Title: VIDEO APPARATUS HAVING AN EDITION FUNCTION

A

F[n] F[n+m]
F[n-1] F[n+1] F[n+m+1]
- 0 0 -

B

F[n] F[n+m] F[n] F[n+m]
- 0 0 + +

R[1] R[k]

Abstract: A video apparatus comprises a detection module. The detection module detects, in original video data, a sequence of images (F[n], F[n+1], ..., F[n+m]) that represents an object that moves relatively fast with respect to other objects. The detection module may form part of a special effect module that causes at least one replay (R[1], ..., R[k]) of the sequence of images (F[n], F[n+1], ..., F[n+m]) so as to obtain video output data that comprises the original video data and, in addition, the at least one replay (R[1], ..., R[k]) of the sequence of images (F[n], ..., F[n+m]) subsequent to the sequence of images (F[n], F[n+1], ..., F[n+m]).
Published: without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Video apparatus having an edition function.

FIELD OF THE INVENTION

The invention mainly relates to a video apparatus that has an editing function. The video apparatus may be, for example, a digital video recorder that records video data on an optical disk (DVD) or a magnetic disk (HD), or both. Other aspects of the invention relate to a method of editing original video data, a computer program product for a video apparatus, and a video display system.

BACKGROUND OF THE INVENTION

US patent 6,229,851 describes a method of looping MPEG2 bit streams. In order not to violate buffer occupancy constraints of downstream decoders, the replay bit rate is modified so that the time taken to replay the looped sequence is made equal to the decode time. Looping of the sequence of comprised video bit stream is used for the purpose of testing MPEG2 decoders.

SUMMARY OF THE INVENTION

According to an aspect of the invention, a video apparatus comprises a detection module. The detection module detects, in original video data, a sequence of images that represents an object that moves relatively fast with respect to other objects.

The invention takes the following aspects into consideration. Video data generally comprises one or more scenes with action. An average viewer regards action as an interesting feature, or even an important feature. Consequently, it may be desirable to make action scenes stand out. In a sense, this can be considered analogous to highlighting keywords in a text. The problem is finding the appropriate keywords to highlight.

It has been found that the following generally applies to an action scene. There are one or more objects that move relatively fast with respect to other objects. That is, there is some form of local motion. An example is a person standing on a field who suddenly jumps in the air. Another example is a speeding vehicle that suddenly enters a scene and then stops in the middle of the scene. The speeding vehicle may also cross the scene. Such a scene
generally constitutes an action scene if the speed of the object of interest is relatively high compared with that of moving objects in other scenes.

In accordance with the aforementioned aspect of the invention, a detection module detects, in original video data, a sequence of images that represents an object that moves relatively fast with respect to other objects.

Accordingly, the video apparatus can automatically detect action scenes in relatively reliable manner. These scenes may subsequently be subject of editing. A user does not have to view and analyze the video data of interest for the purpose of editing. Moreover, the editing can be carried out in a predefined, automatic manner. For those reasons, the invention allows greater user convenience.

Another advantage of the invention relates to the following aspects. Nowadays, many video apparatuses comprise a video encoder or a video decoder, or even both. Video encoding and decoding generally involve some form of temporal prediction. A reference frame is used to predict another, neighboring frame, which may be previous to the reference frame or subsequent to the reference frame. This temporal prediction generates motion-related parameters, which allow relatively easy detection of an object that moves relatively fast with respect to other objects. Consequently, the detection module in accordance with the invention can be implemented at relatively modest cost. For those reasons, the invention allows low cost implementations.

In accordance with another aspect of the invention, the detection module may form part of a special effect module that causes at least one replay of the sequence of images so as to obtain video output data that comprises the original video data and, in addition, the at least one replay of the sequence of images subsequent to the sequence of images. That is, an action scene will be replayed at least once subsequent to the first occurrence of the action scene. Let it be assumed that the scene concerns a person standing on a field who suddenly jumps in the air. In the output video, the person jumps in the air several times in succession. This emphasizes the action, analogous to highlighting a keyword in a text. The replay of an action scene subsequent to the first occurrence of the action scene produces a jittery effect, which the average viewer will generally regard as funny, or even as pleasant. For those reasons, the invention allows an enhanced viewing experience.

These and other aspects of the invention will be described in greater detail hereinafter with reference to drawings.
BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram that illustrates a video display system, which comprises a digital video recorder.

FIGS. 2A and 2B are diagrams that illustrate video output data, which the digital video recorder provides, in an ordinary mode and in a special effect mode, respectively.

FIG. 3 is a functional diagram that illustrates a special effect module that forms part of the digital video recorder.

FIG. 4 is a table that illustrates motion vectors and pixel block indices associated therewith for a particular frame.

FIG. 5 is a functional diagram that illustrates an object motion detector that forms part of the special effect module.

DETAILED DESCRIPTION

FIG. 1 illustrates a video display set VDS. The video display set VDS comprises a display device DPL, a digital video recorder DVR, and a remote control device RCD. The display device DPL displays video output data VO, which the digital video recorder DVR provides. The remote control device RCD allows a user to control the digital video recorder DVR and the display device DPL. The user may define, for example, that the digital video recorder DVR should provide the video output data VO with a particular special effect.

The digital video recorder DVR comprises video input/output connectors IOV, a radiofrequency connector RFC, a receiver REC, an encoding-and-decoding module CODEC and a disk driver DRW for writing data on a disk DSK and for reading data from the disk DSK. The disk DSK may be, for example, an optical disk such as a digital versatile disk (DVD) or a hard disk (HD), on which data is magnetically stored. The digital video recorder DVR further comprises a special effect module SEM and a control module CTRL. The control module CTRL comprises a user interface UIF, which responds to commands from the remote control device RCD. Any of the aforementioned modules may be implemented by means of software or hardware, or a combination of software and hardware. A suitably programmed processor may carry out operations that will be described hereinafter with reference to the aforementioned modules.
The digital video recorder DVR operates as follows. In a recording mode, the encoding-and-decoding module CODEC receives video input data VI from an external entity via the video input/output connectors IOV. Alternatively, the receiver REC may provide the video input data VI, which the receiver REC derives from, for example, a cable network signal applied to the radiofrequency connector RFC. The encoding-and-decoding module CODEC encodes the video input data VI in accordance with a video encoding standard, such as, for example, MPEG2 or MPEG4 (MPEG is a commonly used acronym for Moving Pictures Experts Group).

The disk driver DRW receives encoded video input data VIC from the encoding-and-decoding module CODEC and writes that data onto the disk DSK, which is present in the disk driver DRW. Alternatively, the disk driver DRW may receive the encoded video input data VIC directly from an external entity via a codec bypass BYP, which is illustrated in broken lines. In that case, the encoding-and-decoding module CODEC may still decode the encoded video input data VIC, which the external entity provides. Accordingly, the digital video recorder DVR can retrieve coding parameters and other data from the encoded video input data VIC. This data can be useful for editing, which will be described in greater detail hereinafter.

In a playback mode, the encoding-and-decoding module CODEC receives encoded video output data VOC from the disk driver DRW. The encoding-and-decoding module CODEC decodes the encoded video output data VOC so as to obtain the video output data VO, which is applied to the display device DPL. Alternatively, the disk driver DRW may apply the encoded video output data VOC, which is read from the disk DSK, directly to an external entity that comprises a video decoder. In that case, the coded video output data VO transits via the codec bypass BYP. The encoding-and-decoding module CODEC may still decode the encoded video output data VOC, which the disk driver DRW provides. Accordingly, the digital video recorder DVR can retrieve coding parameters and other data from the encoded video output data VOC. This data can be useful for editing, which will be described in greater detail hereinafter.

The video output data VO may comprise a scene in which there is an object that moves relatively fast with respect to other objects that form part of the scene. For example, a person who suddenly jumps in the air may constitute such a scene. As another example, a relatively fast moving car may suddenly enter a scene and then stop in the middle of the scene. Such a scene will be referred to hereinafter as a fast moving object scene. A fast moving object scene is generally associated with action. The aforementioned equally applies
to the other video data versions: the video input data VI, the encoded video input data VIC and the encoded video output data VOC.

The special effect module SEM detects fast moving object scenes on the basis of coding parameters that the encoding-and-decoding module CODEC provides. These coding parameters include motion vectors MV and, in association therewith, pixel block indices BX and frame indices FX. A motion vector MV relates to a particular block of pixels that forms part of a frame in the video output data VO or the video input data VI, whichever applies. The motion vector MV indicates a similar block of pixels in a neighboring frame. More precisely, the motion vector MV indicates the displacement of the similar block of pixels in the neighboring frame with respect to the block of pixels of the frame to which the motion vector belongs. A pixel block index BX, which is associated with a motion vector MV, indicates the block of pixels to which the motion vector belongs. A frame index FX, which is associated with a motion vector MV, indicates the frame to which the motion vector belongs.

The special effect module SEM causes the disk driver DRW to playback a fast moving object scene several times in succession. To that end, the special effect module SEM applies various output data to the control module CTRL. These output data include a scene start indication SB, a scene end indication SE and a replay command RPL. The scene start indication SB indicates the first frame of a sequence of frames that represents the fast moving object scene. The scene end indication SE indicates the last frame of that sequence. The replay command RPL indicates that the sequence of frames needs to be replayed. In response, the control module CTRL controls the disk driver DRW so that the encoded video data comprises one or more replays of the sequence of frames, which replays occur in succession.

In the description hereinbefore, it is assumed that the user has set the digital video recorder DVR in a special effect mode, which causes a fast moving object scene to be replayed one or more times. The user may select the number of times a fast moving object scene is replayed. The user may disable the special effect mode, in which case the digital video recorder DVR plays back the video data, which is recorded on the disk DSK, without any special effects.

FIG. 2A illustrates the video output data VO that the digital video recorder DVR provides when the user has disabled the special effect mode. A relatively small square box represents a frame F. The output video data comprises a sequence of frames F[n], F[n+1], ..., F[n+m] that represents a fast moving object scene. A circle inside a small square box, which represents a frame, illustrates that this frame represents a relatively fast moving object. Conversely, a minus sign illustrates that the relevant frame does not represent any sufficiently
fast moving object. The latter applies to frame $F[n-1]$, which immediately precedes the first frame $F[n]$ of the sequence that represents a fast moving object scene. This also applies to frame $F[n+m+1]$, which immediately follows the last frame $F[n+m]$ of the sequence.

FIG. 2B illustrates the video output data VO that the digital video recorder DVR provides when the user has enabled the special effect mode. The sequence of frames $F[n], F[n+1], ..., F[n+m]$, which represents a fast moving object scene, is replayed several times. The number of times the sequence is replayed is equal to $k$, which is an integer value. The first replay $R[1]$ of the sequence immediately follows the first occurrence of the sequence of frames $F[n], F[n+1], ..., F[n+m]$ in the video output data VO. The video output data VO resumes its natural course, as it were, after the last replay $R[k]$, which is followed by frame $F[n+m+1]$. A replay of the sequence of frames $F[n], F[n+1], ..., F[n+m]$ corresponds with an insertion of that sequence respect to the video output data VO illustrated in FIG. 2A. A plus sign in a square box, which represents a frame $F$, illustrates that this frame has been inserted with respect to the video output data VO illustrated in FIG. 2A.

FIG. 3 illustrates the special effect module SEM in the form of a functional diagram. In FIG. 3, a block represents a particular function, which the special effect module SEM carries out. It has been indicated hereinbefore that the special effect module SEM may be implemented in the form of a software program that runs on processor. In such a software-based implementation, a block may thus correspond with a set of instructions that forms, for example, a subroutine. The various blocks will be described hereinafter as if they were functional entities for reasons of ease of description.

The special effect module SEM comprises an object motion detector OMD, a sequence identifier ISQ, and a sequence definer DSQ. The sequence identifier ISQ receives a motion threshold value THM. The special effect module SEM further comprises a sequence length detector SLD, a sequence length verifier SLV, a sequence distance detector SDD, a sequence distance verifier SDV, a previous sequence-end memory PSM, and a 2-and logic 2AND. The special effect module SEM may optionally comprise a motion threshold adapter MTA, which is illustrated by means of broken lines.

The special effect module SEM operates as follows. The object motion detector OMD detects whether a frame comprises an object of significance that moves with respect to other objects, or not. The object motion detector OMD further detects how fast the object moves, if there is any such object, and where the object is momentarily located. The object motion detector OMD carries out these detections on the basis of the motion vectors MV that belong to the frame of interest and the pixel block indices BX associated therewith. It should
be noted that, in general, a reference frame has no motion vectors. The object motion detector OMD may simply not take reference frames into account. That is, the object motion detector OMD may skip reference frames. Alternatively, the object motion detector OMD, or another module, may establish motion vectors for a reference frame on the basis of predicted frames which refer to the reference frame and which have motion vectors.

The object motion detector OMD provides an object motion indication MOI, a motion speed indication MSI, and a motion location indication MLI. The object motion indication MOI may be in the form of a binary value. For example, the binary value 1 (MOI=1) indicates that the frame of interest comprises a moving object of significance. Conversely, the binary value 0 (MOI=0) indicates that the frame does not comprise any moving object of significance. The motion speed indication may be in the form of a multi-bit value that is proportional to one or more motion vector lengths, which indicate the speed of the moving object. The motion location indication MLI may also be in the form of a multi-bit value that corresponds with a pixel block index BX, which indicates the location of the moving object. The object motion detector OMD will be described in greater detail hereinafter.

The sequence identifier ISQ identifies a sequence of frames that represents an object that moves relatively fast with respect to other objects. To that end, the sequence identifier ISQ checks three conditions on a frame-by-frame basis. Has the object motion indication MOI the binary value 1? Is the motion speed indication MSI is greater than the motion threshold value THM? Is the motion location indication MLI sufficiently similar to that for a previous frame?

A frame for which all three aforementioned conditions are met belongs to a sequence of frames that represents a fast moving object scene. Firstly, the frame comprises a moving object if the object motion indication MOI is 1. Secondly, the moving object moves relatively fast if the motion speed indication MSI is greater than the motion threshold value THM. Thirdly, the moving object is the same throughout the sequence if the motion location indication MLI for the frame is sufficiently similar to that for a previous frame. For example, in case that the motion location indication MLI corresponds with a block pixel index, the motion location indication MLI for the frame and that for the previous frame should indicate neighboring pixel blocks or the same pixel block.

A frame, for which the first two aforementioned conditions are met, constitutes the first frame of a sequence that represents a fast moving object scene, if that frame is preceded by a frame for which at least one of these two conditions is not met. Conversely, a
frame for which all three aforementioned conditions are met constitutes the last frame of a
sequence, if the frame is followed by a frame for which at least one of the three conditions is
not met.

The aforementioned can be illustrated with reference to FIG. 2A. Let it be
assumed that the object motion indication MOI for frame F[n] has the binary value 1 and that
the motion speed indication MSI is greater than the motion threshold value THM. Let it
further be assumed that the object motion indication MOI for frame F[n-1] has the binary
value 0. In that case, the sequence identifier ISQ identifies frame F[n] as the first frame of a
sequence of frames that represent a fast moving object. The same applies in the case where
the object motion indication MOI for frame F[n-1] has the binary value 1, but the object
motion indication MOI for that frame is below the motion threshold value THM.

Still referring to FIG. 2A, let it now be assumed that the object motion
indication MOI for each frame from F[n+1] until frame F[n+m] has the binary value 1, that
the motion speed indication MSI is greater than the motion threshold value THM, and that the
motion location indication MLI sufficiently similar to that for the previous frame. The
sequence of frames F[n], F[n+1], ..., F[n+m] represents a fast moving object. Let it further be
assumed that the object motion indication MOI for frame F[n+m+1] has the binary value 0. In
that case, the sequence identifier ISQ identifies frame F[n+m] as the last frame of the
sequence of frames that represent a fast moving object. The same applies in the case where
the object motion indication MOI for frame F[n+m+1] has the binary value 1, but the object
motion indication MOI for that frame is below the motion threshold value THM. The same
equally applies in the case where the motion location indication MLI for frame F[n+m+1] is
quite different from that for frame F[n+m].

The sequence identifier ISQ provides a first frame indication FF and a last
frame indication FL. These indications correspond with the frame indices FX of the first
frame and the last frame, respectively, of a particular sequence of frames that represents a fast
moving object.

The sequence definer DSQ defines a sequence of frames to be replayed on the
basis of the first frame indication FF and the last frame indication FL. In MPEG encoded
video data, a sequence of frames to be replayed preferably starts with an intra-coded frame (I-
frame) and ends with an I-frame or a predicted frame of the so-called P-type (P-frame). The
sequence definer DSQ identifies the first I-frame that precedes the frame that the first frame
indication FF indicates. The sequence definer DSQ further identifies the first I-frame or P-
frame, whichever comes first, that follows the frame that the last frame indication FL indicates.

The sequence definer DSQ provides the scene start indication SB and the scene end indication SE, which are applied to the control module CTRL as FIG. 1 illustrates. The scene start indication SB indicates the first I-frame that precedes the frame that the first frame indication FF indicates. The scene end indication SE indicates the first I-frame or P-frame, whichever applies, that follows the frame that the last frame indication FL indicates. The scene start indication SB and the scene end indication SE define the sequence of frames to be replayed, which represents a fast moving object scene. This sequence of frames comprises the sequence of frames that the sequence identifier ISQ has identified.

The sequence length detector SLD calculates a sequence length indication SL on the basis of the scene start indication SB and the scene end indication SE, which the sequence definer DSQ provides. The sequence length indication SL indicates how long the sequence of frames to be replayed lasts. The scene start indication SB and the scene end indication SE may each be in the form of, for example, a frame index. The sequence length detector SLD may then subtract the scene end indication SE from the scene start indication SB so as to obtain the sequence length indication SL in terms of numbers of frames.

The sequence length verifier SLV checks whether the sequence length indication SL is comprised between a minimum length value LMIN and a maximum length value LMAX or not. The sequence of frames to be replayed is considered too short if the sequence length indication SL is below the minimum length value LMIN. Replaying a relatively short sequence of frames, such as, for example, a sequence that lasts less than a few tenths of a second will generally appear unpleasant to the user. Conversely, the sequence of frames to be replayed is considered too long if the sequence length indication SL is above the maximum length value LMAX. Replaying a relatively long sequence of frames, such as, for example a sequence that lasts more than a few seconds will also generally appear unpleasant to the user. In this respect, it should be noted that the digital video recorder DVR may allow the user to define the minimum length value LMIN and the maximum length value LMAX, for example, in units seconds and tenths of seconds.

The sequence length verifier SLV provides a length validation LV, which indicates whether the sequence of frames to be replayed has an appropriate length. The length validation LV may be, for example, a binary value. The binary value is 1 (LV=1) if the sequence length indication SL is comprises between the minimum length value LMIN and the
maximum length value LMAX. The binary value is 0 (LV=0) if the sequence length indicator SL is outside this desired range.

The sequence distance detector SDD calculates a sequence distance indication SD on the basis of the scene start indication SB and the scene end indication SE[-1] of the most recently replayed sequence of frames. The previous sequence-end memory PSM provides the scene end indication SE[-1] of the most recently replayed sequence of frames. The sequence distance indication SD indicates how much time has gone by since the most recently replayed sequence of frames. It has been mentioned hereinbefore that the scene start indication SB and the scene end indication SE may each be in the form of, for example, a frame index FX. The sequence distance detector SDD may then subtract the scene start indication SB of the current sequence of frames to be replayed, from the scene end indication SE[-1] of the most recently replayed sequence of frames. In this example, the sequence distance indication SD indicates the relevant time that has gone by in terms of numbers of frames.

The sequence distance verifier SDV checks whether the sequence distance indication SD is above a minimum distance value DMIN, or equal thereto, or not. The sequence of frames to be replayed is considered too close to the most recently replayed sequence of frames if the sequence distance indication SD is below the minimum distance value DMIN. Replaying a sequence of frames shortly after replaying another sequence of frames, is generally unpleasant to the user. What is more, replaying a sequence of frames that represents a fast moving object scene should provide a funny, surprising effect. This funny, surprising effect will be lost if there are relatively many replays in a relatively short interval of time. The user may even get the impression that his or her digital video recording is not correctly operating. In this respect, it should be noted that the digital video recorder DVR may allowance the user to define the minimum distance value DMIN, for example, in units of minutes and seconds.

The sequence distance verifier SDV provides a distance validation DV, which indicates whether the sequence of frames to be replayed is sufficiently distant from the most recently replayed sequence of frames in terms of time elapsed. The distance validation DV may be, for example, a binary value. The binary value is 1 (DV=1) is the sequence distance indication SD is above the minimum distance value DMIN or equal thereto. The binary value is 0 (DV=0) if the sequence distance indication SD is below the minimum distance value DMIN.
The 2-and logic 2AND applies a logic and function to the length validation LV and the distance validation DV. Accordingly, the replay command RPL is obtained, which the special effect module SEM applies to the control module CTRL. FIG. 1 illustrates this. That is, the special effect module SEM applies the replay command RPL when the following two conditions are met. Firstly, the sequence of frames to be replayed has an appropriate length. Secondly, the sequence of frames to be replayed is sufficiently distant from the most recently replayed sequence of frames in terms of time elapsed. The special effect module SEM provides the scene start indication SB and the scene end indication SE in association with the replay command RPL.

The replay command RPL causes the previous sequence-end memory PSM to store the scene end indication SE, which is associated with the replay command RPL. This scene end indication SE replaces the scene end indication SE[-1] of the sequence of frames that was most recently replayed. The scene end indication SE of a sequence of frames that is currently replayed, will constitute the scene end indication SE[-1] of the most recently replayed sequence of frames when a subsequent sequence of frames representing a fast moving object is detected.

The motion threshold adapter MTA, which the special effect module SEM may optionally comprise, compares the scene end indication SE[-1] of the most recently replayed sequence of frames with the frame index FX of the current frame. Accordingly, the motion threshold adapter MTA can establish whether relatively much time has elapsed since the most recently replayed sequence of frames. For example, the motion threshold adapter MTA may establish that a quarter of an hour has passed since the most recently replayed sequence of frames. It is time, as it were, for a new sequence of frames to be replayed. To that end, the motion threshold adapter MTA may reduce the motion threshold value THM. A sequence of frames needs to comprise less motion in order for the sequence to qualify for replay. This increases the likelihood that a sequence of frames will be replayed within relatively short interval of time. Accordingly, the motion threshold adapter MTA can avoid that too much time elapses after the replay of a sequence of frames, which represents a fast moving object, before the replay of a subsequent sequence of frames of similar nature.

FIG. 4 illustrates a table with various motion vectors MV of a particular frame and pixel block indices BX associated therewith, which the object motion detector OMD receives. The table comprises P rows, P being an integer that corresponds with the number of motion vectors MV that belong to the frame of interest. Each row is numbered from 1 to P
and comprises a motion vector and a pixel block index associated therewith. The pixel block index indicates the pixel block to which the motion vector belongs.


FIG. 4 illustrates two groups of motion vectors MV. A top group comprises the S longest motion vectors MV, S being an integer smaller than P. The smallest motion vector in the top group is motion vector MV[P-S] with pixel block index BX[P-S] associated therewith in row P-S of the table. A bottom group comprises the Q smallest motion vectors MV, Q being an integer smaller than P. The longest motion vector in the bottom group is motion vector MV[Q] with pixel block index BX[Q] associated therewith in row Q of the table.

It has been mentioned hereinbefore that a reference frame generally does not comprise motion vectors. It has also been mentioned that the digital video recorder DVR can establish motion vectors for a reference frame as yet. In that case, FIG. 4 also applies to such motion vectors.

FIG. 5 illustrates the object motion detector OMD in the form of a functional diagram, similar to FIG. 3. The object motion detector OMD comprises a motion cluster detector MCD, an off-boundary motion detector BMD, a cluster coherence detector CHD, a local motion detector LMD, and a 4-and logic 4AND. It is assumed that the object motion detector OMD receives the motion vectors MV[P], .., MV[1] and the pixel block indices BX[P], .., BX[1] that FIG. 4 illustrates.

The object motion detector OMD operates as follows. The motion cluster detector MCD detects whether the respective pixel blocks that belong to the top group of motion vectors MV[P], MV[P-1], .., MV[P-S] form a cluster or not (= CLST ?). The motion cluster detector MCD can carry out this detection on the basis of the respective pixel block indices BX[P], BX[P-1], .., BX[P-S] associated with these motion vectors.

The motion cluster detector MCD provides a cluster indication CL, which may be in the form of a binary value. The binary value is 1 (CL=1) when the aforementioned respective pixel blocks form a cluster. The pixel blocks may represent an object that moves
relatively fast with respect to other objects. Conversely, the binary value of the cluster indication $CL$ is 0 ($CL=0$) when the aforementioned respective pixel blocks do not form a cluster. In that case, the pixel blocks are scattered over the frame of interest, as it were, and do therefore not represent a relatively fast moving object of significance.

The off-boundary motion detector BMD detects whether any of the respective pixel blocks that belong to the top group of motion vectors $MV[P], MV[P-1], .., MV[P-S]$ is at the boundary of the frame of interest or not ($\neq BRD$?). The off-boundary detector can carry out this detection on the basis of the respective pixel block indices $BX[P], BX[P-1], .., BX[P-S]$ associated with these motion vectors $MV$.

The off-boundary motion detector BMD provides an off-boundary indication $OB$, which may be in the form of a binary value. The binary value is 1 ($OB=1$) if none of the pixel blocks in the top group is at the boundary of the frame of interest. In that case, there may be one or more relatively fast moving objects in a central zone of the frame of interest. Conversely, the binary value of the off-boundary indication $OB$ is 0 ($OB=0$) when there is at least one pixel block that is at a boundary of the frame of interest. In that case, the pixel blocks may represent a relatively fast moving object that is at the boundary of the frame. In general, this is less noticeable and less interesting for the user. For that reason, it is preferable to ignore a relatively fast moving object at a boundary of the frame.

The cluster coherence detector CHD verifies whether the motion vectors $MV[P], MV[P-1], .., MV[P-S]$ that are in the top group are of sufficiently similar length. To that end, the cluster coherence detector CHD verifies the following condition. Has the smallest motion vector $MV[P-S]$ of the top group a length equal to or greater than $X\%$ the length of the longest motion vector $MV[P]$, or not? In this condition ($MV[P-S] \geq X\% \times MV[P]$ ?), $X$ is an integer representing a percentage.

The cluster coherence detector CHD provides a cluster coherence indication $CO$, which may be in the form of a binary value. The binary value is 1 ($CO=1$) if the aforementioned condition is met. In that case, it is likely that each pixel blocks for which the motion vectors $MV[P], MV[P-1], .., MV[P-S]$ are in the top group, represent an object, or a set of objects, which moves relatively fast. The binary value is 0 ($CO=0$) if the aforementioned condition is not met. In that case, it may be that only a few pixel blocks of the top group represent a relatively fast moving object. This means that the relatively fast moving object is relatively small and, therefore, less noticeable and less interesting to user. For that reason, it is preferable to ignore a relatively fast moving object of insignificant size.
The local motion detector LMD detects whether there is local motion or global motion within the frame of interest. To that end, the local motion detector LMD verifies the following condition. Has the largest motion vector MV[Q] of the bottom group a length equal to or smaller than Y% the length of the longest motion vector MV[P], or not? In this condition \((MV[Q] \leq Y\% \ MV[P])\), Y is an integer representing a percentage.

The local motion detector LMD provides a local motion indication LM, which may be in the form of a binary value. The binary value is 1 (LM=1) if the aforementioned condition is met. In that case, a portion of the frame of interest comprises an object, or a set of objects, that have little motion, or are even stationary. The portion of the frame corresponds with the pixel blocks for which the motion vectors MV are in the bottom group. In this case, there is a portion of the frame that moves, as it were, and a portion of the frame that is stationary. There is a motion contrast, which may be noticeable and interesting to user and which may therefore deserve a replay.

The binary value of the local motion indication LM is 0 (LM=0) if the aforementioned condition is not met. In that case, it may be that all objects within the frame of interest move, or that nearly all the objects move. There is no motion contrast, or there is insufficient motion contrast. Camera motion may cause such a global motion where all the objects move. Replay of global motion is generally less interesting and may even be annoying. For that reason, it is preferable to ignore a global motion.

The 4-and logic 4AND applies a logic and function to the cluster indication CL, the off-boundary indication OB, the cluster coherence indication CO, and the local motion indication LM. Accordingly, the object motion indication MOI is obtained, which the object motion detector OMD applies to the sequence identifier ISQ. FIG. 3 illustrates this. That is, the object motion indication MOI has the binary value 1 when the following four conditions are met. Firstly, the respective pixel blocks of the S largest motion vectors MV[P], \(\ldots\), MV[P-S] form a cluster. Secondly, none of these pixel blocks are at a boundary of the frame of interest. Thirdly, the S but the largest motion vector MV[P-S] has length that is at least X% of the length of the largest motion vector MV[P]. Fourthly, the Q but the largest motion vector MV[Q] has length that does not exceed Y% of the length of the largest motion vector MV[P].

The combination of the aforementioned first, third, and fourth condition being met, corresponds with the following case. The frame of interest comprises a homogeneous area of motion. This relates to the first condition. The homogeneous area of motion is not too small. This relates to the third condition. The homogeneous area of motion is neither too
large, which relates to the fourth condition. The second condition being met corresponds with the exclusion of a homogeneous area of motion, if any, which is in a boundary zone of the frame of interest.

The object motion detector OMD further provides the motion speed indication MSI and the motion location indication MLI, which FIG. 3 illustrates. The motion speed indication MSI may correspond with, for example, the longest motion vector MV[P] of the frame of interest. As another example, the motion speed indication MSI may correspond with the smallest motion vector MV[P-S] in the top group, which FIG. 4 illustrates. The motion location indication MLI may correspond with, for example, the pixel block index BX of a pixel block that has a central position in the cluster formed by the pixel blocks that belong to the top group of motion vectors MV[P], MV[P-1], .., MV[P-S].

The special effect module SEM, which FIG. 1 illustrates, may analyze the video input data VI in the recording mode. The special effect module SEM may also analyze the encoded video output data VOC, which is read from the disk DSK, in the playback mode. In either case, the object motion detector OMD is in active mode, whereas the other functions of the object motion detector OMD may be in a passive mode. The object motion detector OMD provides respective object motion indications MOI, motion speed indications MSI, and motion location indications MLI for respective frames in the video input data VI or the encoded video output data VOC, whichever is the case. The digital video recorder DVR stores these indications in a memory. Alternatively, the digital video recorder DVR may store a subset of these indications or certain type of indications only.

The digital video recorder DVR may establish appropriate values for one or more parameters of the special effect module SEM on the basis of the indications that have been stored as described hereinbefore. For example, the control module CTRL of the digital video recorder DVR may calculate an appropriate motion threshold value THM. An appropriate motion threshold value THM causes the replay command RPL to occur not too often, on the one hand, and not too sporadic, on the other hand. For example, an appropriate threshold value causes the replay command RPL to occur every five minutes.

The user may define a desired average rate of the replay command RPL via, for example, the remote control device RCD. The digital video recorder DVR then calculates the motion threshold value THM that provides the desired average rate. This calculation is based on the object motion indications MOI and the motion speed indications MSI, which has been obtained through analysis of the video data of interest. The motion location indications MLI may also be taken into account. The motion threshold value THM will be relatively low if, on
average, motion in the video data is relatively slow. Conversely, the motion threshold value THM will be relatively high if, on average, motion in the video is relatively fast.

The digital video recorder DVR may also calculate various different motion threshold values THM, each value applying to a particular segment of the video data. A relatively low motion threshold value THM may apply to a segment with relatively slow motion. A relatively high motion threshold value THM may apply to a segment with relatively fast motion.

The digital video recorder DVR may use the indications, which have been obtained through analysis of the video data of interest, to calculate values for other parameters of the special effect module SEM: the minimum length value LMIN, the maximum length value LMAX and the minimum distance value DMIN, which are some examples. The digital video recorder DVR may store one or more parameters for the special effect module SEM in association with a particular video data to which the one or more parameters relate. The digital video recorder DVR retrieves the one or more parameters thus stored and applies those to the special effect module SEM one the particular video data is read from the disk DSK.

The digital video recorder DVR may also generate replay markers on the basis of the indications, which have been obtained through analysis of the video data of interest. These replay markers mark respective sequences of frames. The digital video recorder DVR may write these replay markers on the disk DSK, so as to cause each respective sequence of frames to be replayed. This replay may be subject to the user having enabled the special effect mode. This replay may also occur when another digital video recorder DVR plays back the disk DSK, provided that the other digital video recorder DVR has been provided with suitable hardware or software, or both. The digital video recorder DVR may also store the replay markers in a memory in association with the disk DSK. This allows the digital video recorder DVR to replay each respective sequence of frames that has been marked, without any replay markers on the disk DSK itself.

CONCLUDING REMARKS

The detailed description hereinbefore with reference to the drawings illustrates the following characteristics, which are cited in claim 1. A video apparatus (DVR) comprises a detection module (combination of object motion detector OMD and sequence identifier ISQ). The detection module (OMD, ISQ) detects, in original video data (on the disk DSK), a
sequence of images \((F[n], F[n+1], ..., F[n+m])\) that represents an object that moves relatively fast with respect to other objects.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 2. The detection module (OMD, ISQ) forms part of a special effect module (SEM) that causes at least one replay \((R[1], ..., R[k])\) of the sequence of images \((F[n], F[n+1], ..., F[n+m])\) so as to obtain video output data (VO) that comprises the original video data and, in addition, the at least one replay \((R[1], ..., R[k])\) of the sequence of images \((F[n], F[n+1], ..., F[n+m])\) subsequent to the sequence of images \((F[n], F[n+1], ..., F[n+m])\).

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 3. The video apparatus comprises a video processor (encoding-and-decoding module CODEC) that provides respective motion vectors (MV) for respective pixel blocks in an image. The detection module (OMD, ISQ) detects the sequence of images \((F[n], F[n+1], ..., F[n+m])\) on the basis of the respective motion vectors (MV). This allows low-cost implementations.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 4. The detection module (OMD, ISQ) verifies that, in an image, the pixel blocks that have the \(S\) longest motion vectors (MV) form a cluster, \(S\) being an integer (motion cluster detector MCD carries out this verification). This contributes to a reliable detection of an action scene.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 5. The detection module (OMD, ISQ) verifies that the cluster, which the \(S\) longest motion vectors (MV) form, is not at a boundary of the image (off-boundary motion detector BMD carries out this verification). This prevents replay of a scene with motion in a boundary of the image only, which generally is less interesting to a viewer.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 6. The detection module (OMD, ISQ) verifies that, in an image, there are at least \(Q\) motion vectors (MV) which are relatively small compared with the \(S\) longest motion vectors (MV), \(Q\) and \(S\) being integers (local motion detector LMD carries out this verification). This contributes to a reliable detection of an action scene.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 7. The detection module (OMD, ISQ) establishes a motion speed indication (MSI) on the basis of the \(S\) longest motion vectors (MV) and verifies
that the motion speed indication (MSI) is greater than a motion threshold value (THM). This contributes to a reliable detection of an action scene.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 8. A sequence length verifier (SLV) verifies that the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \), which the detection module (OMD, ISQ) has detected, corresponds with an interval of time that is comprised in a desired range of intervals of time (\( LMIN \leq SL \leq LMAX \)). This avoids replay of actions scenes that are relatively short and relatively long. A viewer will generally consider the replay of such an action scene as unpleasant. Consequently, the aforementioned characteristics contribute to user satisfaction.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 9. The special effect module (SEM) establishes a sequence distance indication (SD), which is representative of a time interval between the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \) that has been detected and the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \) that has most recently been caused to replay. The special effect module (SEM) verifies that the sequence distance indication (SD) is greater than a minimum distance value (DMIN). This avoids replay of actions scenes that are relatively close to each other. A viewer will generally consider the replay of such an action scene as unpleasant. Consequently, the aforementioned characteristics contribute to user satisfaction.

The detailed description hereinbefore further illustrates the following optional characteristics, which are cited in claim 10. The video apparatus (DVR) comprises a control module (CTRL) that stores a location indication (SB, SE) and a motion indication when the detection module (OMD, ISQ) has detected a sequence of images. The location indication (SB, SE) indicates the location of the sequence of images in the original video data. The motion indication (MSI) indicates the motion of the object that moves relatively fast. The control module (CTRL) establishes at least one criterion, which determines whether a particular sequence of images will be replayed or not, on the basis of respective location indications (SB, SE) and respective motion indications (MSI) of respective sequences of images that the detection module (OMD, ISQ) has detected. This allows adaptation of action replay with regard to a particular original video input data, which may comprise relatively much action or which may comprises relatively few action.

The aforementioned characteristics can be implemented in numerous different manners. In order to illustrate this, some alternatives are briefly indicated.

The video apparatus may be any type of video apparatus, such as, for example a set-top box, a television set, a personal computer, a personal digital assistant, or a mobile
phone. Moreover, any source may provide the original video data. A disk is merely an example.

Let it be assumed, for example, that the video apparatus is a set-top box, which has a video memory. A cable network program may provide original video data in real time. At the beginning of a viewing session, a viewer watches the original video data in real time. The set-top box detects a sequence of frames that comprises an object that moves relatively fast with respect to other objects. The set-top box replays the sequence of frames one or more times. This replay causes the viewing session to be time shifted if, subsequent to the replay, the original video data is continued without any skipping of frames. The video memory of the set-top box can accommodate for this time shift, as well as for any further time shift due to any further replay of a particular scene. The video memory may be any type of memory. For example, the video memory may be a solid state memory, which comprises at least one memory chip.

There are numerous manners to implement the detection module in accordance with the invention. FIG. 5 merely illustrates an example. For example, it is possible to leave out one or more of the functions that FIG. 5 illustrates in the form of blocks. It is also possible to replace a function, which FIG. 5 illustrates, by another function. The same remarks apply to the special effect module, which FIG. 3 illustrates. For example, leaving out the sequence length detector and the sequence length verifier simplifies the special effect module.

Conversely, it is possible to add another criterion on which the replay of a particular sequence of frames depends. The same remarks apply to the identification of a sequence of images that represents a relatively fast moving object, which may be based on more or fewer conditions. For example, the sequence identifier ISQ, which FIG. 3 illustrates, may ignore the motion location indication MLI, in which case the object motion detector OMD does not have to provide this indication. This simplifies the special effect module.

It should be noted that detection of fast moving object scenes in accordance with the invention can be used for purposes other than replay. For example, the digital video apparatus may make a compilation of such scenes. The compilation can be regarded as an action abstract of the video data of interest. Accordingly, the user can quickly and conveniently see what action the video data of interest comprises. Numerous other editing functions are possible based on the detection of fast moving object scenes.

The terms "frame" and "image" should be understood in a broad sense. These terms are exchangeable and include a field or any other entity that may wholly or partially constitute an image or picture.
There are numerous ways of implementing functions by means of items of hardware or software, or both. In this respect, the drawings are very diagrammatic, each representing only one possible embodiment of the invention. Thus, although a drawing shows different functions as different blocks, this by no means excludes that a single item of hardware or software carries out several functions. Nor does it exclude that an assembly of items of hardware or software or both carry out a function.

The remarks made herein before demonstrate that the detailed description with reference to the drawings, illustrate rather than limit the invention. There are numerous alternatives, which fall within the scope of the appended claims. Any reference sign in a claim should not be construed as limiting the claim. The word “comprising” does not exclude the presence of other elements or steps than those listed in a claim. The word “a” or “an” preceding an element or step does not exclude the presence of a plurality of such elements or steps.
Claims.

1. A video apparatus (DVR) comprising:
   - a detection module (OMD, ISQ) arranged to detect, in original video data, a sequence of images \(F[n], F[n+1], \ldots, F[n+m]\) that represents an object that moves relatively fast with respect to other objects.

2. A video apparatus as claimed in claim 1, the detection module (OMD, ISQ) forming part of a special effect module (SEM) arranged to cause at least one replay \(R[1], \ldots, R[k]\) of the sequence of images \(F[n], F[n+1], \ldots, F[n+m]\) so as to obtain video output data (VO) that comprises the original video data and, in addition, the at least one replay \(R[1], \ldots, R[k]\) of the sequence of images \(F[n], F[n+1], \ldots, F[n+m]\) subsequent to the sequence of images \(F[n], F[n+1], \ldots, F[n+m]\).

3. A video apparatus as claimed in claim 1 comprising a video processor (CODEC) that provides respective motion vectors (MV) for respective pixel blocks in an image, the detection module (OMD, ISQ) being arranged to detect the sequence of images \(F[n], F[n+1], \ldots, F[n+m]\) on the basis of the respective motion vectors (MV).

4. A video apparatus as claimed in claim 2, the detection module (OMD, ISQ) being arranged to verify that, in an image, the pixel blocks that have the S longest motion vectors (MV) form a cluster, S being an integer.

5. A video apparatus as claimed in claim 3, the detection module (OMD, ISQ) being arranged to verify that the cluster, which the S longest motion vectors (MV) form, is not at a boundary of the image.

6. A video apparatus as claimed in claim 2, the detection module (OMD, ISQ) being arranged to verify that, in an image, there are at least Q motion vectors (MV) which are relatively small compared with the S longest motion vectors (MV), Q and S being integers.

7. A video apparatus as claimed in claim 2, the detection module (OMD, ISQ) being arranged to establish a motion speed indication (MSI) on the basis of the S longest
motion vectors (MV) and to verify that the motion speed indication (MSI) is greater than a motion threshold value (THM).

8. A video apparatus as claimed in claim 1 comprising a sequence length verifier (SLV) being arranged to verify that the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \), which the detection module (OMD, ISQ) has detected, corresponds with an interval of time that is comprised in a desired range of intervals of time.

9. A video apparatus as claimed in claim 2, the special effect module (SEM) being arranged to establish a sequence distance indication (SD), which is representative of a time interval between the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \) that has been detected and the sequence of images \( F[n], F[n+1], \ldots, F[n+m] \) that has most recently been caused to replay, the special effect module (SEM) being further arranged to verify that the sequence distance indication (SD) is greater than a minimum distance value (DMIN), or equal thereto.

10. A video apparatus as claimed in claim 2, the video apparatus comprising a control module (CTRL) being arranged to store a location indication (SB, SE) and a motion indication (MSI) when the detection module (OMD, ISQ) has detected a sequence of images, the location indication (SB, SE) indicating the location of the sequence of image in the original video data and the motion indication (MSI) indicating the motion of the object that moves relatively fast, the control module (CTRL) being further arranged to establish at least one criterion, which determines whether a particular sequence of images will be replayed or not, on the basis of respective location indications (SB, SE) and respective motion indications (MSI) of respective sequences of images that the detection module (OMD, ISQ) has detected.

11. A method of editing original video data, the method comprising:
   - a detection step (OMD, ISQ) in which a sequence of images \( F[n], F[n+1], \ldots, F[n+m] \) that represents an object that moves relatively fast with respect to other objects is detected in the original video data.

12. A method as claimed in claim 11 comprising:
- a special effect step (SEM) in which at least one replay (R[1], .., R[k]) of the sequence of images (F[n], F[n+1], .., F[n+m]) is caused so as to obtain video output data (VO) that comprises the original video data and, in addition, the at least one replay (R[1], .., R[k]) of the sequence of images (F[n], F[n+1], .., F[n+m]) subsequent to the sequence of images (F[n], F[n+1], .., F[n+m]).

13. A computer program product for a video apparatus (DVR) arranged to edit original video data, the computer program product comprising a set of instructions that, when loaded into the video apparatus, causes the video apparatus to carry out:
- a detection step (OMD, ISQ) in which a sequence of images (F[n], F[n+1], .., F[n+m]) that represents an object that moves relatively fast with respect to other objects is detected in the original video data.

14. A computer program product method as claimed in claim 13, comprising a further set of instructions that causes the video apparatus to carry out:
- a special effect step (SEM) in which at least one replay (R[1], .., R[k]) of the sequence of images (F[n], F[n+1], .., F[n+m]) is caused so as to obtain video output data (VO) that comprises the original video data and, in addition, the at least one replay (R[1], .., R[k]) of the sequence of images (F[n], F[n+1], .., F[n+m]) subsequent to the sequence of images (F[n], F[n+1], .., F[n+m]).

15. A video display system (VDS) comprising a video apparatus (DVR) as claimed in claim 1, and a display device (DPL) arranged to display the video output data (VO) that the video apparatus (DVR) provides.
<table>
<thead>
<tr>
<th></th>
<th>MV</th>
<th>BX</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>MV[P]</td>
<td>BX[P]</td>
</tr>
<tr>
<td>P-1</td>
<td>MV[P-1]</td>
<td>BX[P-1]</td>
</tr>
<tr>
<td>P-S</td>
<td>MV[P-S]</td>
<td>BX[P-S]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MV</th>
<th>BX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>MV[Q]</td>
<td>BX[Q]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MV</th>
<th>BX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MV[1]</td>
<td>BX[1]</td>
</tr>
</tbody>
</table>

**FIG. 4**