

Method for optimising the transmission of video data
streams in a wireless network

5 The present invention deals with a method for enhancing the reliability and the quality of reception of video data streams over a wireless digital network among others, governed by communication protocols for example of Wi-Fi type. The streams concerned are multicasted, or multibroadcast, that is to say that
10 they originate from at least one transmitter broadcasting them to receivers of a group subscribed to said broadcast. The receiving devices, or clients, forming the recipient group are capable of viewing the streams sent, and are provided for this purpose with at
15 least one application making it possible to process and view the information received.

More particularly, the present invention relates to a processing, performed on reception of video streams, that makes it possible to enhance the quality of the
20 decoded signals when there are blocks of data lost.

One of the possible applications of the invention is the almost real time broadcasting of events of sports meeting or show type, within the perimeter of the enclosure where said event takes place. The client
25 application software on the one hand allows the fluid viewing of video images offered among other things by a service provider linked to the organizer of the event, and, on the other hand, the viewing to be enriched by processing operations likely to confer an added value
30 on the video streams received, for example a repetition and therefore a reviewing of certain sequences, if necessary in slow motion.

Such processing operations require the video streams, conventionally transmitted in the form of packets of
35 information essentially containing groups of images, to be received in a sufficient quantity first of all for the viewing thereof to be simply comfortable, then also

for any subsequent signal processing operations to be able to be based on an information base sufficient for the performance thereof.

Now, on wireless local area networks, whatever the communication protocols used and the broadcasting mode - that therefore applies also to the multicast Wi-Fi networks which will be used in the text as preferential example - the transmission error rate lies between 0% and 15%, sometimes more. This error rate in practice consists of a loss of blocks of information transmitted by the network. If video stream transmissions are assumed, the result of these losses is poor quality of the videos obtained, the images being able to exhibit exogenous macroblocks which degrade them and consequently degrade the quality of the streams, when they are not purely and simply lost. Depending on the case, these losses can affect the video stream as far as preventing the broadcasting of certain sequences.

In practice, the video data streams are coded in the form of packets G which are in reality essentially composed of groups of images of different categories, these packets being then divided into data blocks. According to a conventional scheme, which results also from the advance implementation of lost data recovery conditions, these packets G each comprise K first data blocks which essentially code the images of the video stream and N so-called redundancy blocks that can be used if necessary for forward error correction (by an algorithm of FEC type).

A stream therefore comprises a succession of groups of images or packets G each comprising $K+N$ blocks transmitted by the transmitting device, which multicasts it to client viewing devices, for example smartphones or tablets.

To ensure a reliable and quality reception of the video streams, despite the losses that are always possible, the method comprises, according to the

invention and principally, the following steps, implemented by each client device for each of the data packets G received from the transmitting device or devices:

- 5 - a/ checking the correct reception of the K first data blocks, decoding and viewing the video stream in case of a positive result;
- b/ in the absence of reception of all of the K first data blocks, and if the total number X of
10 K+N blocks received is at least equal to K, decoding, by means of a forward error correction (FEC) algorithm, to retrieve the missing data of the blocks K, decoding and
15 viewing the video stream in case of positive result;
- c/ if the total number X of blocks K+N received is less than K or, in the absence of a positive result to the decoding via the forward error correction algorithm (FEC), sending, by the
20 client device, of a unicast message giving the transmitter information at least concerning the last block or blocks lost;
- d/ if a statistical algorithm of the transmitting device organizes the returning of
25 the missing data, checking the correct reception of the data returned by the transmitting device according to a/ and b/, decoding and viewing the video stream in case of a positive result.

30 The idea on which the invention is based is to try to correct the errors by successive steps, the implementation of each of the steps depending on at least one test performed in the preceding step. The implementation of the steps depends in particular on
35 the rate and the distribution of the errors detected in the data packets. In a favorable hypothesis, only the first step, that is to say the first test, is

implemented. If all of the K first blocks has arrived at the client device, that means that there is no error, no loss of information, and the video decoding can be performed for the viewing.

5 In a more unfavorable hypothesis, the FEC algorithm must be used to retrieve missing data: this step in fact makes it possible to correct the losses of blocks distributed in time, when the error rate is not too great (it is then qualified as low to medium). The
10 condition for implementation of this step is that the total number of blocks received is at least equal to K .

 Depending on the typology of the errors, this step can perfectly well be either a failure or unfeasible through lack of data, and therefore not make it
15 possible to correct the errors: such is, for example, the case when errors occur, for example by entire packets, that is to say grouped errors, representing an error rate qualified as medium to high. Another routine is then to be implemented, according to the invention,
20 which assumes an exchange with the transmitting device. The client which is in this case sends a unicast message to the transmitter, which possibly returns the missing data following a statistical algorithm. That obviously assumes that the latter have been identified
25 by the client device.

 The integrity or the legibility of the data returned is checked according to the steps a/ and b/ on reception by the client device, which can then proceed to decode the stream for it to be viewed.

30 The method of the invention however goes further, and also considers the hypothesis whereby the data returned by the transmitting device are not always received or are not received sufficiently rapidly, in conditions allowing the video stream to be displayed correctly.

35 In this case, the following steps are implemented according to the invention:

- e/ in the absence of correct reception of the data returned, checking the reception of a reference image with internal coding in the packet G of data received, then
- 5 - f/ if such a reference image is received complete, implementing an error concealment algorithm applied to the compressed data, and
- g/ decoding and viewing the video stream.

10 The reference image alluded to is that with which the packet G typically begins, essentially formed by a group of images, the succession of which, repeated periodically until the end of the encoding, in short constitutes the encoded video stream. This is a reference image with internal coding whose decoding is
15 autonomous and does not depend on the preceding or subsequent images. This category is used in association with images of other categories, for example with predictive coding, in an order which defines a particular group. The visible images are then generated
20 (or decoded) from the coded images contained in this predefined group.

25 This type of image, independent of the other types of image forming the group, is considered as reference image, and the test aiming to determine the relevance of the implementation of an error concealment algorithm is therefore preferably, according to the invention, based on the complete existence of such a reference image.

30 When a client device has not been able to correctly reconstruct the video stream returned by the transmitting device, it implements an error concealment step. The latter is however performed only on the condition that a reference image has been received in the data packet G process. This new step based on the
35 concealment makes it possible to conceal the errors and provide, at the time of decoding, encoded and computed samples which replace missing samples of the signal

from data of the reference image and any other images received in the packet G. The estimation of the missing parts of the images on the encoded data makes it possible to visually attenuate the data reception errors in the compressed video streams, and is performed by using the spatial and temporal correlations between images, either within a same image (spatial correlation) or in past or future images (temporal correlation). The idea on which these routines are based is that there are rarely abrupt changes between spatially adjacent pixels of an image, and that there is a temporal continuity in the successive images of a video sequence.

The method of the invention then considers the possibility of the non-reception of such a reference image with internal coding in the data packet of the stream currently being processed. In this case, according to a possibility specific to the invention, the following steps are implemented:

- 20 - h/ in case of non-reception of a reference image with internal coding in the data packet G received, checking the reception of at least one reference image of the preceding G-1 and next G+1 packets,
- 25 - i/ implementing an interpolation method on the uncompressed or linear data for the reconstruction of images, then
- j/ decoding and viewing the video stream.

This new step of the method of the invention this time uses algorithmic reconstruction possibilities rather than error concealment techniques used above, in a context that is a little different. It involves interpolation methods which are also considered temporally or spatially, and this time operate with uncompressed video streams. In a temporal interpolation, they make it possible to generate

missing images in a stream by using the preceding and subsequent images.

If it so happens that none of the steps described previously allow a conclusion, particularly in the context of the last step implemented, because there is no reception of at least one reference image of the preceding G-1 and next G+1 packets, the packet G is not displayed.

The method of the invention is in reality a chain of successive solutions aiming to adapt the response of the system to video signal transmission defects, the nature and gravity of which are detected progressively.

The invention will now be described in more detail, with reference to the attached figures, representing one possibility of implementation of the method of the invention, and for which:

- figure 1 represents a flow diagram schematically representing the overall implementation of the method of the invention; and
- figure 2 shows a same data packet, constituting a possible encoding of a group of images and, by repetition, a video stream, different types of possible data losses being represented on these data packets.

Referring to figure 1, the first test performed in the context of the method consists in checking whether the K first blocks have been received. In each step, after each test, in a favorable hypothesis, that is to say if there is no data loss problem, or if any such problems have been resolved, the data packets forming the video stream are processed by the video decoder for the broadcasting of the transmitted stream.

If the result to the first test is positive, that means in particular that the packet data corresponds to the case No. 1 of figure 2, whereby the K first blocks of the data packet have been received. In figure 2, a visual code defines the different blocks, appearing in

the key given at the bottom of the figure, and comprising the first K blocks, the blocks K to N, the reference images I and the lost blocks.

5 In a negative hypothesis, the next test relates to the number X of blocks received out of all of the blocks K + N transmitted, that is to say including the redundancy blocks N, placed after the blocks K in the representations of figure 2. If the total number of blocks received is at least equal to K (even in case of
10 errors, lost blocks), that is to say if $X \geq K$, corresponding to the case No. 2 of figure 2, a forward error correction (FEC) algorithm is implemented, then a new checking test is implemented. Since it involves a type of correction which is suited to losses
15 distributed in time, over all of the data packet, that is to say over all of the blocks N+K, this error correction strategy does not necessarily work.

If this test is negative, which can mean that data losses are rather concentrated and not distributed, or
20 if the number X of blocks received out of the N+K blocks is less than K - corresponding to the case No. 3 of figure 2 - a procedure (called NAK) for recalling unreceived data is launched. This routine involves a unicast communication in the reverse direction, between
25 one of the receiving client devices and a transmitting device, and necessitates an identification of the missing data.

The latter returns, by unicast or multicast, the data identified by the client as not received according to a
30 statistical algorithm, and a new correct reception test is performed in the client device. The next test relates to the correct reception of a reference image I with internal coding for each packet or group of images i. In figure 2, the reference image I is placed at the
35 start of the packet, which is very generally the place that it occupies in such encodings. If this image I is completely or partially received, that is to say in

cases No. 4 and No. 5 illustrated in figure 2, the transmission errors observed and which have not been resolved in the preceding steps are processed by means of a concealment algorithm. The errors are in this case
5 concealed at the video decoder level, but not corrected. The aim of this type of routine, which acts on the compressed data streams, is to visually attenuate the reception errors in the video streams.

In the reverse hypothesis, that is to say if there is
10 no reception of a reference image with internal coding I in the group of images or packet G, the method of the invention tests the reception of such a reference image I in the packets or groups of images G-1 and G+1. That corresponds to the case No. 6 of figure 2. If this is
15 the case, a reconstruction of the damaged images can still be implemented, on the basis of an interpolation algorithm acting on the uncompressed video streams, and generating the missing images or the parts of missing images respectively by using the immediately preceding
20 or subsequent images in the succession of images, in a temporal perspective, or by using the parts of the same image immediately adjacent to those which are missing, in a spatial perspective.

When none of these successive processing operations
25 succeeds satisfactorily, the packet or group of images is not displayed.

The invention is of course not limited to the examples described and explained with reference to the figures, but it encompasses the variants and versions
30 which fall within the scope of the claims.

CLAIMS

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1 - A method for enhancing the reliability and the quality of reception of video data streams over a wireless network governed by WiFi-type communication protocols, the video data stream being coded in the form of packets G each comprising K first data blocks and N redundancy blocks for forward error correction (FEC), said stream comprising a succession of packets G each comprising K+N blocks being transmitted by at least one transmitting device multicasting same to client viewing devices of smartphone type, the method being characterized by the following steps, implemented by the client device for each of the data packets G received from the transmitting device or devices:

20

- a/ checking the correct reception of the K first data blocks, decoding and viewing the video stream in case of a positive result;

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- b/ in the absence of reception of all of the K first data blocks, and if the total number X of K+N blocks received is at least equal to K, decoding, by means of a forward error correction algorithm (FEC), to retrieve the missing data of the blocks K, decoding and viewing the video stream in case of a positive result;

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- c/ if the total number X of K+N blocks received is less than K or in the absence of a positive result to the decoding via the forward error correction algorithm (FEC), sending, by the client device, of a unicast message giving the transmitter information at least concerning the lost block or blocks;

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- d/ if a statistical algorithm of the transmitting device organizes the returning of

the missing data, checking the correct reception of the data returned by the transmitting device according to a/ and b/, decoding and viewing the video stream in case of a positive result.

5 2- The method for enhancing the reliability and the quality of reception of the video data stream over a wireless local area network as claimed in the preceding claim, characterized by the following steps:

- 10 - e/ in the absence of correct reception of the data returned according to d/ or in the absence of returned data, checking the reception of a reference image with internal coding in the data packet G received, then
- 15 - f/ if such a reference image is received complete, implementing an error concealment algorithm applied to the compressed data, and
- g/ decoding and viewing the video stream.

20 3- The method for enhancing the reliability and the quality of reception of video data streams over a wireless local area network as claimed in the preceding claim, characterized by the following steps:

- 25 - h/ in case of non-reception of a reference image with internal coding in the data packet G received, checking the reception of at least one reference image of the preceding G-1 and next G+1 packets,
- i/ implementing an interpolation method on the uncompressed or linear data for the reconstruction of images, then
- 30 - j/ decoding and viewing the video stream.

4- The method for enhancing the reliability and the quality of reception of video data streams over a wireless local area network as claimed in the preceding claim, characterized in that, in case of incomplete
35 reception of at least one reference image of the preceding G-1 and next G+1 packets, the packet G is not displayed.