

Description

The present invention relates to a method of picture motion measurement comprising subdividing pictures into two or more regions and correlating corresponding regions of two pictures as a function of displacement thereby to determine from peak correlation values a plurality of motion vectors. The invention also relates to apparatus for use with such a method.

A method of the above type is described in GB-A-2188510 which is particularly concerned with the generation of motion vectors for television pictures. In the field of High Definition Television (HDTV) such motion vectors are conveyed with a television signal and are used to produce at a receiver an enhanced display either by assisting in producing additional lines to those in the received signal or in producing additional fields between those in the received signal. Because of limited capacity it is not always possible to transmit every motion vector generated and thus a selection needs to be made from the generated motion vectors. GB-A-2187059 and EP-A-181215 both disclose arrangements for producing a single motion vector.

It is an object of the present invention to provide a method of the above type and apparatus in which the most dominant motion vectors can be readily selected.

The invention according to a first aspect provides a method of picture motion measurement comprising sub-dividing pictures into two or more regions and correlating corresponding regions of two pictures to determine correlation as a function of displacement thereby to determine from peak correlation values a plurality of motion vectors, said method being characterised by the further steps of:-

- i) weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation function,
- ii) individually summing those weighted motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates, and
- iii) selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.

Such a method has the advantage that the most dominant motion vectors may be established in a reliable manner.

The weighting of the motion vectors may depend upon the relative magnitudes of the peaks in the correlation functions. Thus the greater the magnitude of a peak the greater the number of pixels in a region which have the same degree of movement and if such

a degree of movement dominates in other regions then its importance is emphasised by weighting. As an alternative or in addition the weighting could be dependent on the relative widths of the peaks which is related to blurring produced at picture source by possible integration.

The given number of dominant motion vectors may be directly proportional to the interval between the two pictures. Thus if the two pictures are spaced two television frames apart the number of motion vectors will be twice that if the pictures are only spaced by one television frame.

If at least said given number of the summed quantities are of a correspondingly large magnitude a complexity signal may be produced in addition to or instead of selecting coordinates to form the most dominant motion vectors, the complexity signal indicating that the pictures contain a large degree of motion complexity.

The invention also provides apparatus for use with the above method. Apparatus for picture motion measurement according to a second aspect of the invention may comprise means for correlating corresponding regions of two pictures to determine correlation as a function of displacement to determine from peak correlation values a plurality of motion vectors, and may be characterised by additionally comprising means for weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation functions, means for individually summing those weighted vector motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates and means for selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.

The means for weighting the motion vectors may comprise means for weighting the motion vectors depending upon the relative magnitudes and/or the relative widths of the peaks in the correlation functions.

In the case where at least the given number of summed quantities are of a corresponding large magnitude means may be provided for producing a complexity signal which signal may be produced in addition to or instead of the most dominant motion vectors.

The above and other features will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of apparatus for use with the invention, and

Figure 2 is a typical correlation surface for the same region of two pictures of a television signal.

In the block diagram of Figure 1 the reference 1 denotes a motion vector generator having a lumi-

nance input Y in which the television pictures for a television system are sub-divided to form a number of regions and it will be assumed for present purposes that each region is 32 pixels by 32 lines though of course that other sized regions are possible. The luminance information for corresponding regions in two adjacent television pictures are correlated to produce a correlation function for each pair of corresponding regions, a typical correlation surface for such a function being shown in Figure 2 where the displacement in the X and Y directions run from -16 to +16 sample positions where each sample is one pixel apart. In practice Figure 2 would not appear as a continuous correlation function but as a series of discrete samples of given magnitudes spaced one pixel apart or closer if the function is determined to sub-pixel accuracy. The correlation surface may be achieved by means of phase correlation as described in the above UK Patent Application or in the article "Video-rate Image Correlation Processor" by J.J. Pearson, D.C. Hines Jr., S. Golosman and C.D. Kinglin, SPIE Vol. 119, Applications of Digital Image Processing (IOCC 1977) or by any other suitable method such as optimal matching of corresponding regions. Zero displacement represents lack of movement and the peaks located away from the zero displacement coordinates indicate varying degrees of movement of components within the region.

The peaks in the correlation surface indicate the coordinates for motion vectors for the region in question and further processing may be used to increase the accuracy of peak location in order to increase the accuracy of the coordinates. This may be achieved as described in our copending application EP-A-366165 or in our copending application EP-A-367310. The motion vector coordinates for each region of a picture, or at least the most dominant (say 10) for each region are applied over a connection 2 to a weighting circuit 3 which also receives from the motion vector generator 1 over a connection 4 a signal for each motion vector representing the relative magnitude and/or the relative width of the peak it is derived from. The magnitude of a peak is related to the number of pixels in a region that have the same degree of movement whilst the width of a peak is related to blurring produced at picture source by possible integration. By means of the weighting circuit 3 each motion vector from each region can be weighted according to the input from connection 4.

The resulting weighted motion vectors are applied to a two-dimensional summing arrangement 5 which comprises 32 by 32 individual stores or "bins" each one of which corresponds to a particular one of the 32 by 32 motion vectors. Each store therefore receives and stores a number of weighted quantities for a corresponding motion vector depending on the number of regions in which that vector appears and its relative magnitude and/or width, these quantities

being summed in their respective stores. Summing arrangement 5 can be thought of as providing a two-dimensional vector histogram. The resulting summed quantities are applied to a largest vector selector 6 which selects a given number (say 16) of motion vectors whose stores in the summing arrangement 5 contain the largest quantities. This given number forms the most dominant motion vectors for the adjacent television frames under consideration which motion vectors are applied to a terminal 7 for coding prior to transmission with the television signal. Should the picture under investigation have a large degree of motion complexity such as in the case of picture zooming where no one vector dominates, normal motion vector techniques at the receiver which use a limited number of motion vectors will not portray the true position in the picture. In such a case many of the stores in the summing arrangement 5 will contain summed quantities of corresponding magnitude. If the selector 6 confirms such a situation (say more than 16 motion vectors of similar large magnitude) it will produce a complexity flag signal at an output 8. When this happens receivers will use simpler methods of interpolation which do not depend on motion vectors.

In the above description the two pictures are adjacent and thus one picture or frame period apart to produce the given number e.g. 16 dominant motion vectors. There is no reason why the period over which the dominant motion vectors are derived should not be an integral number of picture periods greater than one in which case the given number of dominant motion vectors would be multiplied by that integral number. Thus the number of dominant motion vectors relevant to a two picture period could be 32. Although the greater number of dominant motion vectors could be selected by operating on motion vectors produced over (say) a two picture or frame period it would be simpler if a two-dimensional summing operation were produced for the first frame period in the manner as described and then adding these to the motion vector produced by the regions for the second frame period. In other words a two-dimensional histogram is produced for the first frame period which is "topped up" during the second frame period. The most dominant motion vectors are then taken from the resulting summing operation.

Although in the above the method is described as being carried out by apparatus units which have specified functions it will be realised that the method may be performed by a microcomputer under dedicated software control.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in the design, manufacture and use of the method and apparatus and component parts thereof and which may be used instead of or in

addition to features already described herein.

Claims

1. A method of picture motion measurement comprising subdividing pictures into two or more regions and correlating corresponding regions of two pictures to determine correlation as a function of displacement thereby to determine from peak correlation values for each region a plurality of motion vectors, said method being characterised by the further steps of:-
 - i) weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation functions,
 - ii) individually summing those weighted motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates, and
 - iii) selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.
2. A method as claimed in Claim 1, in which the weighting of said motion vectors depends upon the relative magnitudes of peaks in the correlation functions.
3. A method as claimed in Claim 1 or 2, in which the weighting of said motion vectors depends upon the relative widths of peaks in the correlation functions.
4. A method as claimed in Claim 1, 2 or 3, in which said given number of dominant motion vectors is directly proportional to the interval between said two pictures.
5. A method as claimed in Claim 1, 2 or 3 for use in a television system, in which said given number of dominant motion vectors is directly proportional to the number of frames between said two pictures.
6. A method as claimed in any of the preceding claims, in which in the case that at least said given number of said summed quantities are of a correspondingly large magnitude a complexity signal is produced in addition to or instead of selecting coordinates to form the most dominant motion vectors, said complexity signal indicating that said pictures contain a large degree of mo-

tion complexity.

7. Apparatus for picture motion measurement comprising means for correlating corresponding regions of two pictures to determine correlation as a function of displacement to determine from peak correlation values for each region a plurality of motion vectors, characterised in that said apparatus additionally comprises means for weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation functions, means for individually summing those weighted motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates and means for selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.
8. Apparatus as claimed in Claim 7, in which said means for weighting said motion vectors comprises means for weighting said motion vectors depending upon the relative magnitudes of peaks in the correlation functions.
9. Apparatus as claimed in Claim 7 or 8, in which said means for weighting said motion vectors comprises means for weighting said motion vectors depending upon the relative widths of the peaks in the correlation functions.
10. Apparatus as claimed in Claim 7, 8 or 9, in which in the case where at least said given number of said summed quantities are of a correspondingly large magnitude means are provided for producing a complexity signal which signal may be produced in addition to or instead of the most dominant motion vectors.

Patentansprüche

1. Verfahren zur Messung der Bildbewegung mit Unterteilung von Bildern in zwei oder mehr Bereiche und Korrelieren korrespondierender Bereiche von zwei Bildern zur Ermittlung von Korrelation als Funktion einer Verschiebung, um dadurch aus Spitzenkorrelationswerten für jeden Bereich eine Mehrzahl von Bewegungsvektoren zu ermitteln, wobei das genannte Verfahren durch die folgenden weiteren Schritte gekennzeichnet ist:
 - i) Gewichtung von Bewegungsvektoren aus Bereichen des genannten unterteilten Bildes

addition to features already described herein.

Claims

1. A method of picture motion measurement comprising subdividing pictures into two or more regions and correlating corresponding regions of two pictures to determine correlation as a function of displacement thereby to determine from peak correlation values for each region a plurality of motion vectors, said method being characterised by the further steps of:-

i) weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation functions,

ii) individually summing those weighted motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates, and

iii) selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.

2. A method as claimed in Claim 1, in which the weighting of said motion vectors depends upon the relative magnitudes of peaks in the correlation functions.

3. A method as claimed in Claim 1 or 2, in which the weighting of said motion vectors depends upon the relative widths of peaks in the correlation functions.

4. A method as claimed in Claim 1, 2 or 3, in which said given number of dominant motion vectors is directly proportional to the interval between said two pictures.

5. A method as claimed in Claim 1, 2 or 3 for use in a television system, in which said given number of dominant motion vectors is directly proportional to the number of frames between said two pictures.

6. A method as claimed in any of the preceding claims, in which in the case that at least said given number of said summed quantities are of a correspondingly large magnitude a complexity signal is produced in addition to or instead of selecting coordinates to form the most dominant motion vectors, said complexity signal indicating that said pictures contain a large degree of mo-

tion complexity.

7. Apparatus for picture motion measurement comprising means for correlating corresponding regions of two pictures to determine correlation as a function of displacement to determine from peak correlation values for each region a plurality of motion vectors, characterised in that said apparatus additionally comprises means for weighting motion vectors from regions of said sub-divided picture in dependence upon a given relative quantity representative of a characteristic of the peaks in said correlation functions, means for individually summing those weighted motion vectors having corresponding coordinates from each of said regions of said sub-divided picture to produce a plurality of summed quantities each quantity relating to particular motion vector coordinates and means for selecting the coordinates of a given number of the largest of said summed quantities to form a plurality of the most dominant of said motion vectors.

8. Apparatus as claimed in Claim 7, in which said means for weighting said motion vectors comprises means for weighting said motion vectors depending upon the relative magnitudes of peaks in the correlation functions.

9. Apparatus as claimed in Claim 7 or 8, in which said means for weighting said motion vectors comprises means for weighting said motion vectors depending upon the relative widths of the peaks in the correlation functions.

10. Apparatus as claimed in Claim 7, 8 or 9, in which in the case where at least said given number of said summed quantities are of a correspondingly large magnitude means are provided for producing a complexity signal which signal may be produced in addition to or instead of the most dominant motion vectors.

Patentansprüche

1. Verfahren zur Messung der Bildbewegung mit Unterteilung von Bildern in zwei oder mehr Bereiche und Korrelieren korrespondierender Bereiche von zwei Bildern zur Ermittlung von Korrelation als Funktion einer Verschiebung, um dadurch aus Spitzenkorrelationswerten für jeden Bereich eine Mehrzahl von Bewegungsvektoren zu ermitteln, wobei das genannte Verfahren durch die folgenden weiteren Schritte gekennzeichnet ist:

i) Gewichtung von Bewegungsvektoren aus Bereichen des genannten unterteilten Bildes



in Abhängigkeit von einer gegebenen relativen Menge, die typisch für eine Eigenschaft der Spitzenwerte in den genannten Korrelationsfunktionen ist,

- ii) Individuelle Summierung dieser gewichteten Bewegungsvektoren mit korrespondierenden Koordinaten aus jedem der genannten Bereiche des genannten unterteilten Bildes zur Erzeugung einer Mehrzahl von summierten Größen, wobei sich jede Größe auf bestimmte Bewegungsvektorkoordinaten bezieht, und 5
 - iii) Auswahl der Koordinaten aus einer gegebenen Anzahl der größten der genannten summierten Größen zur Bildung einer Mehrzahl der dominantesten der genannten Bewegungsvektoren. 10
2. Verfahren nach Anspruch 1, in dem die Gewichtung der genannten Bewegungsvektoren von den relativen Größen der Spitzenwerte in den Korrelationsfunktionen abhängt. 20
 3. Verfahren nach Anspruch 1 oder 2, in dem die Gewichtung der genannten Bewegungsvektoren von den relativen Breiten der Spitzenwerte in den Korrelationsfunktionen abhängt. 25
 4. Verfahren nach Anspruch 1, 2 oder 3, in dem die genannte Anzahl dominanter Bewegungsvektoren direkt proportional zu dem Intervall zwischen den genannten beiden Bildern ist. 30
 5. Verfahren nach Anspruch 1, 2 oder 3 zur Verwendung in einem Fernsehsystem, in dem die genannte Anzahl dominanter Bewegungsvektoren direkt proportional zu der Anzahl der Frames zwischen den genannten beiden Bildern ist. 35
 6. Verfahren nach einem der vorausgehenden Ansprüche, in dem im Falle, daß zumindest die genannte Anzahl der genannten Größen von einem entsprechend großen Wert ist, ein Komplexitätssignal zusätzlich oder anstelle einer Auswahl von Koordinaten erzeugt wird, um die dominantesten Vektoren zu bilden, wobei das Komplexitätssignal anzeigt, daß die Bilder ein großes Maß an Bewegungskomplexität enthalten. 40
 7. Vorrichtung zur Messung der Bildbewegung mit Mitteln zur Korrelierung korrespondierender Bereiche von zwei Bildern, um Korrelation als Funktion einer Verschiebung zu ermitteln, um aus Spitzenkorrelationswerten für jeden Bereich eine Mehrzahl von Bewegungsvektoren zu ermitteln, dadurch gekennzeichnet, daß die genannte Vorrichtung zusätzlich Mittel zur Gewichtung von Bewegungsvektoren aus Bereichen des genannten 50

ten unterteilten Bildes in Abhängigkeit von einer gegebenen relativen Größe umfaßt, die für eine Eigenschaft der Spitzenwerte in den genannten Korrelationsfunktionen typisch ist, Mittel zur individuellen Summierung dieser gewichteten Bewegungsvektoren mit korrespondierenden Koordinaten aus jedem der genannten Bereiche des genannten unterteilten Bildes zur Erzeugung einer Mehrzahl von summierten Größen, wobei sich jede Menge auf bestimmte Bewegungsvektorkoordinaten bezieht, und Mittel zur Auswahl der Koordinaten einer gegebenen Anzahl aus den größten der genannten summierten Größen zur Bildung einer Mehrzahl der dominantesten der genannten Bewegungsvektoren.

8. Vorrichtung nach Anspruch 7, in der das genannte Mittel zur Gewichtung der genannten Bewegungsvektoren Mittel zur Gewichtung dieser Bewegungsvektoren in Abhängigkeit von den relativen Höhen der Spitzenwerte in den Korrelationsfunktionen umfaßt.
9. Vorrichtung nach Anspruch 7 oder 8, in der das genannte Mittel zur Gewichtung der genannten Bewegungsvektoren Mittel zur Gewichtung dieser Bewegungsvektoren in Abhängigkeit von den relativen Breiten der Spitzenwerte in den Korrelationsfunktionen umfaßt.
10. Vorrichtung nach Anspruch 7, 8 oder 9, in der, für den Fall, daß zumindest die genannte gegebene Anzahl von summierten Größen von entsprechend großem Wert ist, Mittel zur Erzeugung eines Komplexitätssignals bereitgestellt werden, dessen Signal zusätzlich zu oder anstelle von den dominantesten Bewegungsvektoren erzeugt werden kann.

Revendications

1. Méthode de mesure du mouvement d'image qui consiste à subdiviser des images en deux ou plus de deux zones et à mettre en corrélation des zones correspondantes de deux images afin de déterminer la corrélation en tant que fonction de déplacement et, de ce fait, de déterminer pour chaque zone, à partir des valeurs de corrélation les plus élevées, une pluralité de vecteurs de mouvement, ladite méthode étant caractérisée par les étapes suivantes :
 - i) pondération des vecteurs de mouvement à partir de zones de ladite image subdivisée suivant une quantité relative donnée et représentative d'une caractéristique des crêtes dans ladite fonction de corrélation;
 - ii) sommation individuelle des vecteurs de



mouvement pondérés ayant des coordonnées correspondantes de chacune desdites zones de ladite image subdivisée afin de produire une pluralité de quantités sommées, chacune de ces quantités ayant trait à des coordonnées bien précises d'un vecteur de mouvement, et

iii) sélection des coordonnées d'un nombre donné desdites quantités sommées les plus élevées afin de constituer une pluralité desdits vecteurs de mouvement les plus dominants.

2. Méthode suivant la revendication 1, dans laquelle la pondération desdits vecteurs de mouvement dépend des amplitudes relatives des crêtes dans les fonctions de corrélation.

3. Méthode suivant la revendication 1 ou 2, dans laquelle la pondération desdits vecteurs de mouvement dépend des largeurs relatives des crêtes dans les fonctions de corrélation.

4. Méthode suivant la revendication 1, 2 ou 3, dans laquelle le nombre donné de vecteurs de mouvement dominants est directement proportionnel à l'intervalle entre les deux dites images.

5. Méthode suivant la revendication 1, 2 ou 3 destinée à être utilisée dans un système de télévision, dans laquelle un nombre donné de vecteurs de mouvement dominants est directement proportionnel au nombre d'images complètes entre les deux dites images.

6. Méthode suivant l'une quelconque des revendications précédentes dans laquelle, dans le cas où au moins le nombre donné desdites quantités sommées présente un niveau d'amplitude élevé correspondant, un signal de complexité est créé en supplément ou en remplacement de la sélection des coordonnées en vue de constituer les vecteurs de mouvement les plus dominants, ledit signal de complexité indiquant que les images contiennent un niveau élevé de complexité de mouvement.

7. Dispositif de mesure du mouvement d'image comprenant un moyen pour mettre en corrélation des zones correspondantes de deux images afin de déterminer la corrélation en tant que fonction de déplacement et, par ce fait, de déterminer pour chaque zone à partir des valeurs de crêtes de corrélation une pluralité de vecteurs de mouvement, ledit dispositif étant, en outre, caractérisé en ce qu'il comprend un moyen supplémentaire pour la pondération des vecteurs de mouvement à partir des zones de ladite image subdivisée sui-

vant une quantité relative donnée et représentative d'une caractéristique des crêtes dans lesdites fonctions de corrélation, un moyen de sommation individuelle des vecteurs de mouvement pondérés ayant des coordonnées correspondantes de chacune desdites zones de ladite image subdivisée afin de produire une pluralité de quantités sommées, chacune de ces quantités ayant trait à des coordonnées bien précises d'un vecteur de mouvement et un moyen de sélection des coordonnées d'un nombre donné desdites quantités sommées les plus élevées afin de constituer une pluralité desdits vecteurs de mouvement les plus dominants.

8. Dispositif suivant la revendication 7, dans lequel ledit moyen de pondération desdits vecteurs de mouvement comprend un moyen de pondération desdits vecteurs de mouvement suivant les amplitudes relatives des crêtes dans les fonctions de corrélation.

9. Dispositif suivant la revendication 7 ou 8, dans lequel ledit moyen de pondération desdits vecteurs de mouvement comprend un moyen de pondération desdits vecteurs de mouvement suivant les largeurs relatives des crêtes dans les fonctions de corrélation.

10. Dispositif suivant la revendication 7, 8 ou 9, dans lequel, dans le cas où au moins ledit nombre donné desdites quantités sommées présente un niveau d'amplitude correspondant, des moyens sont prévus pour créer un signal de complexité qui peut être créé en supplément ou en remplacement des vecteurs de mouvement les plus dominants.

