PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only
International Application No.
International Filing Date
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 6818-137WO

Box No. I TITLE OF INVENTION
A METHOD AND APPARATUS FOR MULTI-VIEW VIDEO CODING

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

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Sheet No. ...2...

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

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This person is applicant for the purposes of:
- [ ] all designated States
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Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
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Applicant's registration No. with the Office

State *(that is, country)* of nationality:

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This person is applicant for the purposes of:
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Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
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This person is applicant for the purposes of:
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Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

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This person is applicant for the purposes of:
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Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

☐ KR Republic of Korea **is not designated** for any kind of national protection

☐ RU Russian Federation **is not designated** for any kind of national protection

(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1) 16/September/2005	60/718,080	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☒ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

* *Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* . . . .

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA / US . . . .

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:

			Number of declarations
☐	Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐	Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐	Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐	Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐	Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application **contains:**

(a) **on paper,** the following number of sheets:

request (including declaration sheets)	:	4
description (excluding sequence listing and/or tables related thereto)	:	8
claims	:	5
abstract	:	1
drawings	:	7
Sub-total number of sheets	:	25
sequence listing	:	
tables related thereto	:	
(for both, actual number of sheets if filed on paper, whether or not also filed in electronic form; see (c) below)		
Total number of sheets	:	25

(b) ☐ **only in electronic form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in electronic form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: ....
- ☐ tables related thereto: ....

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):* — Number of items

1. ☐ fee calculation sheet :
2. ☐ original separate power of attorney :
3. ☐ original general power of attorney :
4. ☐ copy of general power of attorney; reference number, if any: .... :
5. ☐ statement explaining lack of signature :
6. ☐ priority document(s) identified in Box No. VI as item(s): .... :
7. ☐ translation of international application into *(language)*: .... :
8. ☐ separate indications concerning deposited microorganism or other biological material :
9. ☐ sequence listing in electronic form *(indicate type and number of carriers)*
   - (i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application) :
   - (ii) ☐ *(only where check-box (b)(i) or (c)(i) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter* :
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11. ☒ other *(specify)*: Postcard .... :

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

[signature]

RICHARD A. HINSON, REGISTRATION NO. 47,652

Date: 15 SEPTEMBER 2006

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1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /
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A METHOD AND APPARATUS FOR MULTI-VIEW VIDEO CODING

FIELD OF THE INVENTION

[0001] The present invention is related to the field of video coding and, more particularly, to video coding compression.

BACKGROUND

[0002] Multi-view video coding (MVC) codes multiple camera views generated when a scene is captured from different vantage points using multiple cameras. The result is that a viewer has the opportunity to view the same scene from different view points. The viewer, moreover, is afforded the freedom to choose different view points for viewing a scene.

[0003] In a multi-view coding system, multiple cameras are used at a sender to capture a scene. A multi-view encoder is used to compress the output of all the cameras jointly. A video stream is delivered from the sender to a receiver over a data communications or other network. The receiver can be, for example, a television lacking a multi-view capability, a television capable of rendering three-dimensional scenes, or a multi-view receiver that provides for interactive viewer selection.

[0004] Advances in video coding technologies have made possible a new generation of video applications, and many observers expect these advances to continue, if not accelerate. As a result, there is heightened interest in MVC. A persistent challenge to the technological advance, however, is the need for compression technologies that exploit redundancies in the multiple views generated in order to achieve a high compression ratio. A useful compression algorithm typically needs to support fast decompression and accurate renderings of the multiple views.

[0005] Conventional algorithms that have been proposed typically exploit multiple-view redundancies using inter-view reference frames according to which frames are used to predict the video rendering in another frame from a different view. Most, if not all, conventional algorithms are limited in that they fail to provide a compact way to represent view dependencies; that is, rendering each successive frame depends on decoding all previous frames. In general, if there are n cameras, which give rise to n different views, then a rendering of the n-th view, requires the decoding of (n-1) views. The chain of dependency grows as the number of cameras increase. The result, typically, is high computational cost for extracting corresponding views at the receiver.

[0006] Accordingly, there is a need for a more efficient mechanism for performing MVC. In particularly, there is a need for a scalable prediction structure that reduces view dependencies associated with MVC.

SUMMARY

[0007] The present invention is directed to performing multi-view video coding. One aspect of the invention is a scalable prediction structure that reduces view dependencies associated with multi-view video coding.

[0008] One embodiment of the invention is a method of multi-view video coding, the method can include generating a multiple-view compressed encoded data sequence by encoding a plurality of video signals that each defines a distinct camera view of one of a plurality of cameras. The encoding, according to the method, can be based on a hypercube prediction structure that includes a plurality of nodes that each represents a distinct camera view. The method further can include conveying the compressed encoded data sequence over a data communication network connection, and presenting a visual display by decoding the compressed encoded data sequence based upon the hypercube prediction structure.

[0009] Another embodiment of the invention is a multi-view video coding system, which can include an encoder to generate a multiple-view compressed encoded data sequence by encoding a plurality of video signals that each a distinct camera view of one of a plurality of cameras. The encoder can perform the encoding based on a hypercube prediction structure comprising a plurality of nodes, each node representing a distinct camera view. The system can further include a decoder to present a visual display based on a decoding of the compressed encoded data sequence, the decoding being based upon the hypercube prediction structure.

[00010] Still another embodiment is a method of multi-view video coding, which includes generating a multiple-view compressed encoded data sequence by encoding a

plurality of video signals that each video signal define a distinct camera view of one of a plurality of cameras, the encoding being based on a hyperdimensional prediction structure comprising a plurality of nodes that each represents a distinct camera view. Additionally, the method can include conveying the compressed encoded data sequence over a data communication network connection, and presenting a visual display by decoding the compressed encoded data sequence, the decoding being based upon the hyperdimensional prediction structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[00011] There are shown in the drawings, embodiments which are presently preferred, it being understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown.

[00012] FIG. 1 is a schematic representation of an environment including a system according to one embodiment of the invention.

[00013] FIG. 2 is a more detailed schematic view of the system illustrated in FIG. 1.

[00014] FIG. 3 is a schematic representation of a hypercube prediction structure according to another embodiment of the invention.

[00015] FIG. 4 is a schematic representation of a hypercube prediction structure according to still another embodiment of the invention.

[00016] FIG. 5 is a schematic representation of a hypercube prediction structure according to still another embodiment of the invention.

[00017] FIG. 6 is a schematic representation of a camera array based on numbering according to still another embodiment of the invention.

[00018] FIG. 7 is a schematic representation of a camera array based on numbering according to yet another embodiment of the invention

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[00019] FIG. 1 provides a schematic view of an environment 100 in which a system 102, according to one embodiment of the invention, operates. The environment 100 illustratively includes a plurality of cameras 104 that provide video

inputs to the system 102. The system 102, as explained herein, generates one or more video outputs that are illustratively supplied to at least one display system 106. The display system 106, more particularly, can be a television, such as a high definition television (HDTV), stereo visual system, or multi-view display system. Preferably, the display system 106 is a television having the capability to render a three-dimensional display.

[00020] Referring additionally now to FIG. 2, the system 102 illustratively includes a multi-view video encoder 205 and video decoder 210 in communication with one another via a channel 215. Both the video encoder 205 and the video decoder 210 can be implemented in dedicated hardwired circuitry, machine-readable code, or a combination of circuitry and code.

[00021] Operatively, the video encoder 205 and the video decoder 210 encode and decode, respectively, video signals, defining camera views. Camera views are encoded and decoded using a prediction structure for multi-view coding, which is referred to herein as a hypercube prediction structure and which is described more particularly below. Operatively, once the hypercube prediction structure is determined for the system 102, the camera views can be compressed according to an efficient compression algorithm such as the H.264, or MPEG-4 Part 10, high compression digital video codec standard written by the ITU-T Video Coding Experts Group (VCEG) together with the ISO/IEC Moving Picture Experts Group (MPEG).

[00022] Inputs to the encoder 205 are video signals, defining multiple camera views, received from the plurality of cameras 104. The encoder 205 generates output based on the received multiple camera views and provides an output in the form of a multiple-view compressed sequence. The multiple-view compressed sequence output, can be stored and later viewed and/or transmitted over the channel 215, which can be, for example, a path over a data communications or other network. The decoder 210 receives the transmitted multiple-view compressed sequence as input. The decoder 210 decodes the multiple-view compressed sequence according to the hypercube prediction structure described more particularly in the following.

[00023] A hypercube prediction structure 300 for an eight-camera array is schematically represented in FIG. 3. According to the hypercube prediction structure,

generally, each camera view is represented as a node of a hypercube of n dimensions. For an n-cube, the number of nodes in the n-cube is 2^n. Accordingly, for the hypercube prediction structure 300, the eight-camera array corresponds to a 3-cube prediction structure, since eight cameras provide eight distinct views that each represents one of eight nodes. The numbering of the nodes in a hypercube provides a well structured dependency description.

[00024] Each node can be assigned a unique identification indicator. According to one embodiment, the nodes in an n-cube are identified by an identification indicator (or node ID number) comprising an n-bit binary number. For the 3-cube prediction structure illustrated in FIG. 3, according to this embodiment, the node ID numbers range from 0 to 7. The node with ID = 0 is referred to as a root node. The corresponding root camera view (or simply root view) is encoded without any dependency on other views using a dependency-free I frame. This allows systems without MVC support to merely decode and display the root view to a user. The node IDs of an n-cube have the property that the binary IDs of adjacent nodes differ only in one-bit position and each node has n-adjacent nodes. The binary node IDs with the equivalent decimal ID in parenthesis can be represented as shown in FIG. 3.

[00025] Each node of a hypercube prediction structure, generally, can be reached from any other node by traversing through the adjacent nodes. The reference views for a node V_i can be determined by selecting a dependency path from the root (node 0), through the adjacent nodes, to the node V_i. Using this approach, the reference views can be readily determined at the receiver without any additional information. For example, node 7 can be reached from node 0 over paths: 0 – 1 – 3 – 7 or 0 – 2 – 3 – 7 or 0 – 2 – 6 – 7 or 0 – 1 – 5 – 7.

[00026] According to one embodiment, for the sake of efficient operation, a selection criterion can be established for selecting a particular one of the alternative dependency paths. The selection criterion can be based, for example, on a summation of the node IDs traversed along each dependency path. The selection criterion, according to this embodiment, can be to select the path that traverses nodes having node IDs that yield the smallest sum. According to this criterion, the dependency path from the root to node 7 is selected 0 – 1 – 3 – 7, so that camera view 7 is coded using

references frames from additional views 0, 1, 3. It will be readily apparent that alternative selection criteria can be used. For example, one alternative selection criterion is to select the dependency path that traverses nodes having node IDs that yield the largest sum.

[00027] It is to be noted that the hypercube prediction structure results in a more efficient MVC. Table 1 summarizes the view dependencies for the 3-cube structure.

Table 1. Reference views for an eight camera array

View No. (V_i)	**Reference Views (V_j)**
0 (000)	-
1 (001)	0
2 (010)	0
3 (011)	0,1
4 (100)	0
5 (101)	0,1
6 (110)	0,2
7 (111)	0,1,3

[00028] Note that, by contrast, sequential prediction according to conventional algorithms would yield a far less compact representation for the same eight-camera array. The reference views for an eight-camera array are shown in Table 2.

Table 2. Sequential Prediction: Reference views for an eight camera array

View No. (V_i)	**Reference Views (V_j)**
0 (000)	-
1 (001)	0
2 (010)	0,1
3 (011)	0,1,2
4 (100)	0,1,2,3
5 (101)	0,1,2,3,4
6 (110)	0,1,2,3,4,5
7 (111)	0,1,2,3,4,5,6

The contrasting results demonstrate that the MVC according to the hypercube prediction structure can effect savings in terms of computational cost and processing time.

[00029] According to yet another embodiment, the signals conveyed from the encoder 205 to the decoder 210 via the channel 215 can be embedded with additional

machine-readable code that provides hypercube prediction structure information. The hypercube prediction structure information, for example, can inform the decoder 210 of the size or dimension of the particular hypercube prediction structure that is to be used in decoding. According to still another embodiment, a view dependency table containing view numbers and corresponding reference views can be conveyed to the decoder 210 via the channel 215.

[00030] In general, in order to decode and play the view n, the maximum number of views to be decoded is $\log_2(n)$. For example, in the 3-cube networks, where n = 8, the number of views to be decoded for rendering camera view 7 is $\log_2 8 = 3$.

[00031] Other P-frames in a sequence are encoded and decoded based on the previous P-frame in its view and a P-frame from an adjacent view, as illustrated in Figure 4. In this example, the 2^{nd} P-frame in view 2 is encoded/decoded based on the 1^{st} P-frame of the same view and the 1^{st} and 2^{nd} frames of view 0.

[00032] If the number of cameras is greater than 8, a larger hypercube will be created. An example of 4-cube with 16 cameras schematically represented in FIG. 5. In this instance, for the last node, 15, to be decoded, there are $\log_2 16 = 4$ views to be encoded.

[00033] Cameras in a practical, real-world environment will not necessarily be positioned as a hypercube, but are likely to be arranged as a rectangular array. According to another aspect of the invention, the cameras are assigned node IDs in such a way that the adjacent nodes, in fact, represent camera views that are closely correlated. The view IDs can be updated as necessary by specifying appropriate updates. Such view ID updates can be indicated in headers of coded bitstreams, for example. Numbering and camera positioning for an array of 8 and 16 cameras are shown in FIGs. 6 and 7, respectively.

[00034] Although the invention has been described primarily in terms of a hypercube of different dimensions, it will be readily apparent to one of ordinary skill in the art that other hyper-dimensional structures can used in place of a hypercube. Moreover, as described above, the dimension can be very low as well as extremely large; a 1-cube, for example, would correspond to multiple views generated with the use of only two cameras. Nonetheless, it is worth emphasizing again that different

hyper-dimensional structures can be substituted for the hypercube structures described herein, the hyper-dimensional structure providing a compact, bitwise representation that improves the efficiency of MVC.

[00035] The invention can be realized in hardware, software, or a combination of hardware and software, as described above. The invention can be realized in a centralized fashion in one computer system, or in a distributed fashion in which different elements are spread across several interconnected computer systems. Any kind of computer system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software can be a general purpose computer system with a computer program that, when being loaded and executed, controls the computer system such that it carries out the methods described herein.

[00036] The invention can be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

[00037] This invention can be embodied in other forms without departing from the spirit or essential attributes thereof. .

CLAIMS

We claim:

1. A method of multi-view video coding, the method comprising:

generating a multiple-view compressed encoded data sequence by encoding a plurality of video signals, each video signal defining a distinct camera view of one of a plurality of cameras, the encoding being based on a hypercube prediction structure comprising a plurality of nodes, each node representing a distinct camera view;

conveying the compressed encoded data sequence over a data communication network connection; and

presenting a visual display by decoding the compressed encoded data sequence, the decoding being based upon the hypercube prediction structure.

2. The method of Claim 1, further comprising determining reference views for at least one node based upon a dependency path selection criterion.

3. The method of Claim 1, further comprising determining a dependency path between a pair of the plurality of nodes, wherein the path traverses a plurality of nodes and wherein each node traversed is an adjacent node of another node traversed along the path.

4. The method of Claim 1, further comprising assigning a unique identification indicator to each node of the hypercube prediction structure.

5. The method of Claim 2, further comprising determining a dependency path between a pair of the plurality of nodes, wherein the path traverses a plurality of nodes and wherein each node traversed is an adjacent node of another node traversed along the path, and wherein, if alternative paths are available, one path is selected based upon a path dependency selection criterion.

6. The method of Claim 5, wherein the dependency path selection criterion is based upon a summation of identification indicators along each alternative path.

7. The method of Claim 1, further comprising embedding prediction-dependency indicators within the compressed encoded data sequence prior to conveying the compressed encoded data sequence over a data communication network connection.

8. The method of Claim 7, wherein the prediction-dependency indicators comprise at least one of a hypercube prediction structure size and a hypercube prediction structure dimension.

9. The method of Claim 7, further comprising conveying a view-dependency table over a data communication network connection, the view-dependency table being used in decoding the compressed encoded data sequence.

10. A multi-view video coding system, comprising:

an encoder to generate a multiple-view compressed encoded data sequence by encoding a plurality of video signals, each video signal defining a distinct camera view of one of a plurality of cameras, the encoding being based on a hypercube prediction structure comprising a plurality of nodes, each node representing a distinct camera view; and

a decoder to present a visual display based on a decoding of the compressed encoded data sequence, the decoding being based upon the hypercube prediction structure.

11. The system of Claim 10, wherein the encoder comprises:

a camera numbering unit for numbering a plurality of cameras based on the hypercube prediction structure;

a motion estimation unit for estimating motion velocity and direction of motion in a visual scene based upon the distinct camera views, the estimating being based upon the hypercube prediction structure; and a camera view encoding unit for encoding the camera views based upon input received from the camera number unit and motion estimation unit.

12. The system of Claim 10, wherein the decoder comprises

an information extractor unit for extracting hypercube prediction structure information from the compressed encoded data sequence;

a motion compensation unit for synchronizing motion estimations based upon the compressed encoded data sequence; and

a camera view decoding unit for generating an output based upon the hypercube prediction structure information and synchronized motion estimates.

13. An electromagnetic carrier wave, comprising:

computer-based instructions for performing at least one of generating a multiple-view compressed encoded data sequence and decoding a compressed encoded data sequence;

wherein generating a multiple-view compressed encoded data sequence comprises encoding a plurality of video signals, each video signal defining a distinct camera view of one of a plurality of cameras, the encoding being based on a hypercube prediction structure comprising a plurality of nodes, each node representing a distinct camera view; and

wherein decoding a compressed encoded data sequence is based upon the hypercube prediction structure.

14. A machine-readable storage medium, the storage medium comprising computer instructions for:

generating a multiple-view compressed encoded data sequence by encoding a plurality of video signals, each video signal defining a distinct camera view of one of a plurality of cameras, the encoding being based on a hypercube prediction structure comprising a plurality of nodes, each node representing a distinct camera view; and

conveying the compressed encoded data sequence over a data communication network connection; and presenting a visual display by decoding the compressed encoded data sequence, the decoding being based upon the hypercube prediction structure.

15. The machine-readable storage medium of Claim 14, further comprising computer instructions for determining reference views for at least one node based upon a dependency path selection criterion.

16. The machine-readable storage medium of Claim 14, further comprising computer instructions for determining a dependency path between a pair of the plurality of nodes, wherein the path traverses a plurality of nodes and wherein each node traversed is an adjacent node of another node traversed along the path.

17. The machine-readable storage medium of Claim 14, further comprising computer instructions assigning a unique identification indicator to each node of the hypercube prediction structure.

18. The machine-readable storage medium of Claim 15, further comprising computer instructions for determining a dependency path between a pair of the plurality of nodes, wherein the path traverses a plurality of nodes and wherein each node traversed is an adjacent node of another node traversed along the path, and wherein, if alternative paths are available, one path is selected based upon a path dependency selection criterion.

19. The machine-readable storage medium of Claim 18, wherein the dependency path selection criterion is based upon a summation of identification indicators along each alternative path.

20. The machine-readable storage medium of Claim 14, further comprising computer instructions for embedding prediction-dependency indicators within the compressed encoded data sequence prior to conveying the compressed encoded data sequence over a data communication network connection.

21. The machine-readable storage medium of Claim 20, wherein the prediction-dependency indicators comprise at least one of a hypercube prediction structure size and a hypercube prediction structure dimension.

22. The machine-readable storage medium of Claim 20, further comprising computer instructions for conveying a view-dependency table over a data communication network connection, the view-dependency table being used in decoding the compressed encoded data sequence.

23. A method of multi-view video coding, the method comprising:

generating a multiple-view compressed encoded data sequence by encoding a plurality of video signals, each video signal defining a distinct camera view of one of a plurality of cameras, the encoding being based on a hyperdimensional prediction structure comprising a plurality of nodes, each node representing a distinct camera view;

conveying the compressed encoded data sequence over a data communication network connection; and

presenting a visual display by decoding the compressed encoded data sequence, the decoding being based upon the hyperdimensional prediction structure.

Abstract

A method of multi-view video coding is provided. The method includes generating a multiple-view compressed encoded data sequence, sequence being generated by encoding a plurality of video signals. Each video signal defines a distinct camera view of one of a plurality of cameras. The encoding is based on a hypercube prediction structure formed by multiple nodes that each node represent a distinct camera view. The method also includes conveying the compressed encoded data sequence over a data communication network connection, and presenting a visual display. The visual display is presented by decoding the compressed encoded data sequence, the decoding being based upon the hypercube prediction structure.

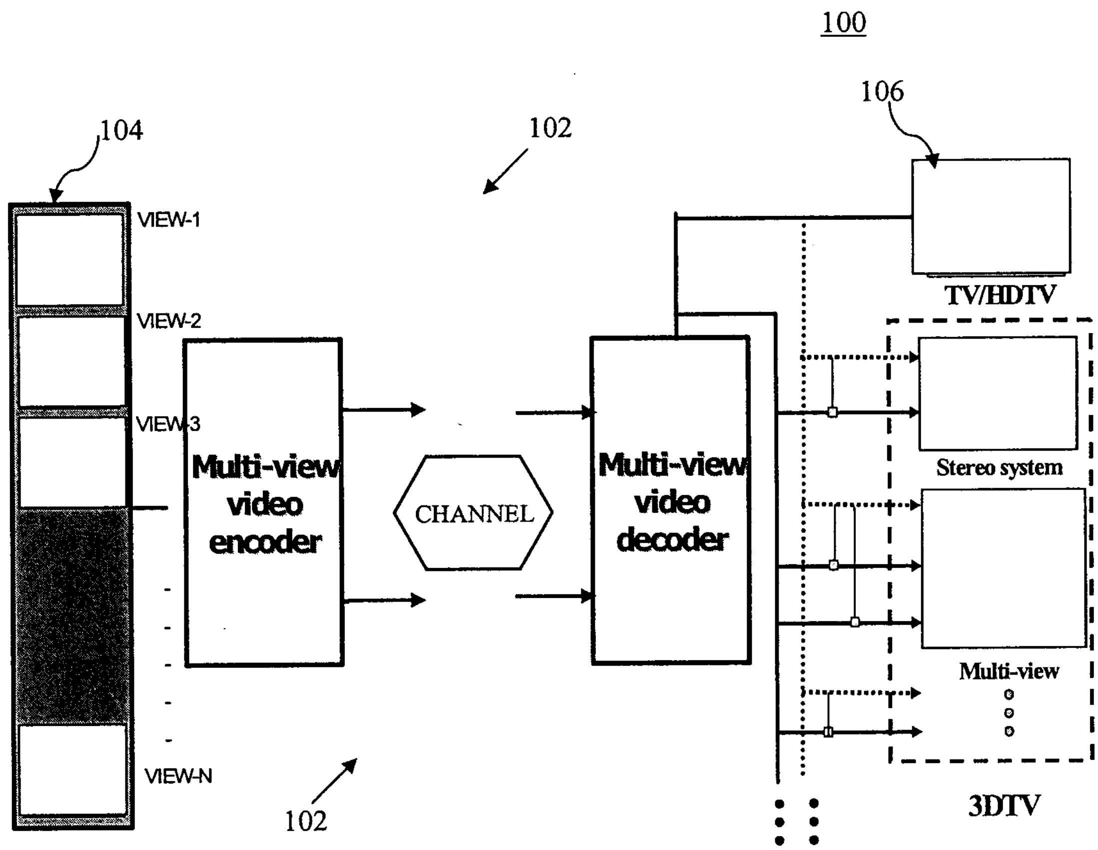

100
106
104
102
VIEW-1
VIEW-2
VIEW-3
Multi-view video encoder
CHANNEL
Multi-view video decoder
TV/HDTV
Stereo system
Multi-view
VIEW-N
102
3DTV

FIG. 1

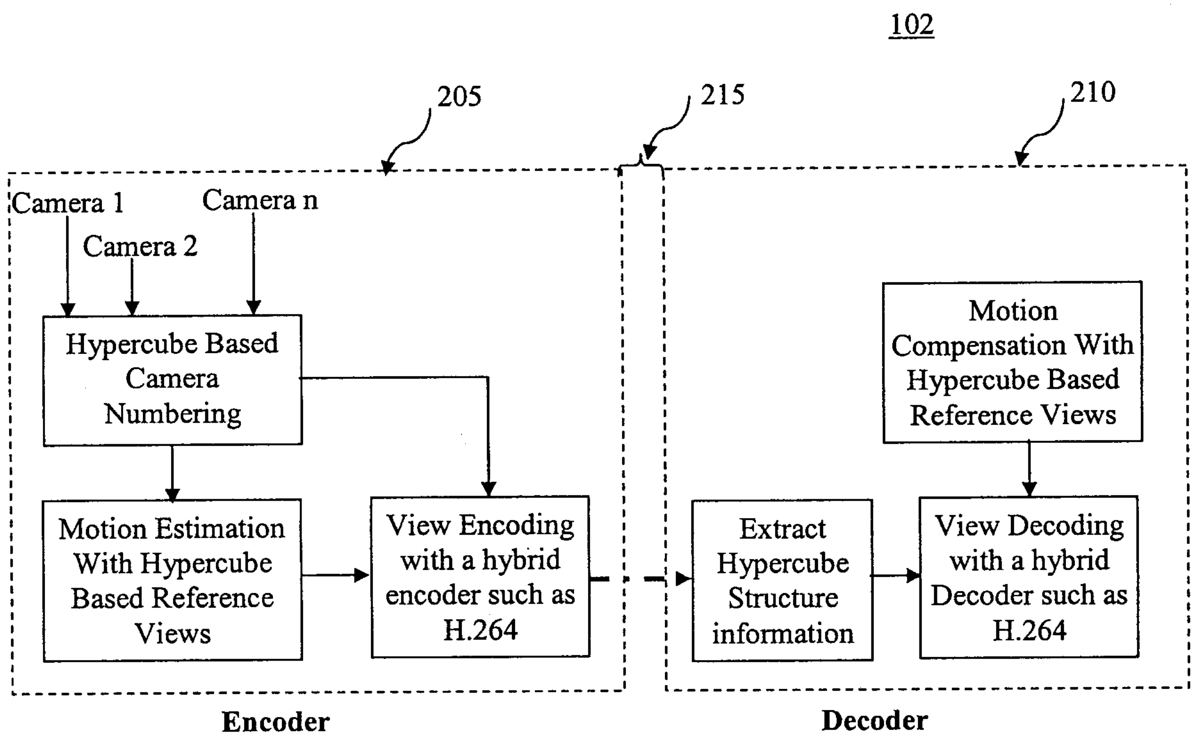

102
205
215
210
Camera 1
Camera 2
Camera n
Hypercube Based Camera Numbering
Motion Estimation With Hypercube Based Reference Views
View Encoding with a hybrid encoder such as H.264
Extract Hypercube Structure information
Motion Compensation With Hypercube Based Reference Views
View Decoding with a hybrid Decoder such as H.264
Encoder
Decoder

FIG. 2

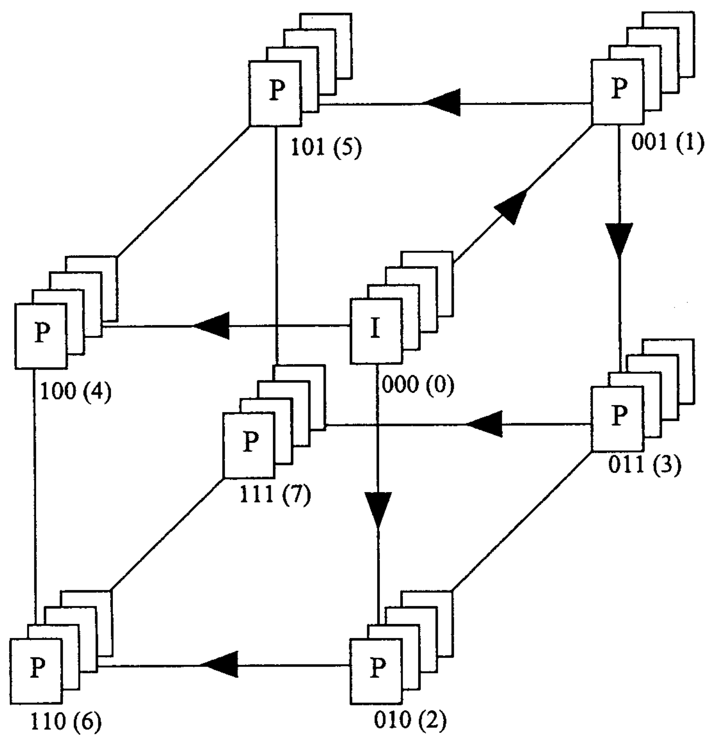


FIG. 3

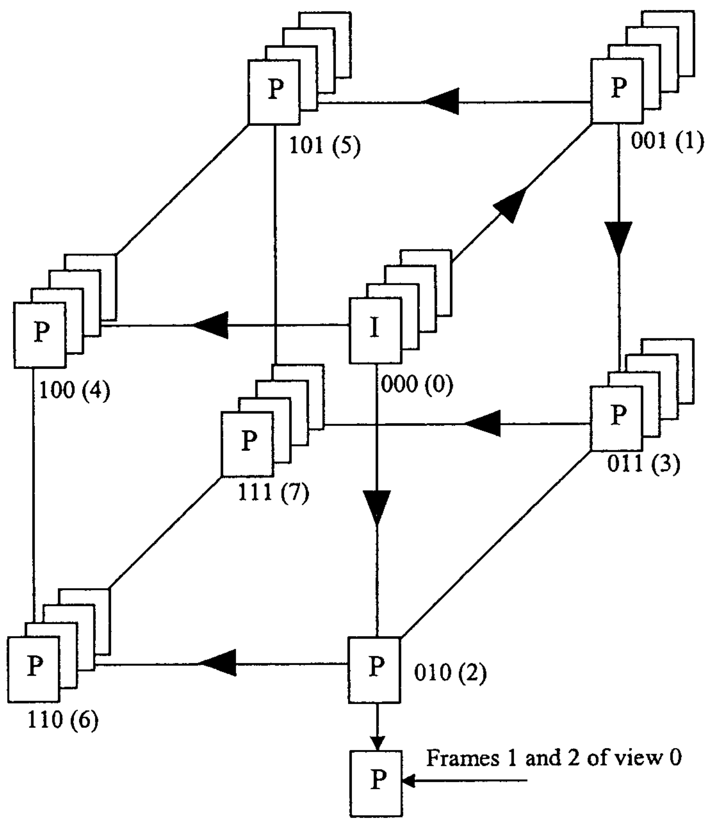

P
101 (5)
P
001 (1)
P
I
100 (4)
000 (0)
P
P
111 (7)
011 (3)
P
P
010 (2)
110 (6)
P
Frames 1 and 2 of view 0

FIG. 4

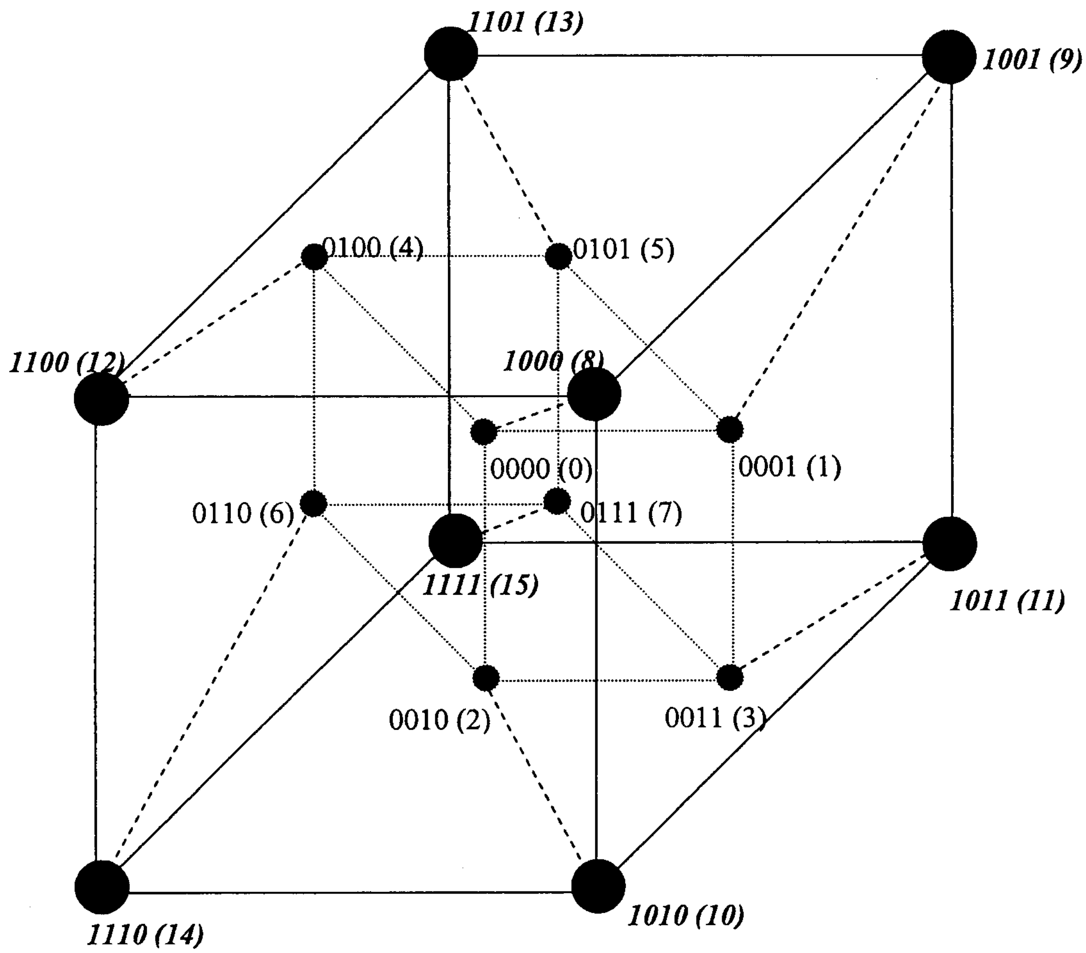
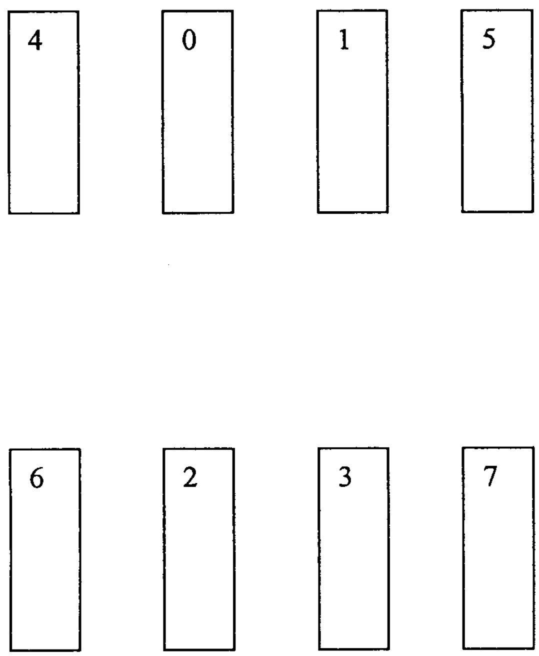
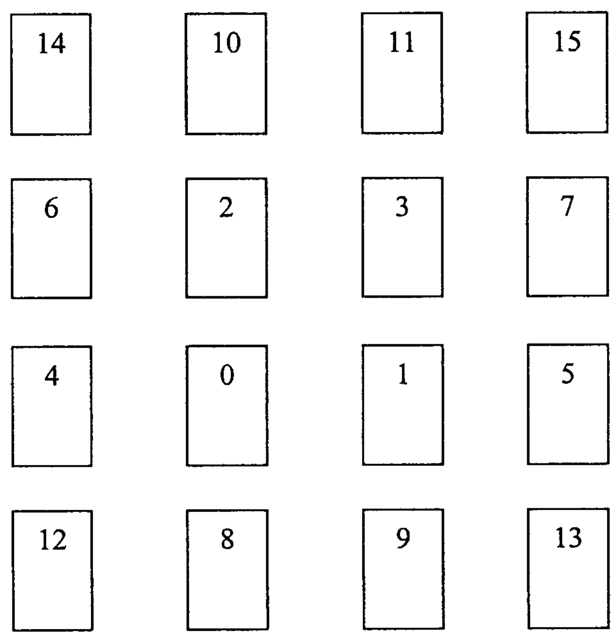

1101 (13)
1001 (9)
0100 (4)
0101 (5)
1100 (12)
1000 (8)
0000 (0)
0001 (1)
0110 (6)
0111 (7)
1111 (15)
1011 (11)
0010 (2)
0011 (3)
1110 (14)
1010 (10)

FIG. 5



Numbering of an 8 camera array.

FIG. 6



Numbering of a 16 camera array.

FIG. 7