

A Video Streaming System

Field of the Invention

- 5 The present invention relates to a video streaming system and to a streaming device for use with a video streaming system.

Background of the Invention

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Various types of video streaming methodologies exist, including the following:

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“Direct streaming” wherein video data indicative of video information is streamed from a server device to a client device in real time, that is, the video data is streamed without buffering;

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“Progressive streaming” wherein some of the video data is buffered at the client side prior to commencing display of the video information;

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“Multi-rate streaming” wherein the bitrate of the streamed video data is modified according to the capacity of the communication path between the video server and the client device; and

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“Adaptive streaming” wherein some of the video data is buffered at the client side prior to commencing display of the video information, and the bitrate of the streamed video data is modified according to the capacity of the communication path between the video server and the client device.

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It is known to provide a video streaming system that includes at least one video camera, a video recording device arranged to store video data indicative of video

information captured by the video camera, a client device, and a communications network arranged to facilitate communications between the video recording device and the client device. Under control of the client device, video
5 data may be streamed from the video recording device to the client device for viewing at the client device.

Typically, the video recording device is in the form of a digital video recorder (DVR), and the DVR and client
10 device are configured so that the DVR and the client device are able to communicate directly with each other, for example using proprietary protocols. For a multi-rate or adaptive type streaming system, the DVR and client device may be arranged to communicate with each other so
15 that the DVR uses the most appropriate bitrate for the capacity of the communications path between the DVR and the client device.

While operation of this type of video streaming system is
20 generally satisfactory, the system is dependent on the DVR in order to provide multi-rate or adaptive streaming. In addition, since each type of DVR typically has a dedicated client device, the system can become overly cumbersome for a user if multiple types of DVR device are required to be
25 monitored by the user because multiple client devices are required.

Summary of the Invention

30 In accordance with a first aspect of the present invention, there is provided a video streaming system comprising:

a primary video streaming device capable of communicating with a digital video recorder (DVR) and a
35 data storage device arranged to store video data, such that video data is receivable from the DVR and/or from the data storage device; and

a secondary video streaming device arranged to communicate with the primary video streaming device through a communications network;

the primary video streaming device arranged to stream
5 video data to the secondary video streaming device, and
the secondary video streaming device arranged to
communicate the streamed video data to a video viewing
device.

10 In one embodiment, the primary streaming device comprises
an encoder arranged to modify the bitrate of video data.
The bitrate of video data produced by the encoder may be
determined in response to a bitrate communication received
by the primary streaming device, the bitrate communication
15 indicative of the best bitrate possible for video
communications between the primary streaming device and
the secondary streaming device.

In one embodiment, the primary streaming device comprises
20 a buffer for buffering video data received from the DVR
and/or from the data storage device.

In one embodiment, the video streaming system comprises a
DVR. The DVR may comprise an application programming
25 interface (API) arranged to facilitate communications with
the DVR.

In one embodiment, the DVR is arranged to modify the
bitrate of video data based on the bitrate communication
30 received at the DVR using the API.

In one embodiment, the DVR is not capable of modifying the
bitrate of video data, and the bitrate of video data is
modified by the primary streaming device based on the
35 bitrate communication.

In one embodiment, the DVR does not comprise an

application programming interface (API), the DVR is not capable of modifying the bitrate of video data, and the primary streaming device is directly connected to the data storage device so as to receive video data from the data storage device.

In one embodiment, the DVR comprises the data storage device.

In one embodiment, the DVR is separate to the data storage device and the DVR is connected to the data storage device.

In one embodiment, the DVR comprises an IP camera.

In one embodiment, the video streaming system comprises at least one video camera, each video camera connected to a DVR.

In one embodiment, the video streaming system comprises a plurality of primary streaming devices, each primary streaming device capable of communicating with a DVR and a data storage device arranged to store video data, such that video data is receivable from the DVR and/or from the data storage device.

In one embodiment, the video viewing device comprises a computing device. The computing device may be arranged to implement a video viewing client usable by an operator to control video data received from the DVR and/or from the data storage device. The video viewing client may be arranged to enable an operator to select the start and end times of the video data received from the DVR and/or from the data storage device.

In one embodiment, the video streaming system is arranged to compress video data streamed from the primary video

streaming device to the secondary video streaming device.

The video streaming system may be arranged to compress video data by storing information indicative of an entire video image at the primary and secondary video streaming devices and transmitting information indicative of changes to the video image from the primary streaming device to the secondary streaming device.

10 In one embodiment, the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices at periodic intervals.

15 In one embodiment, the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices every hour.

20 In one embodiment, the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices when information indicative of a current video image differs significantly from information indicative of the stored video image.

In accordance with a second aspect of the present invention, there is provided a primary video streaming device capable of communicating with a digital video recorder (DVR) and a data storage device arranged to store video data, such that video data is receivable from the DVR and/or from the data storage device;

the primary video streaming device arranged to:
communicate through a communications network with a secondary video streaming device arranged to communicate the streamed video data to a video viewing device.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the accompanying drawing
5 in which Figure 1 is a schematic diagram of a video streaming system in accordance with an embodiment of the present invention.

Description of an Embodiment of the Invention

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Referring to Figure 1 of the drawings, there is shown a video streaming system 10 for streaming video from one or more video cameras 12, 12', 12'' to a video viewing device 14. In this example, the video viewing device 14
15 comprises a video viewing client 15 implemented on a computing device which may be a personal computer, tablet computer, smartphone, or any other suitable device capable of implementing a viewing client.

20 The system 10 includes at least one video recording device, in this example a digital video recorder (DVR) 16, 16', 16'' arranged to receive video data produced by one or more video cameras 12, 12', 12''. In this example, 3 digital video recorders (DVR) 16, 16', 16'' are provided
25 of differing types.

A first DVR 16 is of a type having an application programming interface (API) arranged to enable direct communication with the DVR 16. The first DVR 16 is also
30 arranged such that the first DVR 16 is able to produce video data of varying bitrate, with the bitrate being selectable using the API.

A second DVR 16' is of a type having an API arranged to
35 enable direct communication with the second DVR 16', but which is capable of producing video data of fixed bitrate only.

A third DVR 16'' is of a type that does not have an API and, accordingly, direct communication with the third DVR 16'' is not possible.

- 5 In this example, each DVR 16, 16', 16'' is disposed at a different location and the field of view of each camera 12, 12', 12'' is different.

Each of the DVRs 16, 16', 16'' has an associated data
10 storage device 18 arranged to store video data produced by the DVR 16, 16', 16'', and each DVR 16, 16', 16'' includes a video decoder 20, 20', 20'' arranged to receive raw video data from each of the connected cameras 12, 12', 12'' and decode the raw video data, and a video processor
15 22, 22', 22'' arranged to control and coordinate operations in the DVR 16, 16', 16''. For some DVRs, the video processor 22, 22', 22'' is also arranged to produce video data in a format suitable for streaming to the video client 14.

20 Each DVR 16, 16', 16'' is associated with a primary streaming device 24, 24', 24'' arranged to receive video data from a DVR 16, 16', 16'' and produce video data for streaming to a secondary streaming device 26 connected to
25 the video viewing device 14. The first and second streaming devices 24, 26 communicate with each other through a communications network 28, in this example the Internet.

30 Each primary streaming device 24, 24', 24'' includes a control unit 30, 30', 30'' for controlling and coordinating operations in the primary streaming device 24, 24', 24'', an encoder 32, 32', 32'' arranged to enable the primary streaming device to encode video data so that
35 the bitrate of the video data is suitable for transferring through the communication path between the first and

second video streaming device 24, 26. Each primary streaming device also includes a buffer 34 that enables received video data to be buffered, in particular when the encoder 32 is used to modify the bitrate of the video information.

It will be understood that each primary streaming device 24, 24', 24'' is capable of interfacing with multiple DVR types and capable of interacting directly with a data storage device 18. In this way, each primary streaming device 24 is capable of receiving video data from multiple types of DVR and/or from a data storage device 18.

In this example, the first DVR 16 is of a type capable of providing video data of variable bitrate, and has an API that may be used by a primary streaming device to communicate with the first DVR 16, in particular to instigate video streaming and control the bitrate of the video data produced by the first DVR 16. The first primary streaming device 24 connected to the first DVR 16 is configured so as to communicate with the API of the first DVR 16 to select the desired bitrate for the video data, and to stream the video data received from the first DVR 16 to the secondary streaming device 26 through the Internet 28 without buffering and without the need to modify the video data using the encoder 32.

In this example, the second DVR 16' is of a type capable of providing video data of fixed bitrate only, and has an API that may be used by a primary streaming device 24, 24', 24'' to communicate with the second DVR 16', in particular to instigate video streaming. The second primary streaming device 24' connected to the second DVR 16' is configured so as to communicate with the API of the second DVR 16' so as to instigate video streaming, and to subsequently stream video data to the secondary streaming device 26 through the Internet 28. The second primary

streaming device 24' is also configured to buffer video data received from the second DVR 16' in the buffer 34', and to modify the video data using the encoder 32' so as to produce video data having a bitrate suitable for
5 streaming to the secondary streaming device 26.

In this example, the third DVR 16'' is of a type capable of providing video data of fixed bitrate only, and does not have an API. Consequently, it is not possible to
10 communicate directly with the third DVR 16''. The third primary streaming device 24'' connected to the third DVR 16'' is configured so as to communicate directly with the data storage device 18'' associated with the third DVR 16'' so as to instigate video streaming directly from the
15 data storage device 18''. The third primary streaming device 24'' is also configured to buffer video data received from the data storage device 18'' in the buffer 34', and to modify the video data using the encoder 32'' so as to produce video data having a bitrate suitable for
20 streaming to the secondary streaming device 26.

In order that the best bitrate may be selected to use for streaming video data from a primary streaming device 24, 24', 24'' to the secondary streaming device 26, the
25 secondary streaming device includes a flow control device 40 arranged to communicate with a control unit 30, 30', 30'' of a primary streaming device 24, 24', 24'', and to determine the best bitrate that the communication path between the primary streaming device 24, 24', 24'' and the
30 secondary streaming device 26 is capable of supporting. The determined best bitrate is then used by the relevant DVR, if the DVR supports adaptive streaming, or by the relevant primary streaming device 24, 24', 24'', if the DVR does not support adaptive streaming, to stream video
35 data to the secondary streaming device 26.

In addition to video encoding techniques, the system 10

may also be arranged to utilize video compression techniques in order to minimize demand on bandwidth between the primary and secondary streaming devices 24, 26. For this purpose, each primary streaming device 24, 24', 24'' may include a flow control device 42 and a memory 44, and the secondary streaming device 26 may include a memory 46.

According to conventional video compression techniques, a key frame representative of an entire video image is transmitted across a communications network, and between transmissions of the key frames intermediate frames are transmitted. Each intermediate frame is indicative of changes to the last transmitted key frame and, as such, since the intermediate frame relates only to changes, the size of the intermediate frame is generally significantly less than a key frame.

With the present system, in one embodiment, a dictionary key frame d_i representative of an entire video image is stored periodically, for example every hour, in the memory 44 of the primary streaming device 24 by the flow control device 42 of the primary streaming device 24. The dictionary key frame d_i is transmitted to the secondary streaming device 26, and stored in the memory 46 by the flow control device 40 of the secondary streaming device 26. Between storage of the dictionary key frames d_i at the primary and secondary streaming devices 24, 26, a difference frame *diff* is calculated using a current video frame KF and the current stored dictionary key frame d_i , and transmitted to the secondary streaming device 26. At the secondary streaming device 26, the flow control device 40 uses the stored dictionary key frame d_i and the received difference frame *diff* to recreate the current frame.

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If a significant change occurs between storage of dictionary key frames d_i such that the current key frame KF

varies significantly from the current stored dictionary key frame d_i , then the flow control device 40 of the primary streaming device 24 overwrites the current dictionary key frame d_i with a current key frame KF
5 representative of an entire video image. This in turn causes the dictionary key frame d_i stored at the secondary streaming device 26 to also be updated with the new current dictionary key frame d_i .

10 In a variation of the above video compression technique, the flow control device 42 of the primary streaming device 42 does not periodically store dictionary key frames d_i in the memory 44, but instead only replaces the stored dictionary key frames d_i in the memories 44, 46 of the
15 primary and secondary streaming devices 24, 26 when an update is activated, for example because significant changes have occurred such that the current key frame KF differs considerably from the stored dictionary key frames d_i .

20 However, it will be understood that other video compression techniques may be used.

During use, an operator at the computing device 14
25 operates a video viewing client 15 implemented by the computing device 14 to select the camera(s) 12 that correspond to the desired video that the operator wishes to view. The operator also selects the desired start and finish times for the desired video.

30 After video footage has been selected by an operator, the flow control device 40 of the secondary streaming device 26 communicates with the primary streaming device 24, 24', 24'' associated with the desired video, and using the
35 communications the flow control device 40 determines the best bitrate that is possible for video streaming between the primary streaming device 24, 24', 24'' and the

secondary streaming device 26. The determined bitrate is then communicated to the primary streaming device 24, 24', 24''.

5 If video footage associated with the first DVR 16 is selected for viewing by the operator, the first primary streaming device 24 communicates the required bitrate to the first DVR 16 through the API of the first DVR 16, and the first DVR 16 then extracts the required video data
10 from the first data storage device 18 and converts the video data so that the bitrate corresponds to the desired bitrate. The converted video data is communicated through the first primary streaming device 24 to the secondary streaming device 26 through the Internet 28, and to the
15 computing device 14. At the computing device 14, the viewing client displays video representative of the video data to the operator.

If video footage associated with the second DVR 16' is
20 selected for viewing by the operator, the second primary streaming device 24' communicates directly with the second data storage device 18' through the API of the second DVR 16', and extracts the required video data from the second data storage device 18'. Since the second primary
25 streaming device 24' is not capable of modifying the bitrate of video data, the second primary streaming device 24' converts the video data so that the bitrate corresponds to the desired bitrate, and communicates the converted video data to the secondary streaming device 26
30 through the Internet 28, and to the computing device 14. At the computing device 14, the viewing client displays video representative of the video data to the operator.

If video footage associated with the third DVR 16'' is
35 selected for viewing by the operator, the third primary streaming device 24'' communicates directly with the third data storage device 18'' and extracts the required video

data from the data storage device 18. The third primary streaming device 24'' then converts the video data so that the bitrate corresponds to the desired bitrate, and communicates the converted video data to the secondary
5 streaming device 26 through the Internet 28, and to the computing device 14. At the computing device 14, the viewing client displays video representative of the video data to the operator.

10 It will be appreciated that by providing a versatile primary streaming device that is capable of interfacing with multiple types of DVR and directly with a data storage device, and a secondary streaming device arranged to communicate with the primary streaming device and
15 interfaceable with a viewing client, it is possible for an operator to monitor multiple cameras associated with multiple types of DVR using a single viewing client.

Modifications and variations as would be apparent to a
20 skilled addressee are deemed to be within the scope of the present invention.

Claims:

1. A video streaming system comprising:
a primary video streaming device capable of
5 communicating with a digital video recorder (DVR) and a
data storage device arranged to store video data, such
that video data is receivable from the DVR and/or from the
data storage device; and
a secondary video streaming device arranged to
10 communicate with the primary video streaming device
through a communications network;
the primary video streaming device arranged to stream
video data to the secondary video streaming device, and
the secondary video streaming device arranged to
15 communicate the streamed video data to a video viewing
device.
2. A video streaming system as claimed in claim 1,
wherein the primary streaming device comprises an encoder
20 arranged to modify the bitrate of video data.
3. A video streaming system as claimed in claim 2,
wherein the bitrate of video data produced by the encoder
is determined in response to a bitrate communication
25 received by the primary streaming device, the bitrate
communication indicative of the best bitrate possible for
video communications between the primary streaming device
and the secondary streaming device.
- 30 4. A video streaming system as claimed in claim 3,
wherein the primary streaming device comprises a buffer
for buffering video data received from the DVR and/or from
the data storage device.
- 35 5. A video streaming system as claimed in claim 3,
comprising a DVR.

6. A video streaming system as claimed in claim 5, wherein the DVR comprises an application programming interface (API) arranged to facilitate communications with the DVR.

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7. A video streaming system as claimed in claim 6, wherein the DVR is arranged to modify the bitrate of video data based on the bitrate communication received at the DVR using the API.

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8. A video streaming system as claimed in claim 6, wherein the DVR is not capable of modifying the bitrate of video data, and the bitrate of video data is modified by the primary streaming device based on the bitrate communication.

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9. A video streaming system as claimed in claim 5, wherein the DVR does not comprise an application programming interface (API), the DVR is not capable of modifying the bitrate of video data, and the primary streaming device is directly connected to the data storage device so as to receive video data from the data storage device.

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10. A video streaming system as claimed in any one of claims 5 to 9, wherein the DVR comprises the data storage device.

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11. A video streaming system as claimed in any one of claims 5 to 9, wherein the DVR is separate to the data storage device and the DVR is connected to the data storage device.

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12. A video streaming system as claimed in claim 10 or claim 11, wherein the DVR comprises an IP camera.

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13. A video streaming system as claimed in any one of

claims 5 to 11, comprising at least one video camera, each video camera connected to a DVR.

14. A video streaming system as claimed in any one of the
5 preceding claims, comprising a plurality of primary
streaming devices, each primary streaming device capable
of communicating with a DVR and a data storage device
arranged to store video data, such that video data is
receivable from the DVR and/or from the data storage
10 device.

15. A video streaming system as claimed in any one of the
preceding claims, wherein the video viewing device
comprises a computing device.

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16. A video streaming system as claimed in claim 15,
wherein the computing device is arranged to implement a
video viewing client usable by an operator to control
video data received from the DVR and/or from the data
20 storage device.

17. A video streaming system as claimed in claim 16,
wherein the video viewing client is arranged to enable an
operator to select the start and end times of the video
25 data received from the DVR and/or from the data storage
device.

18. A video streaming system as claimed in any one of the
preceding claims, wherein the video streaming system is
30 arranged to compress video data streamed from the primary
video streaming device to the secondary video streaming
device.

19. A video streaming system as claimed in claim 18,
35 wherein the video streaming system is arranged to compress
video data by storing information indicative of an entire
video image at the primary and secondary video streaming

devices and transmitting information indicative of changes to the video image from the primary streaming device to the secondary streaming device.

5 20. A video streaming system as claimed in claim 19, wherein the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices at periodic intervals.

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21. A video streaming system as claimed in claim 20, wherein the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices every hour.

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22. A video streaming system as claimed in claim 20, wherein the video streaming system is arranged to store information indicative of an entire video image at the primary and secondary video streaming devices when
20 information indicative of a current video image differs significantly from information indicative of the stored video image.

23. A primary video streaming device capable of
25 communicating with a digital video recorder (DVR) and a data storage device arranged to store video data, such that video data is receivable from the DVR and/or from the data storage device;

the primary video streaming device arranged to:
30 communicate through a communications network with a secondary video streaming device arranged to communicate the streamed video data to a video viewing device.

24. A primary video streaming device as claimed in claim
35 23, comprising an encoder arranged to modify the bitrate of video data.

25. A primary video streaming device as claimed in claim 24, wherein the bitrate of video data produced by the encoder is determined in response to a bitrate communication received by the primary streaming device,
5 the bitrate communication indicative of the best bitrate possible for video communications between the primary streaming device and the secondary streaming device.

10 26. A primary video streaming device as claimed in claim 25, comprising a buffer for buffering video data received from the DVR and/or from the data storage device.

15 27. A primary video streaming device as claimed in claim 26, wherein the primary video streaming device is arranged to compress video data streamed from the primary video streaming device to the secondary video streaming device.

20 28. A primary video streaming device as claimed in claim 27, wherein the primary video streaming device is arranged to compress video data by storing information indicative of an entire video image at the primary video streaming device and transmitting information indicative of changes to the video image from the primary streaming device to the secondary streaming device.

25 29. A primary video streaming device as claimed in claim 28, wherein the primary video streaming device is arranged to store information indicative of an entire video image at the primary video streaming device at periodic
30 intervals.

30. A primary video streaming device as claimed in claim 29, wherein the primary video streaming device is arranged to store information indicative of an entire video image
35 at the primary video streaming device every hour.

31. A primary video streaming device as claimed in claim

29 or claim 30, wherein the primary video streaming device
is arranged to store information indicative of an entire
video image at the primary video streaming device when
information indicative of a current video image differs
5 significantly from information indicative of the stored
video image.