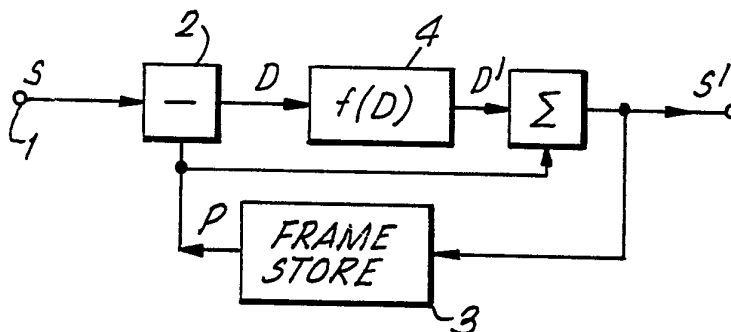

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04N 5/21		A1	(11) International Publication Number: WO 91/03123
			(43) International Publication Date: 7 March 1991 (07.03.91)
(21) International Application Number: PCT/GB90/01252 (22) International Filing Date: 9 August 1990 (09.08.90) (30) Priority data: 8918559.9 15 August 1989 (15.08.89) GB (71) Applicant (for all designated States except US): BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB]; 81 Newgate Street, London EC1A 7AJ (GB). (72) Inventors; and (75) Inventors/Applicants (for US only) : WHYBRAY, Michael, William [GB/GB]; White House, The Street, Nacton, Ipswich, Suffolk IP10 OHD (GB). HOPPER, Robert, William [GB/GB]; 46 Sidegate Lane, Ipswich, Suffolk IP4 4HX (GB).		(74) Agent: BUTTRICK, Richard; British Telecommunications public limited company, Intellectual Property Unit, 151 Gower Street, London WC1E 6BA (GB). (81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent)*, DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US. Published <i>With international search report.</i>	

(54) Title: VIDEO FILTER



(57) Abstract

Temporally filtered video samples are formed as the sum of a previous frame output sample (P) and a nonlinear function of the difference between current (S) and previous (P) samples. The function is nonlinear only for absolute values of differences less than 50 % (preferably 10 %) of the maximum range of the difference, and a smaller lookup table is used for implementing the nonlinear function than would otherwise be the case.

DESIGNATIONS OF "DE"

Until further notice, any designation of "DE" in any international application whose international filing date is prior to October 3, 1990, shall have effect in the territory of the Federal Republic of Germany with the exception of the territory of the former German Democratic Republic.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MC	Monaco
AU	Australia	FI	Finland	MG	Madagascar
BB	Barbados	FR	France	ML	Mali
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Fasso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GR	Greece	NL	Netherlands
BJ	Benin	HU	Hungary	NO	Norway
BR	Brazil	IT	Italy	PL	Poland
CA	Canada	JP	Japan	RO	Romania
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	LI	Liechtenstein	SN	Senegal
CM	Cameroon	LK	Sri Lanka	SU	Soviet Union
DE	Germany	LU	Luxembourg	TD	Chad
DK	Denmark			TG	Togo
				US	United States of America

VIDEO FILTER

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

The invention is defined in the claims.

5 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
10 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

15 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
 $\frac{f(D)}{D}$
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 512×9 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 change-over switch or data selector 11.
The other input to the selector 11 is the input word D
(without its sign bit SGN).

5 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
10 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
15 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
20 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. $D \geq 17$), and an AND gate 16
which produces an active low output when the output of one
25 of the gates 14, 15 is zero.

CLAIMS

1. A filter for digitally coded video signals,
comprising means for forming the difference between each
sample of an input signal and the filter output
corresponding to an earlier frame of the video signal, and
5 means for forming an output sample by adding the said
earlier output to a nonlinear function of the difference,
in which the nonlinear function comprises a nonlinear
portion for absolute values of the difference less than a
threshold equal to 50% or less of the maximum possible
10 absolute value of the difference, and a linear portion for
absolute values of the difference greater than the
threshold, further comprising; nonlinear processing means
comprising

(a) a memory storing values of the said function
15 corresponding to absolute values of difference less than
the threshold and

(b) switching means responsive to the absolute
value to select for output either the unmodified
difference or the corresponding stored function from the
20 memory.

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

3. A filter for digitally coded video signals
25 substantially as herein described with reference to
figures 1 and 3, and figure 4 or 5 of the accompanying
drawings.

1/2

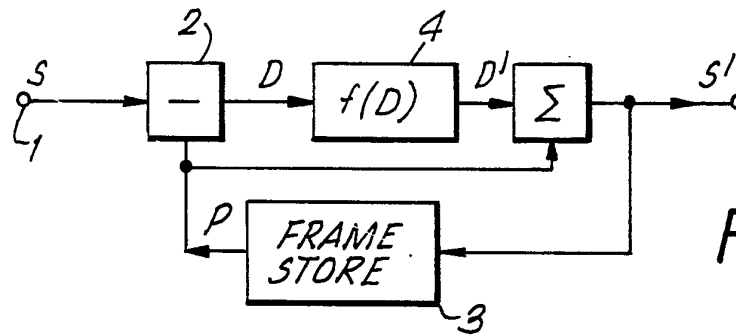


Fig. 1.

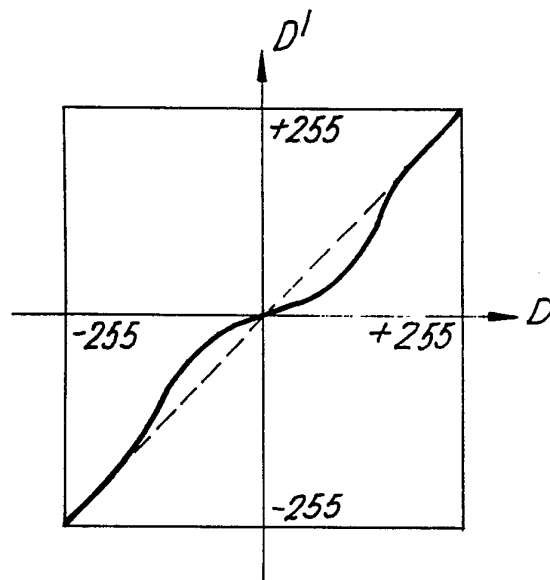


Fig. 2.

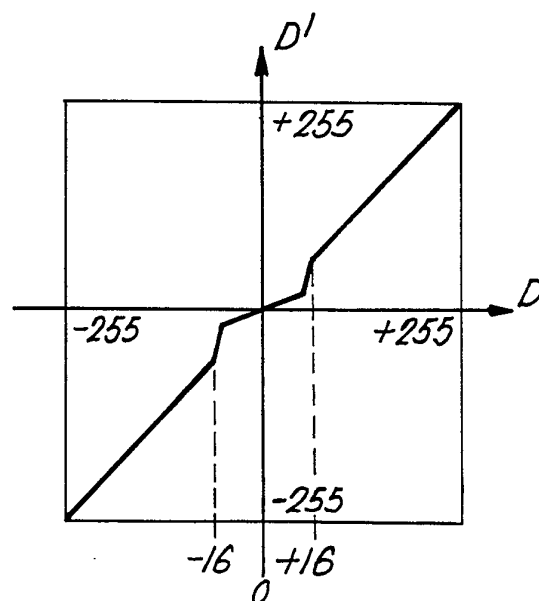


Fig. 3.

2/2

Fig.4.

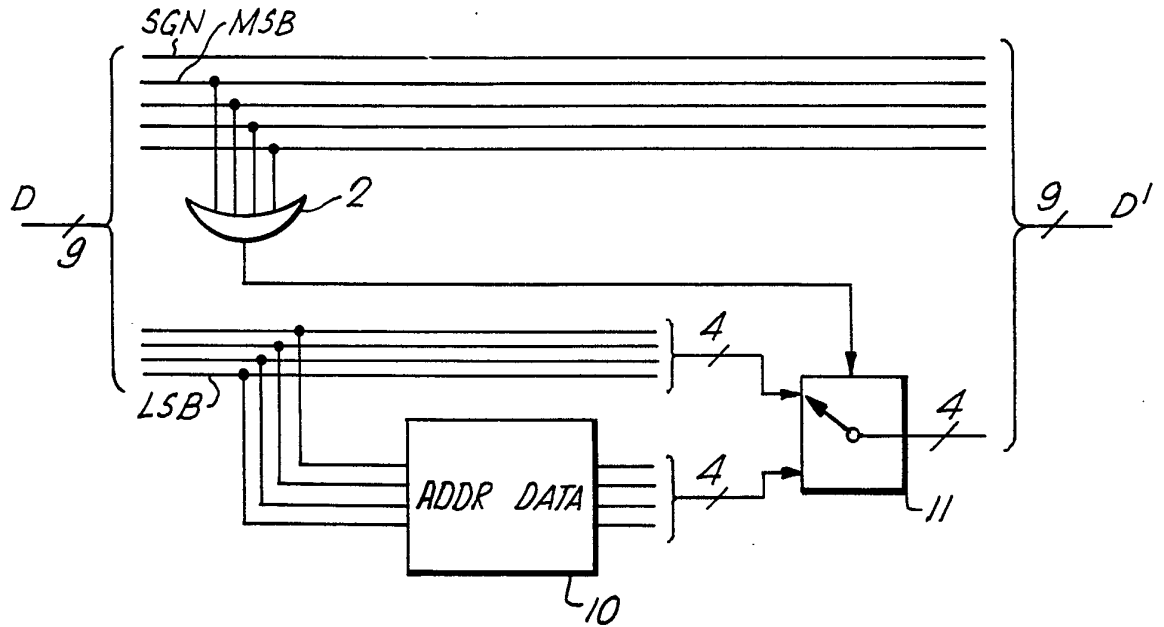
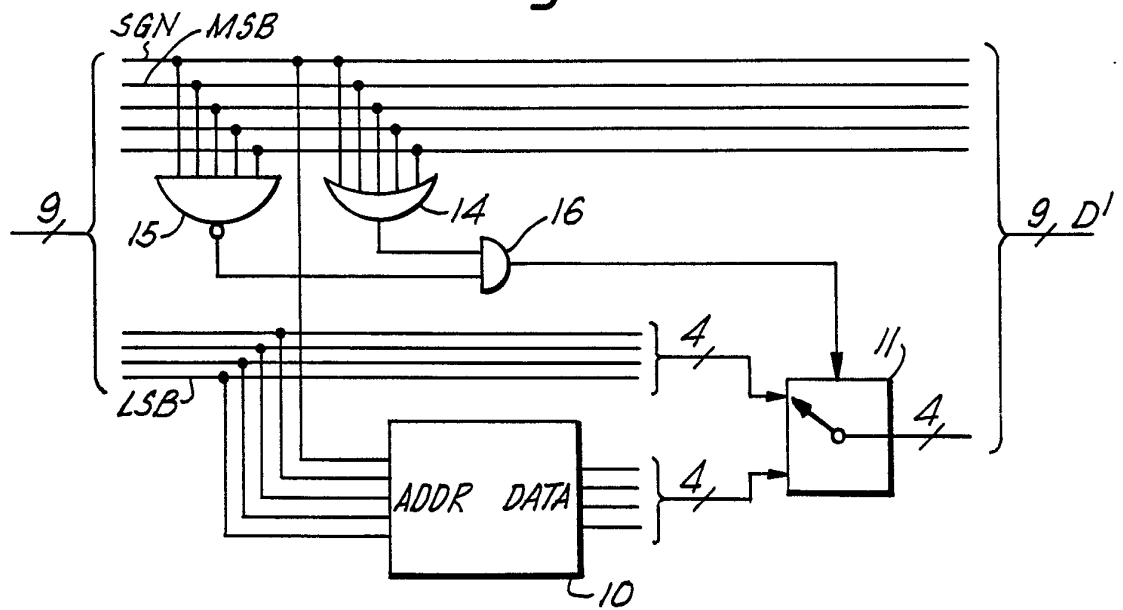
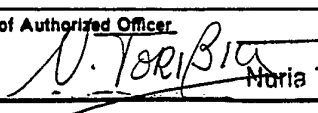


Fig.5.



INTERNATIONAL SEARCH REPORT

International Application No **PCT/GB 90/01252**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁵ : H 04 N 5/21		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁵	H 04 N	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	Proceedings of the I.E.E.-G, volume 127, no. 2, April 1980, (Stevenage GB), T.J. Dennis: "Nonlinear temporal filter for television picture noise reduction", pages 52-56 see page 52, left-hand column, line 11 - page 53, right-hand column, line 13	1,3
A	-----	2
[*] Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 27th November 1990		Date of Mailing of this International Search Report 20. 12. 90
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer  Maria TORIBIO