcast data of multiple minor channels are simultaneously displayed in corresponding display areas in the single screen. As a result, during viewing of the major channel broadcast, the user can easily perform channel selection or switching using up-to-date visual images.

[0125] Referring to FIG. **12**, the method is described as follows.

[0126] When a user initiates DMB reception, a DMB receiver performs channel scan to identify available broadcast channels in step S**410**, and displays a list of the available channels in step S**415**. If a reception history having identifiers of previously received channels is present in the DMB receiver, step S**410** may be skipped. When the user selects a channel in the list, the DMB receiver reproduces broadcast data of the selected channel on the full screen in step S**420**.

[0127] During full screen display, if the user requests an all-channel view mode in step S**425**, the DMB receiver divides the screen into display areas corresponding to the individual available channels in step S**430**. The DMB receiver simultaneously receives broadcast data on the available channels in step S**435**, and resizes video images in the received broadcast data so that the video images can fit within the corresponding display areas in step S**440**.

[0128] After image resizing, the DMB receiver reproduces a video signal of the channel selected at step S**420** (major channel) as a broadcast stream in the corresponding display area in step S**445**, and displays in sequence detected I-frames of the remaining available channels (minor channels) as up-to-date visual images in the corresponding display areas in step S**450**.

[0129] During simultaneous display of multi-channel visual images, the DMB receiver can perform an operation requested by the user in step S**455**. User requested operations are described in connection with FIGS. **13** and **14**.

[0130] Referring to FIG. **13**, in an all-channel view mode, the DMB receiver displays major channel broadcast data and up-to-date minor channel visual images on the single screen. If the user selects a display area associated with the major channel, the DMB receiver transitions to an enlargement mode, enlarges the selected display area at a preset ratio, and displays video images in the major channel broadcast data that are preferably resized according to display area enlargement. If the user inputs a request of full-screen display, the DMB receiver makes a transition to a full-screen mode, and reproduces major channel broadcast data in the full screen. If the user inputs a request of major/minor channel switching, the DMB receiver switches major and minor channel data transmission paths, as later described with reference to FIG. **14**.

[0131] In the enlargement mode, if the user selects a display area associated with the major channel, the DMB receiver enlarges the selected display area at a preset ratio within the screen size limit, and displays video images in the major channel broadcast data that are preferably resized accordingly. If the user inputs a request of full-screen display or if an enlargement event causes an associated display area to exceed the screen size limit, the DMB receiver makes a transition to the full-screen mode.

[0132] In the full-screen mode, the DMB receiver reproduces major channel broadcast data in the full screen. If the user inputs a request of all-channel view, the DMB receiver makes a transition to the all-channel view mode by performing operations described in connection with FIG. **12**. If the user inputs a request of major/minor channel switching, the DMB receiver performs switching between the major and minor channels.

[0133] Sequences of screen layouts in response to user events are described later with reference to FIGS. **15** to **18**.

[0134] Referring to FIG. **14**, during an all-channel view mode in which major channel broadcast data and up-to-date minor channel visual images are displayed on the single screen, when the user requests to switch major/minor channels in step S**605**, the DMB receiver exchanges data transmission paths associated with the major channel and a selected minor channel with each other in step S**610**, detects an I-frame of the former major channel and displays the detected I-frame in the corresponding display area as an up-to-date visual image in step S**615**, and reproduces video and audio signals of the new major channel as a broadcast stream in step S**620**. During major/minor channel switching, visual images of the former major channel and new major channel may be resized according to their corresponding display areas.

[0135] Referring to FIG. **15**, when the user initiates a DMB receiver, the DMB receiver receives information on available broadcast channels from broadcasting center **10** in FIG. **1**, constructs a channel list using the channel information, and displays the constructed channel list as illustrated by an initial screen **510**. To construct a channel list, the DMB receiver may scan channel information for terrestrial DMB, use electronic program guide (EPG) information for satellite DMB, or use a channel reception history for favorite channels.

[0136] Thereafter, for display of multi-channel visual images, the DMB receiver divides the display screen into display areas corresponding to available broadcast channels as illustrated by screen layouts **520**, **530** and **540**. Preferably, the number of display areas is equal to that of available broadcast channels. One of the display areas is associated with a broadcast channel selected as a major channel, and is used to display streaming broadcast data of the major channel. The remaining display areas are associated with broadcast channels other than the major channel (minor channels),

and are used to display I-frames detected in broadcast data of the corresponding broadcast channels as up-to-date visual images.

[0137] Although, for the minor channels, I-frames are displayed as up-to-date visual images, streaming broadcast data may also be displayed. For minor channel streaming broadcast data, audio signals of the minor channel broadcast data are preferably removed to avoid possible collision with the major channel audio signal.

[0138] After division of the screen, streaming broadcast data, including video and audio signals, of the major channel selected with the initial screen **510** is displayed in the associated display area, and I-frames detected in broadcast data of the minor channels are displayed as up-to-date visual images in the display areas associated with the individual minor channels.

[0139] I-frames of the individual minor channels may be displayed at one time through buffering of the I-frames, or be sequentially displayed in order of channel identifiers of the channel list (or in order of thumbnail scanning) as illustrated in FIG. **15**.

[0140] For example, as shown in screen layout **520**, streaming broadcast data of the major channel (Ch**1**) is displayed in the display area associated with the major channel, and an I-frame of a minor channel (Ch**2**) is displayed as an up-to-date visual image in the display area associated with the minor channel. After a preset time duration (N seconds), for example three frame periods, an I-frame of another minor channel (Ch**3**) is displayed as an up-to-date visual image in the associated display area, as shown in screen layout **530**. After a preset time duration according to the number of minor channels to be displayed, I-frames of all minor channels are displayed as up-to-date visual images in the corresponding display areas, as shown in the screen layout **540**.

[0141] As described above, the DMB receiver combines a quantity of I-frames equal to the quantity of minor channels with video data of the major channel, and outputs the combined video data and audio data of the major channel.

[0142] Referring to FIG. **16**, the DMB receiver includes a DMB module **610**, TS demultiplexer **620**, video codec **630**, audio codec **640**, image scaler **650**, speaker **660**, and display unit **680**.

[0143] Elements in the DMB receiver of FIG. **16** are similar in function to corresponding elements in the DMB receiver of FIG. **2**. That is, DMB module **610**, TS demultiplexer **620**, video and audio CODECs **630** and **640**, and speaker **660** and display unit **680** are similar in function to DMB module **110**, TS demultiplexer **120**, the A/V codec **150**, and DMB output unit **170** in FIG. **2**.

[0144] The DMB receiver of FIG. **16** includes image scaler **650** to perform video image resizing on broadcast data, and is a receiver simplified specifically for the purpose of illustrating multi-channel visual image processing, and therefore may include additional elements similar to those illustrated in FIG. **2**.

[0145] Upon initiation of DMB reception, DMB module **610** receives a multi-channel broadcast signal corresponding to broadcast channels selected by the user, and outputs TS data of the selected broadcast channels. TS demultiplexer **620** demultiplexes the TS data from DMB module **610** into broadcast data for each broadcast channel, and separates the channel broadcast data into video and audio data.

[0146] Video codec **630** decodes the video data from TS demultiplexer **620** into a channel video signal. Audio codec **640** decodes the audio data from TS demultiplexer **620** into a channel audio signal.

[0147] Image scaler **650** resizes video images of channel video signals according to sizes and positions of corresponding display areas. To divide the display screen of display unit **680** into display areas corresponding to available broadcast channels, a screen divider (not shown) may be provided in image scaler **650** or as a separate element.

[0148] After resizing, a video signal **671** of a channel (Ch**1**) selected as the major channel is output in a streaming form to an associated display area **681** for display, and an audio signal thereof is output in a streaming form to speaker **660** for reproduction. Detected I-frames (still images **673** to **677**) of the remaining channels Ch**2** to Ch**9** (minor channels) are displayed as up-to-date visual images in their corresponding display areas **683** to **687**.

[0149] The DMB receiver of FIG. **16** divides the display screen into display areas corresponding to broadcast channels, resizes the most recently decoded raw images of the individual broadcast channels, and displays the resized images as thumbnail images in their corresponding display areas. Hence, after channel scanning, thumbnail images can be displayed on the screen to represent corresponding broadcast channels, for example, in the form of a channel list, thereby enabling easy and rapid channel selection and switching for viewing.

[0150] Referring to FIG. **17**, the screen layouts are related to manipulation of a display area associated with a major channel. When the user initiates a DMB receiver, the DMB receiver displays a channel list as illustrated by a screen layout **710**. The channel list may be constructed through channel scanning for terrestrial DMB, using electronic program guide (EPG) information for satellite DMB, or using a channel reception history for favorite channels.

[0151] If the user selects the identifier of a channel (Ch**1**) as the major channel during display of the channel list, the DMB receiver outputs streaming broadcast data of the selected channel by displaying a video signal of the selected channel in a full screen mode as illustrated by a screen layout **720**, and by reproducing an audio signal thereof through a speaker.

[0152] If the user requests all-channel view during the full screen mode, the DMB receiver makes a transition to an all-channel view mode, and displays multi-channel visual images of available channels in their corresponding display areas of the screen, as shown in screen layout **731**, **733** or **735** depending upon the quantity of available channels. The DMB receiver may also make a direct transition to the all-channel view mode in response to a request of all-channel view during display of the channel list.

[0153] During the all-channel view mode, the major channel selected for viewing is preferably distinguished from minor channels as illustrated by screen layout **731**. That is, streaming broadcast data of the major channel Ch**1** is displayed in the associated display area. Still images, such as I-frames detected in broadcast data of individual minor channels Ch**2** to Ch**9**, are displayed as up-to-date visual images in their corresponding display areas.

[0154] If the user selects the display area associated with the major channel during the all-channel view mode, the DMB receiver makes a transition to an enlargement mode, enlarges the associated display area at a preset ratio as illus-

trated by a screen layout **740**, and preferably resizes video images to be displayed according to enlargement of the associated display area.

[0155] If the user again selects the enlarged display area associated with the major channel Ch**1** during the enlargement mode, the DMB receiver transitions to the full screen mode, and enlarges the associated display area to the full screen as shown in screen layout **750**, and preferably resizes video images to be displayed in broadcast data of the major channel Ch**1** according to enlargement of the associated display area.

[0156] Although not shown in FIG. **17**, the DMB receiver may make backward transitions from the current display mode to the previous display modes through, for example, a prior-mode function.

[0157] Referring to FIG. **18**, the screen layouts relate to channel switching. Initially, as shown in screen layout **810**, one major channel Ch**1** is associated with a display area **811** and the DMB receiver is in an all-channel view mode.

[0158] During the all-channel view mode, in which multi-channel visual images of available broadcast channels are displayed, if the user moves the focus from display area **811** to a display area **812** for major/minor channel switching, the DMB receiver places the focus on display area **812** as illustrated by a screen layout **820**. If the user selects the focused display area **812** through a key input or the like, the DMB receiver performs major/minor channel switching as illustrated by a screen layout **830**.

[0159] That is, before the major/minor channel switching (screen layout **820**), a streaming video signal of the major channel Ch**1** is displayed in display area **811**, and an I-frame of a minor channel Ch**2** is displayed in display area **812**. After the major/minor channel switching (screen layout **830**), a streaming video signal of the new major channel Ch**2** is displayed in display area **812**, and a still image, such as an I-frame, of the former major channel Ch**1** is displayed as an up-to-date visual image in display area **811**. The still image may be an I-frame detected in the most recently decoded broadcast data of the former major channel Ch**1**, or be a raw image captured therefrom. The I-frame or raw image may be resized before being displayed according to the size and position of the corresponding display area.

[0160] During the all-channel view mode (screen layout **830**), if the user selects the focused display area **812** associated with the current major channel Ch**2**, the DMB receiver makes a transition to an enlargement mode, enlarges display area **812** at a preset ratio as illustrated by a screen layout **840**, and preferably resizes video images to be displayed in broadcast data of the major channel Ch**2** according to enlargement of display area **812**.

[0161] During the enlargement mode (screen layout **840**), if the user selects the enlarged display area **812** associated with the current major channel Ch**2**, the DMB receiver makes a transition to a full-screen mode, enlarges display area **812** to the full screen as illustrated by a screen layout **850**, and preferably resizes video images to be displayed in broadcast data of the major channel Ch**2** according to enlargement of display area **812**.

[0162] During the full-screen mode (screen layout **850**), if the user requests channel switching between the current major channel Ch**2** and a minor channel Ch**1**, the DMB receiver displays streaming broadcast data of the new major channel Ch**1** on the full screen as illustrated by a screen layout **890**.

[0163] During the enlargement mode (screen layout **840**), if the user moves the focus from display area **812** associated with the current major channel Ch**2** to display area **811** associated with a minor channel Ch**1**, the DMB receiver places the focus on display area **811** as illustrated by a screen layout **860**. If the user selects focused display area **811** associated with the minor channel Ch**1**, the DMB receiver makes a transition to the initial all-channel view mode, and performs major/minor channel switching as illustrated by a screen layout **870**.

[0164] That is, before the major/minor channel switching (screen layout **860**), a streaming video signal of the major channel Ch**2** is displayed in display area **812**, and an I-frame of the minor channel Ch**1** is displayed in display area **811**. After the major/minor channel switching (screen layout **870**), a streaming video signal of the new major channel Ch**1** is displayed in display area **811**, and a still image, such as an I-frame, of a new minor channel Ch**2** is displayed as an up-to-date visual image in the reduced display area **812**. The still image may be an I-frame detected in the most recently decoded broadcast data of the former major channel Ch**2**, or be a raw image captured therefrom. The I-frame or raw image may be resized before being displayed according to the size and position of the corresponding display area.

[0165] During the all-channel view mode (screen layout **870**), if the user selects the focused display area **811** associated with the current major channel Ch**1**, the DMB receiver makes a transition to the enlargement mode, enlarges display area **811** at a preset ratio as illustrated by a screen layout **880**, and preferably resizes video images to be displayed in broadcast data of the major channel Ch**1** according to enlargement of display area **811**.

[0166] During the enlargement mode (screen layout **880**), if the user selects the enlarged display area **811** associated with the current major channel Ch**1**, the DMB receiver makes a transition to the full-screen mode, enlarges the display area **811** to the full screen as illustrated by the screen layout **890**, and preferably resizes video images to be displayed in broadcast data of the major channel Ch**1** according to enlargement of display area **811**.

[0167] As apparent from the above description, the present invention provides a digital broadcast receiver and broadcast data display method enabling simultaneous display of multi-channel visual images. A video broadcast of a major channel and visual images of minor channels are simultaneously displayed and visual images of the minor channels are periodically updated on an I-frame period basis, thereby enabling simultaneous output of up-to-date multi-channel visual images. Hence, the user can easily select a desired channel. In addition, real-time video images of the major channel and up-to-date informational images of the minor channels are displayed together in their corresponding display areas of a single screen, and hence channel switching can be readily performed by selecting both the display area associated with the major channel and the display area associated with a target minor channel. Further, individual video broadcasts of available broadcast channels can be represented by thumbnail images; thereby enabling easy and rapid channel selection and channel switching.

[0168] While preferred embodiments of the present invention have been shown and described in this specification, it will be understood by those skilled in the art that various changes or modifications of the embodiments are possible without departing from the spirit and scope of the invention as further defined by the appended claims.

What is claimed is:

1. A broadcast data display method for a digital broadcast receiver, comprising:

displaying, in response to a broadcast reception request from a user, a channel list having identifiers of available channels;

displaying broadcast data of a channel selected by the user from the channel list on a screen in a full-screen mode;

dividing, in response to a request of all-channel view during channel list display or broadcast reception, the screen into display areas corresponding to the individual available channels of the channel list;

displaying real-time broadcast data of the selected channel in a corresponding display area of the screen; and

displaying still images of the remaining channels simultaneously or sequentially in their corresponding display areas.

2. The broadcast data display method of claim **1**, further comprising resizing the real-time broadcast data and the still images according to positions and sizes of their corresponding display areas.

3. The broadcast data display method of claim **1**, wherein the still images are I-frames detected in broadcast data of the remaining channels other than the selected channel.

4. The broadcast data display method of claim **3**, wherein the I-frames are detected in decoded video data of the corresponding channels.

5. The broadcast data display method of claim **1**, wherein the still images are raw images captured from the most recently decoded broadcast data of the remaining channels other than the selected channel.

6. The broadcast data display method of claim **1**, further comprising periodically updating the still images of the remaining channels.

7. The broadcast data display method of claim **1**, further comprising setting, on the basis of user selections, one channel as a major channel and one or more channels as minor channels.

8. The broadcast data display method of claim **1**, wherein the channel list has a quantity of channel identifiers greater than or equal to the preset quantity of major and minor channels to be simultaneously output to the screen.

9. The broadcast data display method of claim **8**, wherein the channel list has identifiers of channels selected by the user.

10. The broadcast data display method of claim **8**, wherein the channel list has identifiers of favorite channels automatically collected from a channel reception history.

11. The broadcast data display method of claim **8**, wherein the channel list has identifiers of channels scanned by the digital broadcast receiver.

12. The broadcast data display method of claim **8**, wherein the channel list has channel identifiers generated using information of an electronic program guide.

13. The broadcast data display method of claim **1**, further comprising switching, according to a channel switch request from a user or a channel switch condition set in advance, between data transmission paths of the selected channel and of a newly selected one of the remaining channels.

14. The broadcast data display method of claim **1**, further comprising performing a user-requested function in response to a user input, wherein the performing a user-requested function step comprises:

dividing the screen into display areas, and outputting the real-time broadcast data and the still images to their corresponding display areas;

receiving an input from the user to select one of the display areas; and

performing channel switching or enlargement of the selected display area, depending upon channel-display area association.

15. The broadcast data display method of claim **14**, wherein the performing channel switching or enlargement step comprises enlarging, if the selected display area is associated with the selected channel for real-time broadcast data, the selected display area using pre-stored enlargement information.

16. The broadcast data display method of claim **14**, wherein the performing channel switching or enlargement step comprises switching, if the selected display area is associated with one of the remaining channels for still images, between the selected channel and the remaining channel associated with the selected display area.

17. The broadcast data display method of claim **1**, further comprising the steps, performed during broadcast reception, of:

dividing the screen into display areas corresponding to currently active channels;

displaying real-time broadcast data of one of the active channels in a corresponding display area of the screen; and

displaying I-frames of the remaining active channels as still images in their corresponding display areas.

18. The broadcast data display method of claim **17**, further comprising resizing the real-time broadcast data and the still images of I-frames according to positions and sizes of their corresponding display areas.

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