## Description

The present invention concerns video filters of the nonlinear temporal type, particularly, but not exclusively, for use in video coding systems.

The article "Nonlinear temporal filter for television picture noise reduction" published in Proceedings of the I.E.E.-G, Vol. 127, No. 2, pages 52 to 56 discloses a digital video signal filter in which, in order to distinguish motion from noise, small interframe video signal differences are nonlinearly filtered and interframe video signals differences above a predetermined threshold are linearly filtered. A filtering function meeting these requirements is stored as a lookup table. Filtered interframe video signal difference values are output in dependence of interframe video signal input difference values in accordance with the stored function.

The invention is defined in the claims.

Some embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of a filter;

Figure 2 illustrates a known characteristic for the nonlinear lookup unit 4 figure 1;

Figure 3 illustrates a modified characteristic in accordance with one form of the present invention;

Figure 4 is a block diagram of one form of lookup unit 4 in accordance with the invention; and

Figure 5 is a block diagram of an alternative form of lookup unit 4.

A nonlinear temporal filter for digitally coded video signals has (figure 1) a video input 1. Each picture sample S is supplied to a subtractor 2 which takes the difference D between the new sample and the corresponding "previous picture" sample P from a frame store 3. The difference passes through a lookup unit 4 which forms a nonlinear function $D' = f(D)$. The modified difference D' is added in an adder 5 to the previous picture sample P and the resulting filtered new sample S' is forwarded to an output 6 and also written into the frame store 3 to form the new previous picture sample for the next frame.

Thus $S' = P+D' = P+f(D) = P+f(S-P)$.

Hence, if $f(D) = D$ then $S' = S$ and no filtering occurs.

If $0 < \frac{f(D)}{D} < 1$ where f(D) has the same sign as D, then some filtering takes place.

The object of this temporal filtering is to reduce noise; however it has the disadvantage of causing blurring of moving objects on scene changes. Where the difference between the old and new samples is large, this is likely to be caused by changes in picture content, whilst a small difference is more likely to be caused by noise. Therefore the lookup unit 4 is given a nonlinear characteristic in order to effect a greater degree of filtering for small differences than for large ones. A typical characteristic curve is shown in figure 2, with a slope less than unity for small D, and asymptotic to the line $D' = D$.

Assuming a resolution of 8 bits/sample, the difference D (and modified difference D') has a range of -255 to +255, and therefore a memory of 512 x 9 bit capacity is required for the lookup table. Although this is not a large memory by current standards, nevertheless for an integrated circuit video coder implementation where silicon area may be at a premium, it is desirable to reduce this. Accordingly, it is arranged that the characteristic is nonlinear for values of D less than 50% of its maximum absolute value, or more preferably less than 10%, and linear with unity slope for greater values.

For example, the characteristic in figure 3 has a unity slope for absolute values of D greater than or equal to 16. This can be implemented by the lookup unit shown in figure 4, where the four least significant bits of D form the address input to a read-only memory 10 having 16 locations each containing a four-bit word representing half of the characteristic depicted in the central region of figure 3. The data output from the memory 10 forms the four least significant bits of an 8-bit word (whose four most significant bits are always zero) forming one input to an electronic changeover switch or data selector 11. The other input to the selector 11 is the input word D (without its sign bit SGN).

The four most significant bits of D are connected via an OR gate 12 to the control input of the selector 11 so that whenever one of those bits is nonzero (i.e. $|D| \geq 16$) the selector passes the data input D directly to the output D'; otherwise the output is the output of the lookup table 10. The sign bit of the output D' is of course the sign bit of the input D, unmodified. This structure assumes a sign-bit plus magnitude representation of negative values of D. In practice, a twos-complement representation is more convenient for implementing the addition and subtraction, in which case the more complex arrangement shown in figure 5 would be appropriate. It differs from figure 4 in that (1) the read-only memory 10 covers a range from -16 to +15, with its additional address line fed from the sign bit of D, and (2) the range detector comprises an OR gate 14 which produces a logic zero output when the four most significant bits of D, and the sign bit are zero (i.e. $D<16$) a NAND gate 15 which produces a logic zero when these five bits are one (i.e. $D>-17$), and an AND gate 16 which produces an active low output when the output of one of the gates 14, 15 is zero.

## Claims

1. A filter for filtering digitally coded video signals comprising:

* C L M S *

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## Claims

1. A filter for filtering digitally coded video signals comprising:

* C L M S *

means (2) for forming the difference (D) between each sample of an input signal (S) and the filter output corresponding to an earlier frame of the video signal (P); and

means for forming an output sample (S') by adding said filter output corresponding to an earlier frame of the video signal (P) to a nonlinear function (f(D)) of the difference (D);

characterised in that:

the nonlinear function (f(D)) comprises a nonlinear portion for absolute values of the difference (D) less than a threshold equal to 50% or less of the maximum possible absolute value of the difference (D) and a linear portion for absolute values of the difference (D) greater than the threshold;

and in that the filter includes nonlinear processing means comprising:

a memory (10) storing values of the nonlinear function (f(D)) corresponding to absolute values of difference (D) less than the threshold; and

switching means (11) responsive to each absolute value of difference (D) to select for output either the unmodified difference (D) or the corresponding stored value of said non-linear function (f(D)).

2. A filter according to claim 1 in which the threshold is 10% or less of the maximum possible absolute value of the difference (D).

## Patentansprüche

1. Filter zum Filtern digital codierter Videosignale, mit:

einer Einrichtung (2) zur Bildung der Differenz (D) zwischen jedem Abtastwert eines Eingangssignals (S) und dem einem früheren Rahmen des Videosignals (P) entsprechenden Filterausgang; und

eine Einrichtung zur Bildung eines Ausgangs-Abtastwerts (S') durch Addieren des einem früheren Rahmen des Videosignals (P) entsprechenden Filterausgangs mit einer nichtlinearen Funktion (f(D)) der Differenz (D);

dadurch gekennzeichnet, daß

die nichtlineare Funktion (f(D)) für Beträge der Differenz (D), die kleiner sind als ein Schwellenwert, der 50 % oder weniger des maximal möglichen Betrags der Differenz (D) beträgt, einen nichtlinearen Bereich hat, und für Beträge der Differenz (D), die größer als der Schwellenwert sind, einen linearen Bereich hat;

sowie dadurch, daß der Filter eine nichtlineare Verarbeitungseinrichtung umfaßt, die aufweist:

einen Speicher (10) zur Speicherung von Werten der nichtlinearen Funktion (f(D)) entsprechend Beträgen der Differenz (D), die kleiner als der Schwellenwert sind; und

eine Schalteinrichtung (11) die auf jeden Betrag der Differenz (D) anspricht, um als Ausgabe entweder die nichtmodifizierte Differenz (D) oder den entsprechenden gespeicherten Wert der nichtlinearen Funktion (f(D)) auszuwählen.

2. Filter nach Anspruch 1, bei dem der Schwellenwert 10 % oder weniger des maximal möglichen Betrags der Differenz (D) beträgt.

## Revendications

1. Un filtre de filtrage de signaux vidéo codés numériquement comprenant:

un moyen (2) de formation d'une différence (D) entre chaque échantillon de signal entré (S) et la sortie du filtre correspondant à une trame antérieure du signal vidéo (P); et

un moyen de formation d'un échantillon de sortie (S') en ajoutant ladite sortie de filtre correspondant à une trame antérieure du signal vidéo (P) à une fonction non linéaire (f(D)) de la différence (D);

caractérisé en ce que

la fonction non linéaire (f(D)) comprend une partie non linéaire pour des valeurs absolues de la différence (D) inférieures à un seuil égal à 50% ou moins de la valeur absolue maximale possible de la différence (D) et une partie linéaire pour des valeurs absolues de la différence (D) supérieures au seuil;

et en ce que le filtre inclut un moyen de traitement non linéaire qui comprend:

une mémoire (10) qui mémorise les valeurs de la fonction non linéaire (f(D)) correspondant à des valeurs absolues de la différence (D) inférieures au seuil; et

un moyen commutateur (11) qui répond à chaque valeur absolue de différence (D) pour choisir, afin de la sortir, soit la différence non modifiée (D), soit la valeur mémorisée correspondante de ladite fonction non linéaire (f(D)).

2. Un filtre selon la revendication 1 dans lequel le seuil est de 10% ou moins de la valeur absolue maximale possible de la différence (D).