METHOD AND APPARATUS FOR CONCEALING ERRORS WHICH EXTEND OVER SEVERAL PIXELS IN A DIGITAL VIDEO SIGNAL

This application is a continuation of application Ser. No. 07/111,625, filed Oct 21, 1987 now abandoned.

This invention concerns smoothing over defects ("errors")in a digital video signal by replacing disturbed picture point elements, hereinafter referred to as "pixels", by information derived from neighbouring undisturbed pixels. There are already methods and devices for so doing, but these leave much to be desired for cases where a succession of neighbouring pixels are disturbed enough for the corresponding parts of the video signal to be unusable.

Defects in the video signal can arise, for example, from signal dropouts, in reproduction from magnetically stored video signals or in the scanning of motion picture film or television transmission. For the concealing of these defects, for example scratches or dust specks which disturb film scanning, a signal is produced by a detection circuit suitable for the purpose which provides information regarding the position and magnitude of the defective location. This is illustrated for example in German Patent No. 33 18 216. This signal makes it possible, for example, to replace this defective location in a picture with information from the preceding film picture. If the preceding film frame is likewise disturbed at the same location, as for instance in the case of vertically running scratches (socalled motion stripes), this method fails. It is, moreover, unsuitable if the content of the preceding picture field or frame is not identical with that of the current picture field or frame, as may be the case if there is movement in the picture or a change of scene.

For mitigation of these disadvantages, it is already known, from European Patent No. 0 101 180, to utilize signals derived from the defect location to interpolate between two undisturbed pixels at the edges of the defect location and thus to cover over the defect. This method leaves the problem, however, especially in the case of broad scratches, that the interpolated zone of fixed location may be made prominent over the rest of the picture content because of the selected method of interpolation. Furthermore, in these cases oblique edges are broken up for the width of the scratch and vertical edges are smeared horizontally. If the disturbance (defect) location signal is slightly narrower than the location of the disturbance itself, this method leads to erroneous interpolation that can be just as disturbing as the original defect.

SUMMARY OF THE INVENTION

It is an object of the present invention to improve the smoothing over or concealment of errors compared to the above-mentioned simple interpolation in the case of defects wider than a single pixel.

Briefly, the video signal outside and adjacent to the disturbed location is time-expanded with insertion of interpolated pixel values so that the expanded signal will extend over gap in the sequence of undisturbed pixels. This method has an advantage, resulting from an improved interpolation method, that the smoothing over of the disturbance is in practice hardly visible and, in particular, the breaking up of oblique edges as well as the smearing of vertical edges are prevented or greatly reduced.

In particular, it is advantageous to expand the undisturbed video signal on both sides of the disturbance sufficiently for them to cover the disturbed region. The pixel values produced by interpolation can be intercalated on a 1:1 basis if enough undisturbed pixels are available for the necessary expansion. If the spacing between disturbances is not large thus limiting the undisturbed pixel succession available for expansion, the number of interpolated pixel values used for expansion between successive undisturbed pixels may be augmented as the center of the disturbed area is approached and thereafter decreased. It is furthermore possible to combine the method just summarized and apparatus therefor with low pass filtering of the time-expanded video signals effective either in the horizontal direction or in the vertical direction, or in both these directions, with blending in of the filtered signals.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described by way of illustrative example with reference to the annexed drawing, in which:

FIG. **1** is a block circuit diagram of apparatus for carrying out the method of the invention;

FIG. **2** is a graph illustrating signals occurring in the circuit of FIG. **1** on a common time scale;

FIG. **3** is a block circuit diagram of a portion of the circuit of FIG. **1** in which the control signals are generated;

FIG. **4** is a block circuit diagram of the video signal processing circuit **3** of FIG. **1**, and

FIG. **5** is a graph illustrating the processing in FIG. **4** of a video defect extending over four pixels.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

In the circuit shown in block form in FIG. **1** a digital luminance signal Y and a digital chrominance signal C are supplied respectively over the signal lines **1** and **2** to a video signal processing circuit **3**. In the case of a film scanning equipment the digital signals Y and C are produced by analog to digital conversion of the video signals resulting from film scanning. The nature of the processing in the circuit **3** can be preliminarily described by reference to FIG. **2** in connection with smoothing over of a disturbed location F illustrated in line a of FIG. **2**. The desired processing produces a video signal corrected for local defects either as shown in line b or else as shown in line c (of FIG. **2**). That corrected signal is made available at the outputs **4** and **5** which respectively supply corrected luminance and chrominance signals.

In line a of FIG. **2** there is shown a picture line having, at the left, six undisturbed pixels (pixels **1** to **6**), **11** disturbed pixels (F) in the middle and, at the right, six more undisturbed pixels (pixels **18** to **23**). A corrected video signal, shown on line b of FIG. **2**, has an interpolated pixel I inserted between every two successive undisturbed pixels. Each interpolated pixel I is derived from the two adjacent undisturbed pixels.

A control signal generation circuit **6** produces control signals (DF1, DF2 and DFW) which are shown respectively on lines d, e_1 and f_1 of FIG. **2**. In this case an expansion of the undisturbed video signal by the fixed expansion factor **2** is carried out to cover over the location of the disturbed pixels. The expansion factor can be reduced, for the same width of the disturbed region, by increasing the width of the portion of the