Method and device for modulating and demodulating transmission sub-channels for a compatible television system.

The present invention relates to a method and a device for modulating and demodulating transmission sub-channels for a compatible television system.

The methods used in the known devices for digital modulation of television signals such as those described for example in Patent Applications 2 638 305 and 2 638 306 filed in the name of the Applicant consist in grouping the binary elements of the signal to be transmitted into packets each packet transmitting a determined number of symbols.

With such device [sic] the receivers which are designed to work at image resolutions much lower than those of the images transmitted at the transmission end, have an excessively high production cost because their demodulators are designed to restore fully the packets of binary elements which they receive without taking into account the level of resolution of the images restored by the receiver. However, in order to cut receiver production costs, simplifications to the decoders of the receivers which are coupled as output from the demodulations, have already been proposed in Patent Applications 2 643 531 and 2 654 887 likewise filed in the name of the Applicant. These devices make it possible in particular to use decoders which are all the simpler and less expensive the lower the resolution of the receivers, even when the resolution of the image coded by the transmission coder is greater.

The aim of the invention is to alleviate the aforesaid disadvantages, in order to allow each specific demodulator of a given level of image resolution access to only the information strictly necessary for demodulating the image having this level of resolution.

To this end, the subject of the invention is a method for modulating and demodulating transmission

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sub-channels for a compatible digital television system, characterised in that it consists in associating an amplitude A_k and a phase ϕ_k with each digital word of the television signal to be transmitted, and in grouping the pairs into packets matched to the levels of resolution of the receivers in order to form a modulating signal from the pairs contained in each packet.

The subject of the invention is also a device for implementing the aforesaid method,

Other characteristics and advantages of the invention will emerge with the aid of the description which follows given in connection with the attached drawings which represent:

Figure 1, a diagram to illustrate the principle of modulation implemented through the invention.

Figure 2, a tree for splitting the spatio-temporal spectrum of a high-definition television image into sub-bands.

Figure 3, an illustrative grouping of packets complying with the splitting tree of Figure 2.

Figure 4, an embodiment of a compatible demodulator according to the invention.

In the modulation diagram represented in Figure 1, an amplitude A_k and a phase ϕ_k in the complex plane are associated with each digital word of the television signal to be transmitted. Therefore, for constant amplitudes A_k the amplitude phase pairs (A_k, ϕ_k) are found to be distributed over concentric circles as the phase ϕ_k varies.

The method of transmission according to the invention consists in grouping the pairs (A_k, ϕ_k) into packets each corresponding to a level of resolution of a receiver. On fixing at L the number of symbols contained in a packet, the grouping within each packet can then be effected in a way similar to that described in Patent Application No. 2 638 3206 [sic] by carrying out on the pairs (A_k, ϕ_k) an operation of the form:

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$$\sum_{k=1}^{L} A_k \cdot e^{j_k} \cdot e^{2\pi j k \frac{t}{T}} \quad (1)$$

and representing a signal for modulating a sinusoidal carrier wave of frequency fo. The advantage of proceeding in this way is that it allows immediate decoding of only the transmitted packets corresponding to each specific resolution of a receiver. Indeed, as described in Patent Applications 2 643 531 and 2 654 887 it is possible through partitionings of the television signal into sub-bands to match the decoders of the receivers so that they decode just the data of the sub-bands corresponding to their own resolution. In other words, by tapping off from a television image transmission channel a portion of the throughput of the information transmitted in order to reduce it to a lower throughput while conveying a compatible image of lower resolution, as is the case for example for an image containing half as many lines and columns as an original HDTV image, a decoder matched to this halved level of resolution can decode and display a compatible image with a much lower production cost than that of a complete HDTV decoder working on the whole HDTV image. Thus, as shown in Figure 2, the spectrum of the 1250-line SHD signal which is represented in a two-dimensional Fourier space containing horizontally and vertically the spatial frequencies of the image, measured in cycles per image width and height, can be partitioned into sub-bands corresponding to the SED (625 lines) and VT (312 lines) standards in such a way as to associate a corresponding decoder with each of the spectra SHD-SED and VT, and to be compatible with the partitioning into packets described earlier by applying to each decoder the (A_k, ϕ_k) pair packets corresponding to its level of resolution. As shown by the partitioning into packets of Figure 3, it suffices to organise the sequence of packets into a first packet

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corresponding to the pairs (A_k, ϕ_k) of the VT sub-band, then a second packet corresponding to the pairs (A_k, ϕ_k) of the complementary portion of the spectrum leading from the VT spectrum to the SED spectrum and finally to transmit in a third packet corresponding to the pairs (A_k, ϕ_k) of the complementary portion SHDC to the SED spectrum in order to form the SHD spectrum. Naturally a guard interval must be provided between each packet in order to transmit the synchronising signals and the channel equalising signals. Therefore, by demodulating only the information relating to these packets, a demodulator can thus have access to all the information of this sub-channel. Because it only has to demodulate a reduced number of packets, its complexity is thereby reduced.

A corresponding demodulator is represented in Figure 4 inside a dashed line 1. It includes a device 2 for acquiring the wave form transmitted, formed principally by an analogue/digital converter. This device can be the same whether the demodulator be capable of demodulating the total throughput of the signal applied to its input or merely one sub-channel. The demodulator 1 also includes a buffer memory 3 for the signal samples provided by the acquisition device 2, and one or more demodulation processors $4_1 \ldots 4_4$ coupled to the output of the memory 3 by way of a data bus 5.

The memory 3 makes it possible optionally to process the samples acquired by the acquisition device 2 at a tempo which may be slower than that at which they are distributed by the acquisition device 2 especially when the demodulator demodulates only a portion of the packets transmitted. The processors $4_1 \ldots 4_4$ carry out the calculations required for demodulating the symbols transmitted in the packets, each processor preferably being dedicated to one specific packet type such as defined earlier. These processors are for example signal processors programmed to carry out fast FFT calculations on samples read from

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the memory 3; FFT here designating the algorithm known as the "Fast Fourier Transform", descriptions of which can be found for example in the book entitled "Le filtrage numérique" by P.M. BEAUFILS/M. RAMI published by SYBEX or else in the book entitled "Digital communications-fundamentals and applications" by Bernard Sklar published by Prentice Hall. Naturally the demodulator receives the modulated television signal on a channel labelled 5 in Figure 1 and redistributes the samples processed by the demodulation processors 4_i to compatible 7 or complementary 8 decoders.

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CLAIMS

1. Method for modulating and demodulating transmission sub-channels for a compatible digital television system, characterised in that it consists in associating an amplitude A_k and a phase ϕ_k with each digital word of the television signal to be transmitted, and in grouping the pairs (A_k, ϕ_k) into packets matched to the levels of resolution of the receivers in order to form a modulating signal from the pairs contained in each packet.

2. Method according to Claim 1, characterised in that each compatible image is carried by at least one modulating signal.

3. Method according to either one of Claims 1 or 2, characterised in that the compatible images are images of the SHD, SED and VT standards.

4. Demodulator for implementing the method according to any one of Claims 1 to 3, characterised in that it comprises an acquisition device (2) for sampling the modulation signals which is obtained each of the sub-channels [sic], a buffer memory (3) for storing the samples provided by the acquisition device (2) and at least one demodulation processor coupled to the memory (3) proportional in number to the number of packets demodulated per second.

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