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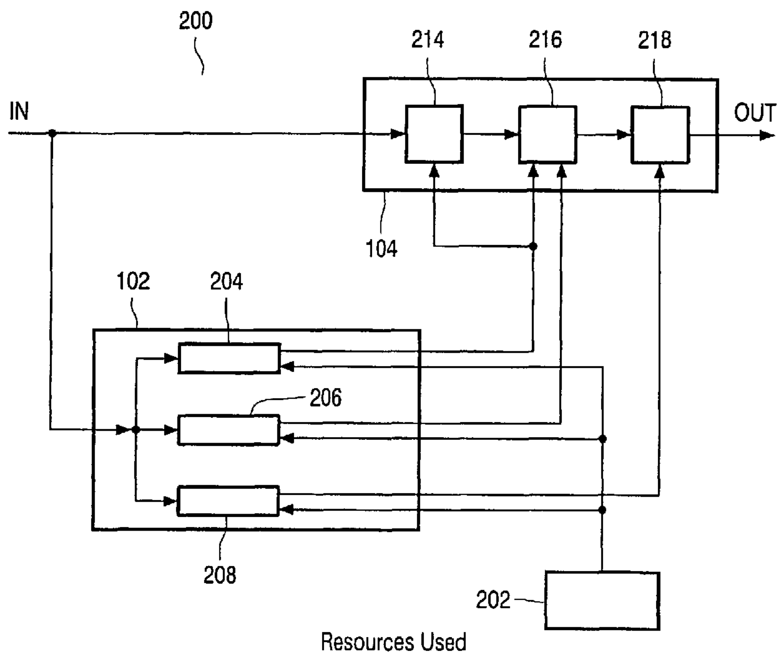
(54) Title: IRREGULAR PROCESSING OF MEDIA DATA WITH CONTINUOUS OUTPUT



(57) **Abstract:** A method and apparatus for efficiently processing media data when the amount of available resources falls below a predetermined level is disclosed. When the overall system control decides that there is a shortage of resources, e.g. when the available resources falls below the predetermined level, or is expected to fall below the predetermined level, the media analysis for global parameters of each frame is suspended and the global parameters from the last fully processed frame are sent to the media processing units.

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Irregular processing of media data with continuous output

The invention relates to media processing, and more particularly to a method and apparatus for monitoring the amount of available resources in a media processing system and suspending calculation of global parameters when the available resources falls below a predetermined level.

Media data, such as video data, have regular deadlines (e.g., fields or frames), where an image has to be displayed. Therefore, image processing is a very regular, continuous process. A typical video processing chain in a consumer device like a television or a set top box includes processing units for video decoding, video enhancement, and display processing. In each unit, images have to be processed and output in a specific time period or frame.

The processing units may comprise a set of algorithms for producing the output image, and currently all algorithms have the same regular processing deadlines to produce a continuous stream of images. As long as these algorithms are implemented in dedicated hardware like ASICS, they are designed for worst case processing, and all of the functionality is guaranteed to be finished in a given time period or frame.

Image analysis, as a part of image processing, can consume quite a lot of resources. In image analysis, each frame of the incoming media data can be analyzed and global parameters such as, for example, noise level, average image spectrum characteristics, bit rate of digital streams, global motion vectors (zoom, tilt) are determined and provided to the image processing units for use during processing of each frame.

With programmable components, an efficient use of the resources cannot be achieved by assigning the processing resources for the worst-case scenario. The situation becomes even worse when the processing becomes data dependent like for MPEG compression/decompression algorithms or motion estimation algorithms.

With programmable components, severe problems occur when the processing requires more than the available resources (resource ceiling). Skipping frames or otherwise affected images can be result, which may not be acceptable to the user. Thus, there is a need for a method and apparatus for providing acceptable image quality when the amount of available resources falls below a predetermined level.

It is an object of the invention to overcome the above-described deficiencies by providing a method and apparatus for efficiently processing media data when the amount of available resources falls below a predetermined level. When the overall system control decides on a shortage of resources, e.g. when the available resources falls below the predetermined level, or is expected to fall below the predetermined level, the media analysis for global parameters of each frame is suspended and the global parameters from the last fully processed frame are sent to the media processing units. Thus, the media processing on individual images/data is still performed with little or no influence on the output image quality.

According to one embodiment of the invention, a method and apparatus for processing data frames is disclosed. When a data frame is received, the resources needed to calculate at least one global parameter for the data frame is estimated. The resources needed to calculate the at least one global parameter can also be pre-knowledge and stored in e.g. a look-up-table. It is then determined if the available resources are greater than a predetermined threshold. If the available resources are below the predetermined threshold, the calculation of the at least one global parameter is skipped. The at least one previously calculated global parameter is then sent to a processing unit which processes the data frame using the sent parameter.

According to another embodiment of the invention, a method and apparatus for processing data frames is disclosed. When a data frame is received, at least one global parameter is calculated for the data frame. The at least one global parameter is then sent to a processing unit which processes the data frame using the calculated global parameters. Prior to finishing processing of the received data frame, it is determined whether available resources are greater than a predetermined threshold. The calculation of at least one global parameter for the next received frame is skipped when the available resources are less than the predetermined threshold, wherein previously calculated global parameters are sent to the processing unit for processing of the next received frame.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereafter.

The invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 illustrates a known image processing system;

Figure 2 illustrates a detailed image processing system according to one embodiment of the invention;

Figure 3 is a flowchart illustrating an image processing method according to one embodiment of the invention; and

Figure 4 is a flowchart illustrating an image processing method according to one embodiment of the invention.

Adaptive algorithms using image analysis are well-known in image processing. The adaptation may be locally image content dependent or globally dependent on the image input parameters like noise level, signal spectrum characteristics, global motion vectors, etc. The image analysis can take quite a lot of resources and in the case of global adaptation, the result may change only by a small amount in adjacent fields or frames. According to one embodiment of the invention, the image analysis is skipped in situations where the amount of available resources becomes small or falls below a predetermined threshold. In this situation, the global parameters from the previous frame are used in the image processing of the next frame.

Figure 1 illustrates a media processing system 100. The media processing system 100 has a media analysis unit 102 and a media processing unit 104. The media analysis unit 102 receives each frame of the incoming data and analyzes each frame to determine at least one global parameter. The global parameters are then sent to the media processing unit 104. The media processing unit 104 processes each incoming data frame using the global parameters from the media analysis unit 102. The media processing unit 104 then outputs a processed frame for display.

Figure 2 illustrates an image processing system 200 which is a more detailed example of the media processing system 100. In this illustrative example, the media analysis unit 102 comprises a noise level detector 204, a detector for global motion vectors 206, and a signal spectrum analyser208, all connected to the input signal. The outputs for the global parameters are the input parameters for the media processing units 214, 216, and 218. A controller 202 is connected to the media analysis units 204, 206, and 208. It will be understood by one skilled in the art that the media analysis unit is not limited to the components described above, but rather can contain any means necessary for calculating global parameters for the media processing unit 104. The media processing unit 104 can be comprised of a video decoding unit 214, a video enhancement unit 216 and a video display processing unit 218, but the media processing unit 104 is not limited thereto.

In this illustrative system, the controller 202 monitors the available resources of the media processing system 200. It will be understood that a different controller in the media processing system 200 could alternatively be used to monitor the available resources of the system 200. When the available resources drops below a predetermined threshold, the controller 202 halts at least part of the image analysis on the received frame. For example, the controller 202 may halt processing in one or more of the noise level detection unit 204, the detector for global motion vectors unit 206, and the signal spectrum analyzer unit 208. For example, noise level is a global parameter and will change slightly from frame to frame. By skipping the noise measurement in the noise detection unit 204 for one or more frames, the previously calculated noise level value can be sent to the media processing unit 104 and the freed resources can be used for other more important purposes. Since the last noise level value is most likely very close to the value that would have been calculated, the output quality from the media processing unit 104 is not greatly affected.

The analysis of available resources can be performed in a variety of ways. Figure 3 is a flow chart illustrating an image processing method according to one embodiment of the invention. When a data frame is received in step 302, the controller 202 estimates the resources needed to calculate the global parameters for the frame in step 304. If the resources needed to calculate the global parameters for the frame are pre-knowledge, step 304 can be skipped. If it is determined in step 306 that the available resources are greater than a predetermined threshold, the media analysis unit calculates the global parameters in step 308 and analyzes the frame in the normal manner and outputs the calculated global parameters to the media processing unit 104 in step 310. However, if it is determined that the available resources are less than a predetermined threshold in step 306, the media analysis unit 102 skips the calculation of at least one of the global parameters in step 312. The media analysis unit 102 then sends at least one previously calculated global parameter to the media processing unit 104 in step 314. As mentioned above, the controller 202 may prevent one or more of the units 204, 206, 208 from calculating a new global parameter. In this situation, the unit 204, 206, 208 which is prevented from calculating a new global parameter sends the previously calculated global parameter to the media processing unit 104. The media processing unit 104 then processes the received frame in the normal manner using the previously calculated global parameters in step 316.

Figure 4 is a flow chart illustrating an image processing method according to another embodiment of the invention. When a data frame is received in step 402, the media analysis unit 102 calculates at least one global parameter for the frame in step 404. The media analysis unit 102 then sends the at least one calculated global parameter to the media processing unit 104 in step 406. The media processing unit 104 then processes the frame using the at least one global parameter in step 408. While the media processing unit 104 is processing the frame, the controller 202 estimates the resources needed to calculate the global parameters for the next frame in step 410. If it is determined in step 412 that the available resources are greater than a predetermined threshold, the media analysis unit 102 will analyze the next frame in the normal manner. However, if it is determined that the available resources are less than a predetermined threshold in step 306, the media analysis unit 102 will skip the calculation of at least one of the global parameters for the next frame in step 414. The media analysis unit 102 will then send at least one previously calculated global parameter to the media processing unit 104 at the appropriate time for the next frame in step 416. As mentioned above, the controller 202 may prevent one or more of the units 204, 206, 208 from calculating a new global parameter for the next frame. In this situation, the unit 204, 206, 208 which is prevented from calculating a new global parameter sends the previously calculated global parameter to the media processing unit 104 for processing of the next frame.

Alternatively, the controller 202 may continuously monitor the amount of available resources and suspend calculation of one or more of the global parameters when the amount of available resources falls below a predetermined level. In this situation, the units which have suspended calculation of the new global parameter will send the last previously calculated global parameter to the media processing unit 104.

The above-described invention has many advantages. First, media processing is almost unaffected, while programmable processing resources can be used in a very flexible manner. The former "hard ceiling" of the maximal available programmable resources becomes a "soft ceiling". The invention is applicable for scalable and non-scalable media processing. The invention can be implement in an inexpensive manner using control software.

It will be understood that the different embodiments of the invention are not limited to the exact order of the above-described steps as the timing of some steps can be interchanged without affecting the overall operation of the invention. Furthermore, the term "comprising" does not exclude other elements or steps, the terms "a" and "an" do not exclude a plurality and a single processor or other unit may fulfill the functions of several of the units or circuits recited in the claims.

CLAIMS:

1. A method for processing data frames, comprising the steps of:

receiving a data frame;

determining if available resources are greater than a predetermined threshold;

skipping calculation of at least one global parameter if the available resources are less than a predetermined threshold;

sending at least one previously calculated global parameter to a processing unit which processes the data frame using the sent parameter.

2. The method according to claim 1, wherein the resources needed to calculate the at least one global parameter is known prior to beginning the processing.

3. The method according to claim 1, further comprising the step of:

estimating resources needed to calculate the at least one global parameter for the data frame.

4. The method according to claim 1, wherein the data frames are audio/video frames or fields.

5. The method according to claim 1, wherein the global parameter comprises at least one of noise level, signal spectrum characteristics, and global motion vectors.

6. A method for processing data frames, comprising the steps of:

receiving a data frame;

calculating at least one global parameter for the data frame;

sending the at least one global parameter to a processing unit which processes the data frame using the calculated global parameters;

determining, prior to finishing processing of the received data frame, whether available resources are greater than a predetermined threshold;

skipping calculation of at least one global parameter for the next received frame when the available resources are less than the predetermined threshold, wherein previously calculated global parameters are sent to the processing unit for processing of the next received frame.

7. The method according to claim 6, wherein the data frames are audio/video frames or fields.

8. The method according to claim 6, wherein the global parameter comprises at least one of noise level, signal spectrum characteristics, and global motion vectors.

9. An apparatus for processing data frames, comprising:

means for receiving a data frame;

means for determining if available resources are greater than a predetermined threshold;

means for skipping calculation of at least one global parameter if the available resources are less than a predetermined threshold;

means for sending at least one previously calculated global parameter to a processing unit which processes the data frame using the sent parameter.

10. The apparatus according to claim 9, wherein the resources needed to calculate the at least one global parameter is known prior to the processing.

11. The apparatus according to claim 9, further comprising the step of:

estimating resources needed to calculate the at least one global parameter for the data frame.

12. The apparatus according to claim 9, wherein the data frames are audio/video frames or fields.

13. The apparatus according to claim 9, wherein the global parameter comprises at least one of noise level, signal spectrum characteristics, and global motion vectors.

14. An apparatus for processing data frames, comprising:

means for receiving a data frame;

means for calculating at least one global parameter for the data frame;

means for sending the at least one global parameter to a processing unit which processes the data frame using the calculated global parameters;

means for determining, prior to finishing processing of the received data frame, whether available resources are greater than a predetermined threshold;

means for skipping calculation of at least one global parameter for the next received frame when the available resources are less than the predetermined threshold, wherein previously calculated global parameters are sent to the processing unit for processing of the next received frame.

15. The apparatus according to claim 14, wherein the data frames are audio/video frames or fields.

16. The apparatus according to claim 14, wherein the global parameter comprises at least one of noise level, signal spectrum characteristics, and global motion vectors.

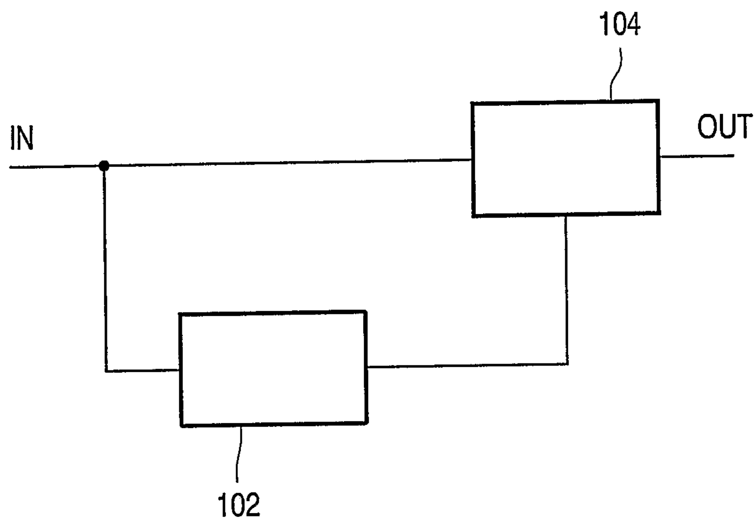
104
IN
OUT
102

FIG. 1

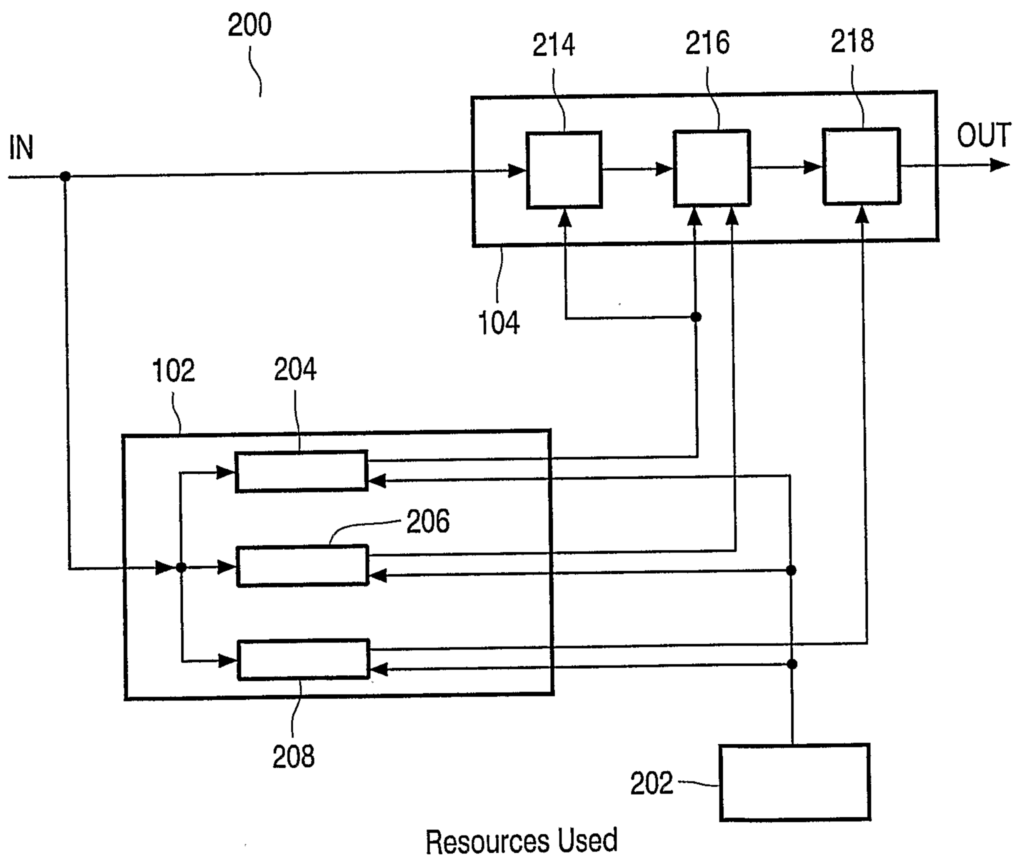
200
214
216
218
IN
OUT
104
102
204
206
208
202
Resources Used

FIG. 2

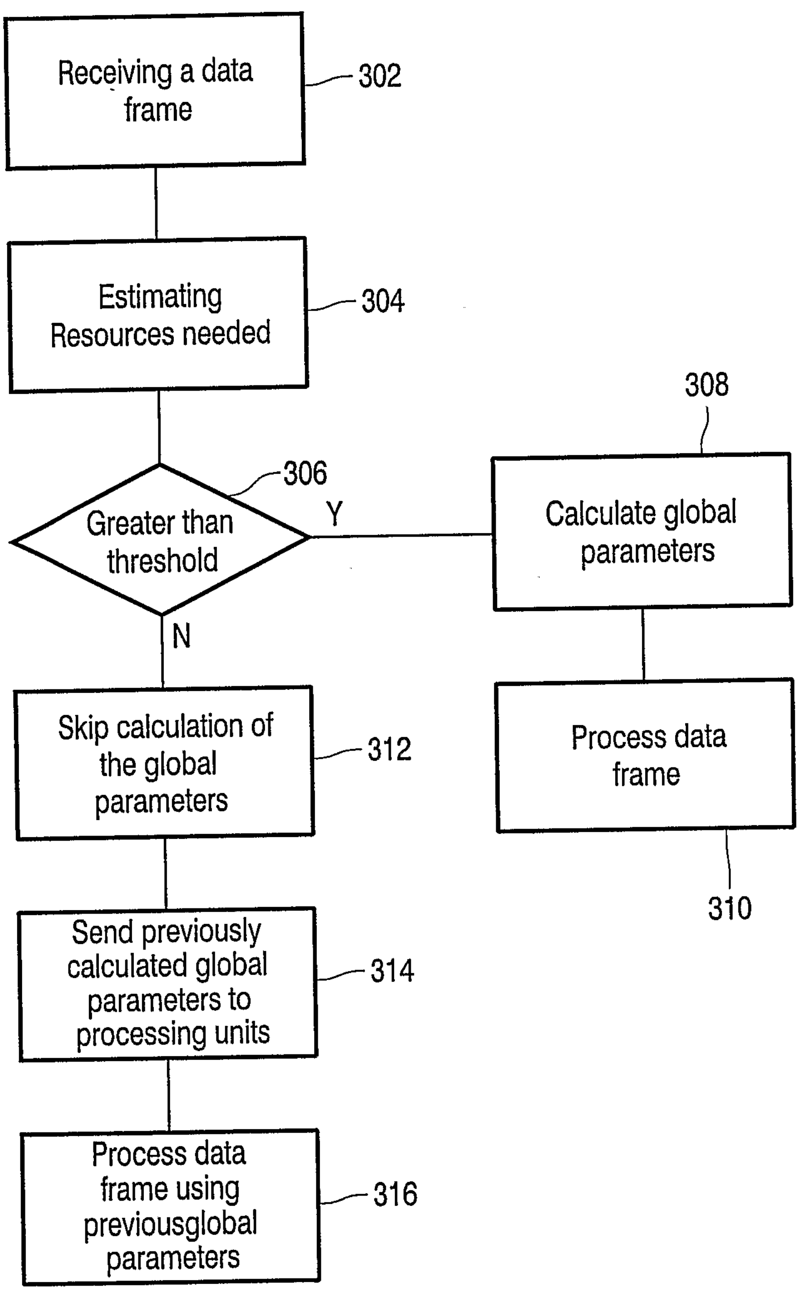
Receiving a data frame
302
Estimating Resources needed
304
308
306
Greater than threshold
Y
Calculate global parameters
N
Skip calculation of the global parameters
312
Process data frame
310
Send previously calculated global parameters to processing units
314
Process data frame using previousglobal parameters
316

FIG. 3

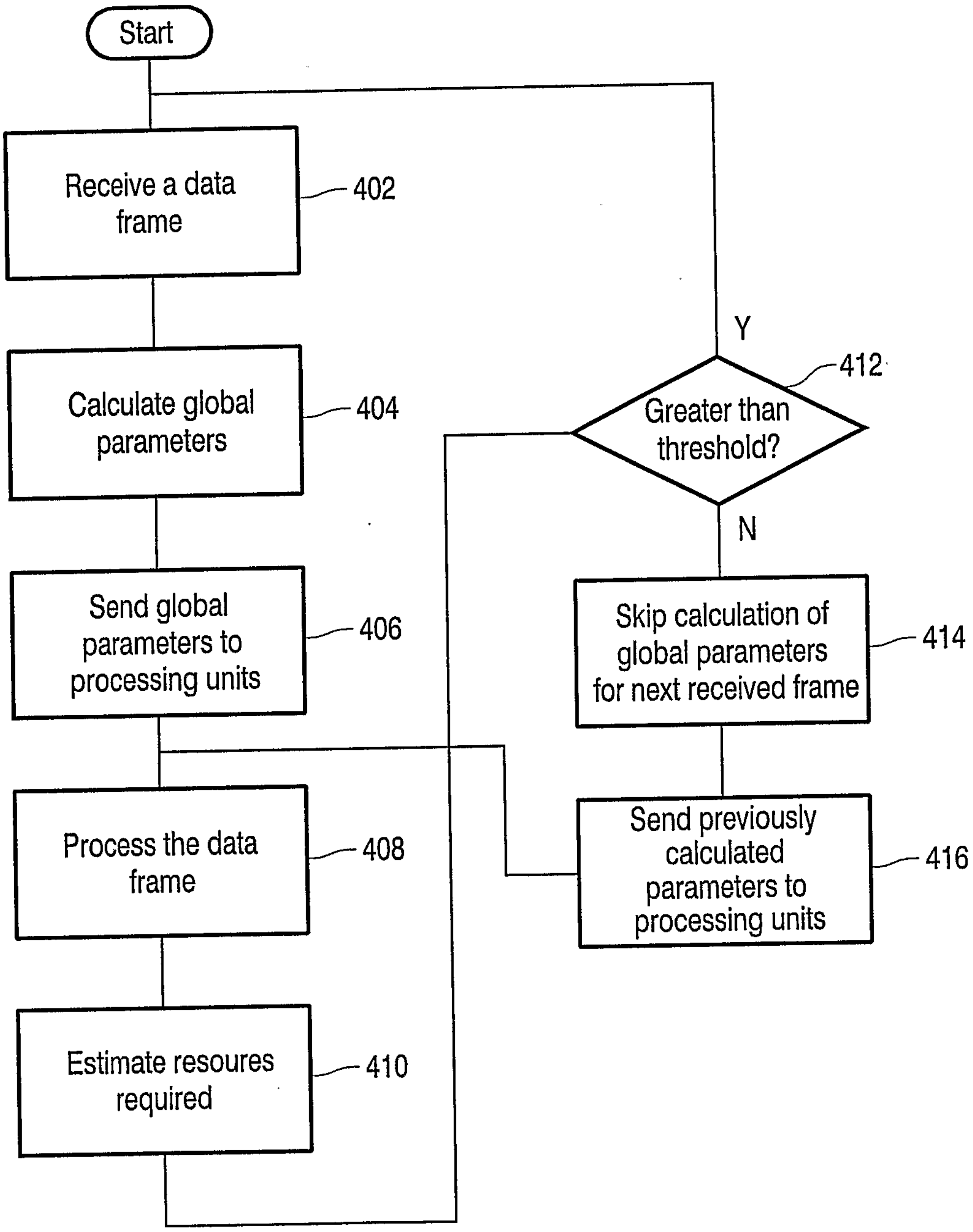
Start
Receive a data frame
402
Calculate global parameters
404
Send global parameters to processing units
406
Process the data frame
408
Estimate resoures required
410
Y
412
Greater than threshold?
N
Skip calculation of global parameters for next received frame
414
Send previously calculated parameters to processing units
416

FIG. 4

INTERNATIONAL SEARCH REPORT

PCT/IB 03/02820

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N5/14 H04N7/26

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

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

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

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 910 219 A (MATSUSHITA ELECTRIC IND CO LTD) 21 April 1999 (1999-04-21) abstract page 4, paragraph 31 - paragraph 32 column 7, line 5 - line 26; figures 1,2 page 5, column 7, paragraph 39; claims 1,2,5,11-14 ---	1-16
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 10, 31 August 1999 (1999-08-31) & JP 11 146398 A (MATSUSHITA ELECTRIC IND CO LTD), 28 May 1999 (1999-05-28)	1,4,9,12
A	abstract --- -/--	2,6,10, 12,14,15

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2003	27/10/2003

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/009149 A1 (GOEL SHASHI ET AL) 24 January 2002 (2002-01-24) abstract page 6, paragraph 55 -page 9, paragraph 76; figures 1-6	1,6,9,14

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