Description

The invention relates to an image processing system and to a method of image processing for effecting spatial transforms on video data representing an image.

Electronic image processing systems are known, capable of capturing video signals representing a television picture and processing these signals to produce the effect of three dimensional manipulation of the picture. One such system is the Encore system manufactured by Quantel Limited of Newbury, Berkshire, England. With this system it is possible to produce a 3D spin of the picture or change the position, size, or view position of the picture using manual controls which includes a tracker ball. To produce these effects, a frame store is provided in which is written a frame of video signals to be processed, and a processing circuit responsive to signals set up by the manual controls determines successive addresses in the frame store from the which successive video signals should be read, to build up an output frame containing the processed picture. The system is interactive, inasmuch as the writing, processing and reading is repeated frame by frame, the input in each frame period, being formed by the output of the preceding frame period. A monitor is provided for displaying successive processed frames as a moving picture so that the operator can observe the effect of his manipulation of the controls in real time. During each frame period the processing circuit responds to the incremental control signals set up during the preceding frame. The processing circuit may for example be of the construction described in our British Patent No. GB-A-2,073,988. (equivalent USA Patent US-A-4437121).

One use to which systems such as described in the preceding paragraph may be put is that of transforming a flat picture so that it can be placed exactly over a polygonal shape (usually quadrilateral) on another picture to build up a composite picture. For example the first picture may be a view through a window and it may be required to place the picture over the window seen from different positions. It is possible to achieve this result using the existing controls on the Encore equipment, but in practice it is a difficult and time consuming process as it may involve a combination of spin - and changes in size, position and point of view of the picture to be superimposed.

The present invention aims to provide an improved image processing system in which effects such as that described in the preceding paragraph can be more easily achieved.

According to one aspect of the present invention there is provided an electronic image processing system for effecting spatial transforms on video data representing an image, the system comprising:

a designating means for designating at least four pinning points

user operable means for effecting notional movement of at least one pinning point in three dimensional space; and

a processor for providing three dimensional transformation data associated with the notional position of the pinning point in three dimensional space as projected onto a viewing screen and for transforming the video data according to the transformation data to produce transformed video data representing the image as projected onto the viewing screen with a related notional movement in three dimensional space to that of the at least one pinning point.

The user operable means may include selecting means for selecting more than one pinning point thereby to enable the user operable means to effect simultaneous notional movement of all selected pinning points and the processor is responsive to the selecting means for providing transformation data associated with the notional positions of the selected pinning points.

The processor may comprise means for setting up equations relating the position of the pinning points at one instant with the position of the pinning points at a later instant after movement of the at least one reference point, means for solving said equations to derive coefficients defining the movement in the interval between said instances resulting from operation of said user operable means, said processor being responsive to said derived coefficients to transform the video data.

Preferably the processor is arranged to impose restrictions on a notional viewing position of the image implied by the notional movement of the pinning points, so as to avoid transformations predicated upon unrealistic projections.

According to another aspect of the present invention there is provided a method of image processing for effecting spatial transforms on video data representing an image, the method comprising the steps of:

designating plural pinning points in the image;

effecting notional movement of at least one pinning point in three dimensional space;

providing three dimensional transformation data associated with the notional position of the pinning point in three dimensional space as projected onto a viewing screen; and transforming the video data according to the transformation data to produce transformed video data representing the image as projected onto the screen with the same notional movement in three dimensional space as that of the at least one

pinning point.

In a further aspect the invention provides an image processing system comprising:

(a) a display means including a viewing screen for displaying an image in response to video signals,

(b) a source of video signals in one raster order representing an initial image,

(c) indicating means for providing initial position signals representing the position coordinates of a plurality of reference points defining the outline of said initial image as represented by said video signals,

(d) operator controlled means for providing other position signals representing the position coordinates of said reference points after an operator selected movement of one or more of said references points to define a desired alteration of said outlines,

(e) coefficient deriving means responsive to said initial and other position signals for deriving coefficient signals defining a group of component transformations including some or all of translation, rotation, magnification and projection which if applied to said initial image could produce said desired alteration of the outline of said initial image,

(f) means responsive to said derived coefficient signals for altering the raster order of the video signals representing said initial image to cause the image represented by said initial video signal to be altered in response to said transformations, and to be displayed on said display means.

In order that the invention may be better understood embodiments will be described hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Figures 1a to 1d are diagrams illustrating an exemplary corner pinning operation;

Figures 2 to 5 are diagrams illustrating the mathematical and physical aspects of the corner pinning operation of Figure 1;

Figure 6 is a schematic block diagram of a first system for effecting a corner pinning operation for a television picture;

Figure 7 is a schematic block diagram of a second system for effecting a corner pinning operation to television pictures; and

Figure 8 illustrates the pinning of non-corner points in an image.

Referring to the drawings, in Figure 1a, rectangle ABCD represents a boundary on a television picture representing a scene projected on a viewing screen. Initially, the boundary coincides with the edges of the television frame although it is not necessarily the case. It wall be appreciated that the picture will be formed by video signals representing respectively a series of picture points in each of a series of lines in well known manner and it will be assumed that video signals are stored in a frame store. The number of a particular picture point in a line and the number of the respective line in the television frame, determine x, y co-ordinates (the address) for the picture point in the store.

For the purpose of illustration, before describing the exemplary embodiment shown in Fig. 6, its operation in transforming the boundary from the rectangular shape A BCD to the quadrialteral A'B'C'D' on the screen will be described with reference to Figures 1(a) to 1(d) of the drawings.

The first step is to move the corner A of the picture boundary to the point A' in the television frame. The system according to the invention has operator-controlled means which the operator can use first to designate corner A for processing and then to feed in signals representing the two component displacements, dx, dy required for the corner. The control signals form a command to transform the addresses of the video signals in the television frame so that the original boundary ABCD is transformed into the boundary A'BCD. This means that all video signals for points in the boundary line AB (coinciding, it is assumed, with the first line of the television frame) are readdressed to the line A'B. Similarly signals for points on the boundary line AD have to be readdressed to the boundary lane A'D. Therefore the video signals on line AB and AD have to be moved to new 'addresses' defining the lines A'B and A'D, in the same or a different frame store so that when read out for display they will occupy different positions on the television raster. All other points on and within the boundary ABCD have to be similarly readdressed to appropriate positions within the transformed boundary A'BCD. The transformation is effected by using the x,y co-ordinates of the original corners ABCD and those of the moved corner (only A' in this case) to derive coefficients which are definitive of the spin, position and view position changes which would be required to make A'BCD the projection on the viewing screen of the original boundary ABCD, after subjecting it to the said spin, posiiton and view position changes. For example picture point m or AB may have its projection at m' in AB. It will be appreciated that distances which are in one ratio on A'B would generally not be in the same ratio in A'B, since projection is involved.

In the foregoing it has been assumed that the transformation of ABCD to A'BCD was made in one step.

However, in the system shown in Fig 6 the change is made interactively over several frame periods in response to successive incremental changes in x,y for the corner A. In any one frame period, an incremental transformation is effected in response to the incremental changes in x and y for the selected

corner, effected by the operator in the previous frame period. The system includes a monitor which displays the transformed frames in succession and so provides the operator with a moving display of the original picture as it is progressivley transformed. He is thus able to control the movement to achieve the desired effect.

It has also been assumed that when addresses are transformed, from line AB to line A'B for example, there will be a storage location in the respective frame store with the transformed address for each picture point in the initial image. In practice, a transformed address will in general turn out to be somewhere in a rectangle defined by two storage locations in each of two adjacent lines of the frame store. The video signal for a picture point when translated to the new address may therefore have to be 'interpolated' among the respective four addresses. One means of achieving such interpolation is described in the aforesaid British Patent GB-A-2073988 (equivalent USA Patent No. US-A-4,437,121) but with a view to simplifying the description of the present invention, it will continue to be assumed that there is a one to one correspondence between transformed addressess in the transformed picture and storage locations in the frame store.

When movement of the first corner is complete, the transformed picture will have the original boundary A'BCD within a rectangular frame ABCD. The original picture point information will all be on or within the boundary A'BCD, and none in the space ABA'D. The operator then uses the control means to select corner B and inserts displacement signals to move corner B to B'. The transforming circuit responds by transforming the boundary A'BCD to A'B'CD as indicated and to transform other picture points within A'BCD correspondingly.

The procedure is repeated for corners C and D resulting in the original picture being transformed so that the boundary becomes A'B'C'D', occupying only part of the television frame. As a practical application, assume that the original picture ABCD was a view of a garden, seen looking straight out of a window for example. The transformation enables the scene to be positioned exactly over a window to build up a composite scene.

Consideration will now be given to the algorithm used for effecting the transformations required to put the invention into practice. Referring to Figure 2, it is known that the image of an object which sits on a flat viewing screen (as displayed on TV monitor say) is transformed into 3D space using the equations:

$$x' = ax + by + kz + c$$
$$y' = dx + ey + lz + f$$
$$z' = ax + hy + mz + j$$

or in matrix form

$$(x'\ y'\ z'\ 1) = (x\ y\ z\ 1) \begin{pmatrix} a & d & g & o \\ b & e & h & o \\ k & l & m & o \\ c & f & j & 1 \end{pmatrix}$$

In these equations, x y define the positon of an image point on the original screen, z a distance measured normal to the screen, and x' y' z' are the co-ordinates of the respective image point moved in 3D space. The coefficients a, b, c .... are determined by the spin, position or size change required to effect the movement.

The object now sitting, as a result of the transformation, in 3D space behind the screen, must be projected back onto the viewing screen (as it would be seen by a person sitting at the viewing position (Vx Vy Vz) on the opposite side of the viewing screen, as indicated in Figure 3. The co-ordinates x" y" z" define the position of an image point when projected back. The co-ordinate z" will be zero, because the plane of the screen is taken to be z = 0.

If we consider the projection of the x' co-ordinate onto the screen at x" as in Fig. 3, by a similar triangle we have:

$$x'' = \frac{x'Vz + z'Vx}{Vz + z'}$$

and similarly

$$y'' = \frac{y'Vz + z'Vy}{Vz + z'}$$

The 3D transformation set out in relation to Fig. 2 can be substituted into these projection equations to allow transformation of each picture point on a 2D to 2D basis. Such a 2D to 2D transformation produces a projection of the original object after subjection to the spin, position and size changes implicit in the 3D equations.

It can be shown that the 2D to 2D equations are of the form:

$$x'' = \frac{Ax + By + C}{Gx + Hy + 1} \text{ and}$$

$$y'' = \frac{Dx + Ey + F}{Gx + Hy + 1}$$

In these equations the capital letters ABC .... are not the a, b, c ... of the 3D equations though they are again related to the spin, position and size changes implied by the movement of the corner.

As the 2D to 2D transformation equations are known, it is believed to be unnecessary to demonstrate the mathematical derivation of the coefficients A to H. For a fuller treatment reference may be had to "Principles of Interactive Computer Graphics", Second Edition, W. M. Newman and Robert F Sproull, published by McGraw-Hill International Book Company - see especially Chapter 22, page 333.

Applying the equations to the Figure 6 embodiment, advantage is taken of the fact that for any particular transformation the starting and finishing co-ordinates of the reference points, the four corners of the pictures, are known. There are therefore four equations in x and four in y which can be set up after each incremental displacement of one or more corners in which these known co-ordinates can be entered, and the equations solved to evalute the coefficients A to H for the particular frame transformation. Using the coefficients thus evaluated, the transformed address for every other picture point in the initial picture can be evaluated.

The projection equations are capable of producing x and y shear or view position change on the input image, as illustrated in Fig. 4 which shows possible projections of an original image subjected to one axis rotations (spin) from flat on the screen. By comparing the views represented by Figure 4 (b) and Figure 4(c) it can be seen that it would be impossible in some circumstances to produce a required shape without changing the viewing position from an initially assumed position, or introducing shear of the original image. Also various arrangements of an object and the viewer may produce the same projection.

This means that a displaced corner such as A' could be the projection of more than one point in space, depending on the viewing position. There is no unique solution for the coefficients A ..... H and it is therefore necessary when evaluating them for a particular movement to postulate limitations on the viewing position which reject unrealistic projections.

Therefore, on feeding the value of the viewing position back into the machine to effect the address transformations, the system is arranged so that certain conditions have to be satisfied. The viewer has to be on the outside of the screen and the transformed picture behind it. The viewing position is the closest

possible to the origin of the screen and a limit for the minimum viewing distance is chosen to be the limit for which 3D controls remain usable. The value for j (which, in the equations above in relaion to Figure 2, is the x and y independent distance of z into the screen) is calculated to produce one side as close to unity as possible and the other to be less than or equal to one.

It has been found in practice that the above conditions are satisfied and acceptable results can be achieved by postulating that the viewing position shall lie on the surface of a hemisphere sitting on the screen and having as a diameter a line joining the vanishing points P1 P2 of the projection, as indicated in Figure 5, assuming four reference points. Spin between Figure 4(a) and Figure 4(b), for example, then becomes realistic. Other sets of conditions may be devised.

In the example of a system according to the invention shown in Figure 6, two frame stores 1 and 2 are provided, having storage locations for storing digital video signals representing every picture point in a television frame. The stores would normally have more than one plane for storing different colour components for each image point in corresponding addresses in the different planes. Video signals representing a picture can be written in each store either from an external source or from the other store, under control of switching circuits 3 and 4. Writing is under control of a write address generator 5 timed by a clock running at picture point frequency so that picture point video signals are written sequentially in the frame store locations in television raster format. The write addresses are applied alternately for frame periods to the store 1 and 2 via a switching circuit 6. Reference 7 denotes a read address generator which generates transformed read addresses for reading video signals from selected addresses in one or other of the frame stores at a picture point rate. The read addresses are applied alternately for frame periods to the stores 1 and 2 via a switching circuit 8, which is synchronised with switching circuit 6 so that when read addresses are applied to one store (1 say) write addresses are applied to the other. The video signals output form the stores 1 and 2 , when read addresses are applied to them, are fed back as aforesaid to the switching circuits 3 and 4 and are also applied to a monitor 9 having a display screen 10 on which successive frames of video signals, read from the stores 1 and 2 and applied to the monitor 9 via switching circuit 10, can be continuously displyed. The operator may also, by means of selector 12 cause related frames of video signals to be applied to a disc store 13 for storage therein.

The address generator 7 constitutes the transforming circuit referred to previously in the specification. It receives inputs from an operator controlled corner displacement generator 14, and from a corner designator 15. The corner designator is also operator-controlled and applies signals to the circuit 7 to determine which corner of a picture is to be displaced at a particular time to effect corner pinning. The generator 14, which may comprise a tracker ball, applies signals to the circuit representing the x and y displacements of the selected corner or corners required by the operator. If more than one corner is selected by the operator, the displacements x y set up by the generator 14 are applied to all the selected corners. The selector 15 is arranged to provide not only a designation of the selected corners, but also the address of all the corners prior to the most recent adjustment. The address adjustment, though effectively tracking the x and y displacements signalled by the generator 14, occurs in steps during each frame period in response to the displacement signalled by the generator 14 in the preceding frame period. The transforming circuit 7 includes means 16 responsive to the inputs from the generator 14 and selector 15 to evalute the coefficients A to H of the 2D to 2D transforming equations referred to in the foregoing. The coefficients are applied to means 17 which uses them to solve for each picture point in an initial picture, the addresses to which that picture point must be assigned in the television raster to cause the picture to be transformed to the projection of the initial picture, subjected for the spin, position or view position changes implied by the displacement of the corner or corners signalled by the outputs of 14 and 15. The evaluations here referred to are subject to conditions which are imposed on the viewing position. The addresses generated by the means 17 are produced at picture point rate. As will be appreciated from the theory described above the addresses generated by the means 17 are addresses to which the successive picture point video signals of the initial picture should be moved in the output raster. However, the addresses produced by the transforming circuit 7 are used in a reading mode to select different addresses from which the untransferred video signal are read from store 1 or 2, so it is necesssary to invert the addresses from the means 17 and this is carried out in address inverting means 18. The picture point video signals read from store 1 or 2 as the case may be are therefore in correct order in the raster to represent the transformed picture.

In using the system illustrated in Figure 6, a picture to be transformed may be read from store 13 and written in one of the stores 1 and 2, (say 1) during a first frame period. During the next frame period this picture is transferred in response to any inputs applied to circuit 7 by the operator and read from the store 1 and written into store 2. The picture in store 2 is then transformed during the next frame period by the circuit 7 in response to inputs made by the operator during the previous frame period, and so on until a desired transformation is completed. In making the transformation, the operator can continuously observe

the effect he is creating on the screen of the monitor 9. The synchronisation of the switching circuits 3, 4, 6, 8 and 10 to achieve the desired mode of operation can be effected under computer control.

The transforming circuit 7 may in fact be constituted by a suitabely programmed computer and this computer may indeed also be programmed so that it can leave the corner pinning mode and effect other transforms such as spin, size, position and view position control which are available in current Encore systems. Means may also be provide, as previously indicated, for effecting interpolation of picture point video signals as required, when a transformed address does not not coincide with an address of a storage location in the stores 1 and 3). Further means may be provided to reduce changes in the brightness of the transformed picture due to compression or expansion of part of the image.

Transformed pictures produced by the system illustrated in Fig. 6 can be keyed into other background pictures to form composite pictures, so that the corner points are "pinned" at predetermined reference points in the background picture or used in other ways. The invention is not confined to television and it could be used in the general graphics field.

The example described with reference to Figs. 1 to 6 operates to pin corner points of an image originally rectangular, to the corners of a quadrilateral seen in perspective. The invention is not, however, confined to systems which operate on this basis and Figs. 7 and 8 illustrate the use of the invention to transform an image of any shape so that reference points on the image can be pinned at predetermined points on a surface in another image (called the scene image), which may be represented as seen from an arbitrary view point. In Figure 7, references 21 to 24 denotes frame store means for storage respectively of (a) cursor video signals representing a cursor, (b) first picture video singals representing an object to be introduced in a scene (picture 1), (c) second picture video signals representing the scene (picture 2) and (d) stencil video signals which in known manner represent a control image (stencil).

Each of the frame store means may be as described in relation to the frame stores 1 and 2 in Fig. 6, and they have source inputs 25 to 28 from which respective video signals may be applied for storage. Reference 29 denotes write address generating means whereby incoming video signals are written in the correct addresses in the frame store means, determined by the position of the video signals in the signal raster. Reference 30, on the other hand, denotes a read address generator which can be operated to read video signals from the store means 21 to 24. The read address singals for the store means 21, 22 and 23 are however applied to the respective store means via address transforming circuit 31, similar to the address generator 7 in Fig. 6.

Reference 32 denotes a combiner 32 for video signals read from the store means 21 to 26 and is controlled by a selector 33 which is operator controlled, and can condition the combiner 32 to superimpose cursor video signals from store means 21 on picture 1 or picture 2 read from store means 22 or 23, or superimpose part of picture 1 on picture 2 read from 23 under control of the stencil from store means 24. The superimposition may be partial, whereby the upper picture appears translucent, or may be complete, the upper image then appearing opaque. Video signals output from the combiner are applied to a display device 34 corresponding to device 9 in Fig. 6, and may also be applied to disc storage means 35 for long term storage. The operation of the frame store means 21 to 26, of the write and read address generator 29 and 30, the combiner 32 and its selector 33 are well known and need not be further described. The combiner 32 may also be conditioned if desired by the selector 33 to pass the signals from any one of the storage means 21 to 24 uncombined with other signals, to the display means 34.

Reference 41 denotes a touch tablet-stylus combination which in this example of the invention can be manipulated to provide address signals representing the addresses of reference points defining the corner of say a rectangle which is used to position picture 1 or picture 2. The touch tablet-stylus combination also provides the operator with means for producing selective adjustment of these addresses to represent positional adjustment of the rectangle. As the operator applies the stylus 45 to different points on the touch table, x y co-ordinate signals of the points are fed to a computer 42 which in turn is connected to a cursor video signal genertor 43. The computer 42 has a mode selector 44 by which the operator can condition the computer to perform different functions. The stylus 45 of the combination 41 has a connection 46 for supplying the computer 42 with a signal representing the pressure with which it is applied to the touch tablet, but this need not be discussed in this application.

As already indicated, the system illustrated in fig. 7 can be used for "pinning" an image of any shape on another image. In Fig. 8 reference 50 denotes a representative non-rectangular image constituting picture 1, the image being shown simply as a circle for convenience. In order to pin this image on picture 2, the system, in response to operator manipulations, writes the respective video signals from source 26 into the frame store means 22 and conditions the combiner 32, using the selector 33, to combine the video signals in frame store means 22 with those in frame in store means 21 (cursor) and apply the combination repetitively during successive frame periods to the display means 34. Initially, frame store means 21 will

contain no cursor video signals, so the display means will display merely pictue 1, without any superimposed cursor. The operator then selects the cursor generation mode, using selector 44 and while observing the picture 1 in the display operates the stylus 46 to designate four reference points on the image 50, say the points 51, 52, 53, 54 shown on Fig. 7. The addresses of these points are fed from 41 to the computer 42 where they are temporarily stored. The computer in response to these address signals causes the cursor generator to produce cursor video signals, in timed relationship with the write addresses from generator 29, to set up in store 21 a video image of a suitable cursor defined by the four reference points. In Fig.7 the cursor image is shown as a simple rectangular grid (shown in dotted lines) with corners located at the reference points 51 to 54. The cursor grid need not be initially rectangular, though in general it must be based on at least four reference points. In principle it could be a polygon of four or more sides.

After generating the cursor, the operator, using the stylus 2, marks on the cursor image the positions on pictue 2 at which the four reference points should be pinned. While doing this the operator may temporarily superimpose the cusor image on picture 2, via the combiner 32. For example, the position at which reference point 52 should be pinned is indicated at 52a. The operator then conditions the computer 42 for generating the address transforms and conditions the combiner 32 to superimpose the cursor image on picture 1 and display the combination on device 34. Having done so the operator selects a reference point (in this case point 52) by pressing the stylus down on the corresponding point on the touch tablet, he then moves the stylus 46 on the touch tablet to drag reference point 52 to point 52A at which pinning is desired, causing the successive generation of new address signals for reference point 52 as the position of this point is adjusted. At the end of each frame period, while this adjustment is taking place, the addresses of the four reference points (including the adjusted address), together with the addresses as they were at the beginning of the period, are used in the computer to set up and solve the equations for evaluating the co-effecients A ... H referred to above. These are fed in turn to the address transforming current 31, to produce the desired transformation of the read addresses for the store means 21 and 22, so that as the position of reference point 52 is adjusted the display means 34 displays picture 1 as if projected on the viewing screen after undergoing the same movement in 3D as implied for the rectangle 51-54 by the adjustment of the address of reference point 52. The same process of adjustment is repeated for each reference point until all of them are positioned at the pinning points derived form picture 2. The transformation is, moreover, carried out interactively whilst the image of picture 1 with the superimposed cursor is displayed.

It is noted that address transformations are carried out by the circuit 31 for all picture points in the cursor image stored in store means 21 and for all picture points in picture 1 stored in store means 22. The address transformation is not limited to picture points with the rectangle initially defined by the reference points 51 to 54. The cursor grid may itself, if desired, initially extend over the whole screen. When the transformation is complete, the image 50 forming picture 1, as transformed, can then be superimposed on picture 2 under control of the stencil video signals from store means 24, the combiner 32 being suitably conditioned for this purpose. The control image formed by the stencil signals may be such that the whole or a part of the picture 1 may be selected for superimposition i.e. picture 1 may be cropped, but in any case the superimposition will be effected in such a way that the four reference points initialy selected by the stylus 46 will be "pinned" at the four chosen points on picture 2.

It will be understood that the modes of operation described with reference to Fig. 6 and Fig. 7 can both be provided in one system if desired. The algorithm used for effecting the address transformations may be similar but as Fig. 7 is a more general case of projecting any quadrilateral, and not simply a rectangle as in Fig. 6, the transformations are more complex. The procedure used for selecting the view position, in the Fig.7 system may also be modified. The matrix values such as A B C .... for an arbitrary view position are first calculated and these values used to calculate the projection of an imaginary rectangle. This projection is then used to postulate a realistic view position for the original quadrilateral using the model illustrated in Fig. 5.

In the Fig. 7 systems it is possible, as in Fig. 6, to select more than one reference point at a time for adjustment, a suitable control routine being prescribed for picking out the described number of reference points to be moved at the same time. Other modes of operation may also be provided for. In one such mode the operator can define four reference points, and then select a further point about which he can spin the picture by "dragging" the stylus from the further point in a prescribed manner. In another so called "size" mode, two sides of the quadrilateral are "moved" by means of the stylus so as to maintain the angles made by the corners. This has the effect of altering size in 3D space.

Claims

1. An electronic image processing system for effecting spatial transforms on video data representing an

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It is noted that address transformations are carried out by the circuit 31 for all picture points in the cursor image stored in store means 21 and for all picture points in picture 1 stored in store means 22. The address transformation is not limited to picture points with the rectangle initially defined by the reference points 51 to 54. The cursor grid may itself, if desired, initially extend over the whole screen. When the transformation is complete, the image 50 forming picture 1, as transformed, can then be superimposed on picture 2 under control of the stencil video signals from store means 24, the combiner 32 being suitably conditioned for this purpose. The control image formed by the stencil signals may be such that the whole or a part of the picture 1 may be selected for superimposition i.e. picture 1 may be cropped, but in any case the superimposition will be effected in such a way that the four reference points initialy selected by the stylus 46 will be "pinned" at the four chosen points on picture 2.

It will be understood that the modes of operation described with reference to Fig. 6 and Fig. 7 can both be provided in one system if desired. The algorithm used for effecting the address transformations may be similar but as Fig. 7 is a more general case of projecting any quadrilateral, and not simply a rectangle as in Fig. 6, the transformations are more complex. The procedure used for selecting the view position, in the Fig.7 system may also be modified. The matrix values such as A B C .... for an arbitrary view position are first calculated and these values used to calculate the projection of an imaginary rectangle. This projection is then used to postulate a realistic view position for the original quadrilateral using the model illustrated in Fig. 5.

In the Fig. 7 systems it is possible, as in Fig. 6, to select more than one reference point at a time for adjustment, a suitable control routine being prescribed for picking out the described number of reference points to be moved at the same time. Other modes of operation may also be provided for. In one such mode the operator can define four reference points, and then select a further point about which he can spin the picture by "dragging" the stylus from the further point in a prescribed manner. In another so called "size" mode, two sides of the quadrilateral are "moved" by means of the stylus so as to maintain the angles made by the corners. This has the effect of altering size in 3D space.

Claims

1. An electronic image processing system for effecting spatial transforms on video data representing an

image, the system comprising:

a designating means (15;30) for designating at least four pinning points;

user operable means (14; 41, 45) for effecting notional movement of at least one pinning point in three dimensional space; and

a processor (7;31) for providing three dimensional transformation data associated with the notional position of the pinning point in three dimensional space as projected onto a viewing screen and for transforming the video data according to the transformation data to produce transformed video data representing the image as projected onto the viewing screen with a related notional movement in three dimensional space to that of the at least one pinning point.

2. An image processing system as claimed in claim 1, wherein the designating means (15;30) is user operable.

3. An image processing system as claimed in claim 1 or 2, wherein the image is quadrilateral and the pinning points are designated at the four corners of the image.

4. An image processing system as claimed in claim 1 or 2 or 3, wherein the user operable means includes selecting means (44) for selecting more than one pinning point thereby to enable the user operable means to effect simultaneous notional movement of all selected pinning points and the processor (31) is responsive to the selecting means for providing transformation data associated with the notional positions of the selected pinning points.

5. An image processing system as claimed in any preceding claim, wherein the processor comprises means for setting up equations relating the position of the pinning points at one instant with the position of the pinning points at a later instant after movement of the at least one reference point, means for solving said equations to derive coefficients defining the movement in the interval between said instances resulting from operation of said user operable means, said processor being responsive to said derived coefficients to transform the video data.

6. An image processing system as claimed in any preceding claim, wherein the processor is arranged to impose restrictions on a notional viewing position of the image implied by the notional movement of the pinning points, so as to avoid transformations predicated upon unrealistic projections.

7. An image processing system as claimed in any preceding claim, comprising a framestore (1,2; 22, 23) for storing said video data; and means (29) for rearranging the video data in said framestore in response to the transformation data provided by said processor, so as to represent the movement of said image in three dimensional space.

8. An image processing system as claimed in any preceding claim, further comprising a combiner (32) responsive to control image data (24) for combining the transformed video data (22) with further video data (23) representing a further image to produce composite video data representing a composite image.

9. A method of image processing for effecting spatial transforms on video data representing an image, the method comprising the steps of:

designating plural pinning points in the image;

effecting notional movement of at least one pinning point in three dimensional space;

providing three dimensional transformation data associated with the notional position of the pinning point in three dimensional space as projected onto a viewing screen; and transforming the video data according to the transformation data to produce transformed video data representing the image as projected onto the screen with the same notional movement in three dimensional space as that of the at least one pinning point.

10. A method of image processing as claimed in claim 9, wherein the image is quadrilateral and four pinning points are designated at the four corners of the image.

11. A method of image processing as claimed in claim 9 or 10, wherein more than on pinning point is selected, simultaneous notional movement of all selected pinning points is effected, and the trans-

formed video data is associated with the notional positions of the selected pinning points.

12. A method of image processing as claimed in claim 9 or 10 or 11, further comprising the steps of:
setting up equations relating the position of the pinning points at one instant with the position of the pinning points at a later instant after moving the at least one pinning point;
solving said equations to derive coefficients defining the movement in the interval between said instances; and
transforming the video data with said derived coefficients.

13. A method of image processing as claimed in any of claims 9 to 12 further comprising the step of imposing restrictions on a notional viewing position of the image implied by the notional movement of the pinning points, so as to avoid transformations predicated upon unrealistic projections.

14. A method of image processing as claimed in any of claims 9 to 13, wherein said video data is stored in a framestore, and further comprising the step of rearranging the video data from said framestore in response to the transformation of locations so as to represent the movement of said picture in three dimensional space.

15. A method of image processing as claimed in any of claims 9 to 14, further comprising combining the transformed video data with further video data representing a further image in response to control image data to produce composite video data representing a composite image.

16. An image processing system comprising:-
(a) a display means (9;34) including a viewing screen for displaying an image in response to video signals,
(b) a source of video signals (25 to 28) in one raster order representing an initial image,
(c) indicating means for providing initial position signals (21) representing the position coordinates of a plurality of reference points defining the outline of said initial image as represented by said video signals,
(d) operator controlled means (14; 41, 45, 46) for providing other position signals representing the position co-ordinates of said reference points after an operator selected movement of one or more of said references points to define a desired alteration of said outlines,
(e) coefficient deriving means (16;31) responsive to said initial and other position signals for deriving coefficient signals defining a group of component transformations including some or all of translation, rotation, magnification and projection which if applied to said initial image could produce said desired alteration of the outline of said initial image,
(f) means (8;31) responsive to said derived coefficient signals for altering the raster order of the video signals representing said initial image to cause the image represented by said initial video signal to be altered in response to said transformations, and to be displayed on said display means.

17. A system according to claim 16, in which said coefficient deriving means includes means for selecting as the viewing position governing the projection, one of plurality of possible viewing positions in dependence of preselected criteria.

18. A system according to claim 16 or 17, in which said coefficient deriving means include means for selecting as the viewing position governing the projection, a position on the surface of a hemisphere sitting on the viewing screen and having as a diameter the line joining the vanishing points of two pairs of opposite sides of said outline in the form then current.

19. A system according to claim 16 or 17 or 18 which is so arranged that said desired alterations of outline are displayed on said viewing screen in response to said operator selected movement of one or more of said reference points.

Patentansprüche

1. Elektronisches Bildverarbeitungssystem zur Durchführung räumlicher Transformationen von ein Bild repräsentierenden Videodaten mit:
einer Bestimmungsanordnung (15; 30) zur Bestimmung von wenigstens vier Festlegungspunkten,

einer von einem Benutzer bedienbaren Anordnung (14; 41, 45) zur Durchführung einer begrifflichen Bewegung wenigstens eines Festlegungspunktes im dreidimensionalen Raum, und
einem Prozessor (7; 31) zur Realisierung einer dreidimensionalen Transformation von der begrifflichen Position des Festlegungspunktes zugeordneten Daten im dreidimensionalen Raum bei Projektion auf einen Betrachtungsschirm sowie zur Transformation der Videodaten gemäß den Transformationsdaten zwecks Erzeugung transformierter das Bild repräsentierender Videodaten bei Projektion auf den Betrachtungsschirm mit einer damit verbundenen begrifflichen Bewegung im dreidimensionalen Raum zu der des wenigstens einen Festlegungspunktes.

2. Bildverarbeitungssystem nach Anspruch 1, bei dem die Bestimmungsanordnung (15; 30) durch eine Bedienungsperson betätigbar ist.

3. Bildverarbeitungssystem nach Anspruch 1 oder 2, bei dem das Bild ein Trapez ist und die Festlegungspunkte auf die vier Ecken des Bildes bezogen sind.

4. Bildverarbeitungssystem nach Anspruch 1, 2 oder 3, bei dem die vom Benutzer betätigbare Anordnung eine Auswahlanordnung (44) zur Auswahl von mehr als einem Festlegungspunkt enthält, wodurch die vom Benutzer betätigbare Anordnung gleichzeitig eine begriffliche Bewegung aller ausgewählten Festlegungspunkte durchführen kann, und bei welcher der Prozessor (31) von der Auswahlanordnung angesteuert ist, um eine Transformation von den begrifflichen Positionen der ausgewählten Festlegungspunkte zugeordneten Daten zu realisieren.

5. Bildverarbeitungssystem nach den vorhergehenden Ansprüchen, bei dem der Prozessor eine Anordnung zur Aufstellung von Gleichungen umfaßt, welche die Position der Festlegungspunkte in einem Augenblick mit der Position der Festlegungspunkte in einem späteren Augenblick nach Bewegung wenigstens eines Referenzpunktes in Beziehung setzt, und bei welcher der Prozessor eine Anordnung zur Lösung dieser Gleichungen enthält, um Koeffizienten abzuleiten, welche die sich aus der Betätigung der vom Benutzer betätigbaren Anordnung resultierende Bewegung im Intervall zwischen den Augenblicken definieren, wobei der Prozessor zur Transformation der Videodaten auf die abgeleiteten Koeffizienten anspricht.

6. Bildverarbeitungssystem nach den vorhergehenden Ansprüchen, bei welchem der Prozessor Beschränkungen der durch die begriffliche Bewegung der Festlegungspunkte gegebenen begrifflichen Betrachtungsposition des Bildes bewirkt, um auf unrealistischen Projektionen beruhende Transformationen zu vermeiden.

7. Bildverarbeitungssystem nach den vorhergehenden Ansprüchen mit einem Bildspeicher (1, 2; 22, 23) zur Speicherung der Videodaten und mit einer Anordnung (29) zur Neuanordnung der Videodaten im Speicher als Funktion der durch den Prozessor durchgeführten Datentransformation um die Bewegung des Bildes im dreidimensionalen Raum darzustellen.

8. Bildverarbeitungssystem nach den vorhergehenden Ansprüchen mit einer von den Steuerbilddaten (24) angesteuerten Kombinationsanordnung (32) zur Kombination der transformierten Videodaten (22) mit weiteren ein weiteres Bild repräsentierenden Videodaten (23) zwecks Erzeugung von ein zusammengesetztes Bild repräsentierenden zusammengesetzten Videodaten.

9. Verfahren zur Durchführung räumlicher Transformationen von ein Bild repräsentierenden Videodaten mit folgenden Schritten:
Bestimmung mehrerer Festlegungspunkte im Bild,
Durchführung einer begrifflichen Bewegung wenigstens eines Festlegungspunktes im dreidimensionalen Raum, und
Realisierung einer dreidimensionalen Transformation von der begrifflichen Position des Festlegungspunktes zugeordneten Daten im dreidimensionalen Raum bei Projektion auf einen Betrachtungsschirm sowie Transformation der Videodaten gemäß den Transformationsdaten zwecks Erzeugung transformierter das Bild repräsentierender Videodaten bei Projektion auf den Betrachtungsschirm mit der gleichen begrifflichen Bewegung im dreidimensionalen Raum wie die des wenigstens einen Festlegungspunktes.

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10. Verfahren zur Bildverarbeitung nach Anspruch 9, bei dem das Bild ein Trapez ist und vier Festlegungspunkte an vier Ecken des Bildes bestimmt werden.

11. Verfahren zur Bildverarbeitung nach Anspruch 9 oder 10, bei dem mehr als ein Festlegungspunkt ausgewählt wird, eine gleichzeitige begriffliche Bewegung aller ausgewählten Festlegungspunkte durchgeführt wird und die transformierten Videodaten den begrifflichen Positionen der ausgewählten Festlegungspunkte zugeordnet werden.

12. Verfahren zur Bildverarbeitung nach Anspruch 9, 10 oder 11 mit folgenden weiteren Schritten:
Aufstellen von Gleichungen, welche die Position der Festlegungspunkte in einem Augenblick mit der Position der Festlegungspunkte in einem späteren Augenblick nach Bewegung des wenigstens einen Festlegungspunktes in Beziehung setzen,
Lösen der Gleichungen zwecks Ableitung von Koeffizienten, welche die Bewegung im Intervall zwischen den Augenblicken definieren, und
Transformation der Videodaten mit den abgeleiteten Koeffizienten.

13. Verfahren zur Bildverarbeitung nach den Ansprüchen 9 bis 12, bei dem einer durch die begriffliche Bewegung der Festlegungspunkte gegebenen begrifflichen Betrachtungsposition des Bildes Beschränkungen auferlegt werden, um auf unrealistischen Projektionen beruhende Transformationen zu vermeiden.

14. Verfahren zur Bildverarbeitung nach den Ansprüchen 9 bis 13, bei dem die Videodaten in einem Bildspeicher gespeichert werden und weiterhin die Videodaten aus dem Bildspeicher als Funktion der Transformation von Plätzen neu angeordnet werden, um die Bewegung des Bildes im dreidimensionalen Raum darzustellen.

15. Verfahren zur Bildverarbeitung nach den Ansprüchen 9 bis 14, bei dem die transformierten Videodaten als Funktion von Steuerbilddaten mit weiteren ein weiteres Bild repräsentierenden Videodaten kombiniert werden, um ein zusammengesetztes Bild repräsentierende zusammengesetzte Videodaten zu erzeugen.

16. Bildverarbeitungssystem mit:
(a) eine Anzeigeanordnung (9; 34) mit einem Betrachtungsschirm zur Anzeige eines Bildes als Funktion von Videosignalen,
(b) einer Quelle (25 bis 28) für ein Anfangsbild repräsentierende Videosignale in Rasteranordnung,
(c) einer Signalgabeanordnung zur Erzeugung von Anfangspositionssignalen (21), welche die Positionskoordinaten einer Vielzahl von Referenzpunkten repräsentieren, die den Umriß des durch die Videosignale repräsentierten Anfangsbildes definieren,
(d) einer von einem Benutzer steuerbaren Anordnung (14; 41, 45, 46) zur Erzeugung von weiteren Positionssignalen, welche die Positionskoordinaten der Referenzpunkte nach einer von der Bedienungsperson ausgewählten Bewegung eines oder mehrerer Referenzpunkte zwecks Definition einer gewünschten Änderung der Umrisse repräsentieren,
(e) einer von den Anfangspositionssignalen und den weiteren Positionssignalen angesteuerten Koeffizientenableitungsanordnung (16; 31) zur Ableitung von Koeffizientensignalen, welche eine Gruppe von einige oder alle Operationen Translation, Rotation, Vergrößerung und Projekton enthaltende Komponententransformationen definieren, welche in Anwendung auf das Anfangsbild die gewünschte Änderung des Umrisses des Anfangsbildes erzeugen können,
(f) einer von den abgeleiteten Koeffizientensignalen angesteuerte Anordnung (8; 31) zur Änderung der Rasterordnung der das Anfangsbild repräsentierenden Videosignale zwecks Änderung des durch das Anfangsvideosignal repräsentierten und auf der Anzeigeanordnung anzuzeigenden Bildes als Funktion der Transformationen.

17. System nach Anspruch 16, bei dem die Koeffizientenableitungsanordnung eine Anordnung zur Auswahl einer Vielzahl von möglichen Betrachtungspositionen in Abhängigkeit von vorgewählten Kriterien als die Projektion beherrschende Betrachtungsposition.

18. System nach Anspruch 16 oder 17, bei dem die Koeffizientenableitungsanordnung eine Anordnung zur Auswahl einer Position auf der Oberfläche einer auf dem Betrachtungsschirm aufsitzenden Halbkugel

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mit einer Linie als Durchmesser, welche die Fluchtpunkte von zwei Paaren gegenüberliegender Seiten des Umrisses in der dann vorhandenen Form als die Projektion beherrschende Betrachtungsposition.

19. System nach Anspruch 16, 17 oder 18 mit einer derartigen Ausbildung, daß die gewünschten Änderungen des Umrisses als Funktion der von einer Bedienungsperson ausgewählten Bewegung eines oder mehrerer Referenzpunkte angezeigt werden.

Revendications

1. Système de traitement électronique d'image pour effectuer des transformées spatiales sur des données vidéo représentant une image, le système comprenant :
un moyen d'indication (15 ; 30) pour indiquer au moins quatre points d'affectation ;
un moyen actionnable par l'utilisateur (14 ; 41, 45) pour effectuer un mouvement fictif d'au moins un point d'affectation dans un espace à trois dimensions ; et
un processeur (7 ; 31) pour fournir trois données de transformation dimensionnelle associées à la position fictive du point d'affectation dans un espace à trois dimensions tel que projeté sur un écran de visualisation et pour transformer les données vidéo en fonction des données de transformation pour produire des données vidéo transformées représentant l'image telle que projetée sur l'écran de visualisation avec un mouvement fictif afférent dans un espace à trois dimensions pour l'au moins un point d'affectation.

2. Système de traitement d'image selon la revendication 1, dans lequel le moyen d'indication (15 ; 30) peut être actionné par l'utilisateur.

3. Système de traitement d'image selon la revendication 1 ou 2, dans lequel l'image est un quadrilatère et les points d'affectation sont indiqués au niveau des quatre angles de l'image.

4. Système de traitement d'image selon la revendication 1, 2 ou 3, dans lequel le moyen qui peut être actionné par l'utilisateur inclut un moyen de sélection (44) pour sélectionner plus d'un point d'affectation pour ainsi permettre au moyen qui peut être actionné par l'utilisateur d'effectuer un mouvement fictif simultané de tous les points d'affectation sélectionnés et le processeur (31) est sensible au moyen de sélection pour fournir des données de transformation associées aux conditions fictives des points d'affectation sélectionnés.

5. Système de traitement d'image selon l'une quelconque des revendications précédentes, dans lequel le processeur comprend un moyen pour élaborer des équations relatives à la position des points d'affectation à un instant donné, à la position des points d'affectation à un instant ultérieur après un déplacement de l'au moins un point de référence, un moyen pour résoudre lesdites équations pour dériver des coefficients définissant le mouvement dans l'intervalle entre lesdits résultats de l'actionnement dudit moyen qui peut être actionne par l'utilisateur, ledit processeur étant sensible auxdits coefficients dérivés pour transformer les données vidéo.

6. Système de traitement d'image selon l'une quelconque des revendications précédentes, dans lequel le processeur est agencé pour imposer des restrictions sur une position de visualisation fictive de l'image mise en jeu par le mouvement fictif des points d'affectation de manière à éviter des transformations prédites suite à des projections non réalistes.

7. Système de traitement d'image selon l'une quelconque des revendications précédentes, comprenant une mémoire d'image (1, 2 ; 22, 23) pour stocker lesdites données vidéo ; et un moyen (29) pour réagencer les données vidéo dans ladite mémoire d'image en réponse aux données de transformation fournies par ledit processeur de manière à représenter le mouvement de ladite image dans un espace à trois dimensions.

8. Système de traitement d'image selon l'une quelconque des revendications précédentes, comprenant en outre un combineur (32) sensible à des données d'image de commande (24) pour combiner les données vidéo transformées (22) à d'autres données vidéo (23) représentant une autre image pour produire des données vidéo composites représentant une image composite.

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9. Procédé de traitement d'image pour effectuer des transformées spatiales sur des données vidéo représentant une image, le procédé comprenant les étapes de :

indication de plusieurs points d'affectation dans l'image ;

réalisation d'un mouvement fictif d'au moins un point d'affectation dans un espace à trois dimensions ;

fourniture de données de transformation en trois dimensions associées à la position fictive du point d'affectation dans un espace à trois dimensions tel que projeté sur un écran de visualisation ; et

transformation des données vidéo en fonction des données de transformation pour produire des données vidéo transformées représentant l'image telle que projetée sur l'écran avec le même mouvement fictif dans un espace à trois dimensions que celui de l'au moins un point d'affectation.

10. Procédé de traitement d'image selon la revendication 9, dans lequel l'image est un quadrilatère et quatre points d'image sont indiqués aux quatre angles de l'image.

11. Procédé de traitement d'image selon la revendication 9 ou 10, dans lequel plus d'un point d'affectation est sélectionné, un mouvement fictif simultané de tous les points d'affectation sélectionnés est effectué et les données vidéo transformées sont associées à la position fictive des points d'affectation sélectionnés.

12. Procédé de traitement d'image selon la revendication 9, 10 ou 11, comprenant en outre les étapes de :

élaboration d'équations relatives à la position des points d'affectation à un instant donné avec la position des points d'affectation à un instant ultérieur après déplacement de l'au moins un point d'affectation ;

résolution desdites équations pour dériver des coefficients définissant le mouvement dans l'intervalle entre lesdits résultats ; et

transformation des données vidéo avec lesdits coefficients dérivés.

13. Procédé de traitement d'image selon l'une quelconque des revendications 9 à 12, comprenant en outre l'étape d'imposition de restrictions sur une position de visualisation fictive de l'image mise en jeu par le mouvement fictif des points d'affectation de manière à éviter des transformations prédites suite à des projections non réalistes.

14. Procédé de traitement d'image selon l'une quelconque des revendications 9 à 13, dans lequel lesdites données vidéo sont stockées dans une mémoire d'image, et comprenant en outre l'étape de réagencement des données vidéo de ladite mémoire d'image en réponse à la transformation d'emplacements de manière à représenter le mouvement de ladite image dans un espace à trois dimensions.

15. Procédé de traitement d'image selon l'une quelconque des revendications 9 à 14, comprenant en outre la combinaison des données vidéo transformées à d'autres données vidéo représentant une autre image en réponse à des données d'image de commande pour produire des données vidéo composites représentant une image composite.

16. Système de traitement d'image comprenant :

(a) un moyen d'affichage (9, 34) incluant un écran de visualisation pour afficher une image en réponse à des signaux vidéo,

(b) une source de signaux vidéo (25 à 28) selon un ordre récurrent représentant une image initiale,

(c) un moyen d'indication pour fournir des signaux de position initiale (21) représentant les coordonnées de positions d'une pluralité de points de référence définissant le contour de ladite image initiale telle que représentée par lesdits signaux vidéo,

(d) un moyen commandé par l'opérateur (14 ; 41, 45, 46) pour fournir d'autres signaux de position représentant les coordonnées de position desdits points de référence après un déplacement sélectionné par opérateur d'un ou de plusieurs desdits points de référence afin de définir une altération souhaitée desdits contours,

(e) un moyen de dérivation de coefficients (16 ; 31) sensible auxdits signaux de position initiale et auxdits signaux d'autres positions pour dériver des signaux de coefficients définissant un groupe de transformations de composantes incluant certaines transformations prises parmi la translation, la rotation, l'amplification et le projection ou toutes, ces transformations de composantes, si elles sont appliquées à ladite image initiale, pouvant produire ladite altération souhaitée du contour de ladite

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image initiale,
(f) un moyen (8 ; 31) sensible auxdits signaux de coefficients dérivés pour altérer l'ordre récurrent des signaux vidéo représentant ladite image initiale pour provoquer l'altération de ladite image représentée par ledit signal vidéo initial en réponse auxdites transformations et pour provoquer l'affichage sur ledit moyen d'affichage.

17. Système selon la revendication 16, dans lequel ledit moyen de dérivation de coefficients inclut un moyen pour sélectionner en tant que position de visualisation gouvernant la projection l'une d'une pluralité de positions de visualisation possibles en fonction de critères présélectionnés.

18. Système selon la revendication 16 ou 17, dans lequel ledit moyen de dérivation de coefficients inclut un moyen pour sélectionner en tant que position de visualisation gouvernant la projection une position sur la surface d'une hémisphère située sur l'écran de visualisation et présentant en tant que diamètre la ligne qui joint les centres de projection de deux paires de côtés opposés dudit contour sous la forme alors courante.

19. Système selon la revendication 16 ou 17 ou 18, qui est agencé de telle sorte que lesdites altérations souhaitées du contour soient affichées sur ledit écran de visualisation en réponse audit mouvement choisi par l'opérateur d'un ou de plusieurs desdits points de référence.

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