image of the two points continues to go through subtle changes below the Rayleigh limit until the two points actually coincide in the scene. (Of course, upon coincidence they are definitely unresolvable.) Accordingly, there is realizable information contained in a blurred image of two points separated by a distance below that of the Rayleigh criterion. Extraction of this information is accomplished in the present invention.

Multiple Image Registration

FIGS. 2*a* and 2*b* illustrate the multiple image registration used in this invention with the simple example of a video frame having only sixteen pixels, four on each side. In FIG. 2*a*, a video frame "a", bounded by the solid line whose corners are denoted a_{11}, a_{14}, a_{41} and a_{44}, comprises sixteen pixels each centered around sixteen respective points a_{ij}. The location of each of the center points symbolized as a_{ij} of the sixteen pixels is illustrated in FIG. 2*a* while the mosaic of the corresponding pixels themselves is illustrated in FIG. 2*b* in solid line.

Multiple image registration is achieved by sampling and storing the sixteen pixels of data comprising the video frame a of FIG. 2*a* illustrated in solid line. Then the camera **5** is displaced in the x direction so as to sample a second video frame b illustrated in dashed line comprising sixteen pixels b_{ij} and bounded by pixels b_{11}, b_{14}, b_{41} and b_{44}. The displacement in the x direction between the video frames a and b is equal to half the distance between the center points a_{11} and a_{12}. The sixteen pixels of data corresponding to the sixteen center points b_{ij} are sampled and stored. The camera **5** is again displaced to sample a third video frame c bounded by pixels c_{11}, c_{14}, c_{41} and c_{44} in FIG. 2*a*. The video frame c is displaced from the original video frame a in the y direction by half the distance between the center points a_{11} and a_{21}. The sixteen pixels corresponding to the sixteen center points c_{ij} are then sampled and stored. The camera **5** is then displaced from the location corresponding to the video frame c in the x direction by a distance corresponding to half the pixel spacing to sense a fourth video frame d illustrated in FIG. 2*a* in dashed-dotted line whose corner pixels bear indicia d_{11}, d_{14}, d_{41} and d_{44}. The sixteen pixels corresponding to the sixteen center points d_{ij} of the video frame d are then sampled and stored.

A composite of the stored data from the video frames a, b, c and d is then formed by reorganizing the data in the order illustrated in FIG. 2*b*. Specifically, FIG. 2*b* illustates the data corresponding to the pixel center points a_{11}, b_{11}, c_{11} and d_{11} in a multiple-registered or composite video frame indicated in dashed line in FIG. 2*b*. Each of the points a_{11}, b_{11}, c_{11} and d_{11} is now the center of a corresponding subpixel illustated in dashed line in FIG. 2*b*. The number of subpixels in the resulting composite mosaic is equal to the square of the sampling improvement multiplied by the number of pixels in any one of the original video frames (in our example $2^2 \times 16 = 64$ subpixels). The dashed line subpixels of FIG. 2*b* are of smaller dimension than the solid line pixels by a factor of 2.

As a general rule, in a multiple registration of n video frames, the video frames are displaced from one another by a fraction $(1/n)^{\frac{1}{2}}$ of the pixel spacing. Thus, while FIG. 2*b* illustrates a multiple image registration of four video frames in which the pixel dimension is reduced by a factor of two, other reduction factors may be achieved by multiple image registration.

Even though the granularity of the video data has been reduced by the multiple image registration, the image represented by the data is nevertheless blurred in accordance with the point spread function of the aperture through which the image was viewed.

In practice, correlation of the spatial displacement between video frames with the reorganization of the stored video data may be made by means of a camera or sensor **5** mounted on a controller **7** as indicated in FIG. 2*c*. The controller may be a camera gyroscopic stabilization platform whose gyro error may be automatically sensed and used as the video frame displacement. Alternatively, the platform **7** may be an image motion compensator using gyro stablization. Again, the gryo error would define the displacement between the subsequent video frames. Finally, a correlation tracker may be used to track the actual displacement due to camera jitter between video frames. Data from the correlation tracker would define the displacement between subsequent video frames. Each of these techniques is compatible with existing systems.

Referring to FIG. 3, a video frame **10** is synthesized by the multiple image registration of sixteen standard video frames of about 500 lines each, could not be entirely displayed on a standard video screen. Instead, the screen could accommodate only a small fraction **10'** of the multiple-registered video image. Accordingly, the data residing in those portions **10*a*, 10*c*,** and **10*d*** of the video frame of FIG. **3** correspond to unnecessary scan excursions by the imager **5** in the Y direction. It is preferable in this invention to restrict the scan of the imager **5** of FIG. 2*c* in the Y direction to cover only the portion of **10** illustrated in FIG. 3 as **10'**, **10*e*,** and **10*b*.** In this way, data comprising the multiple-registered image **10'** which is actually displayed on a television screen may be acquired about four times faster than otherwise for a 4-fold multiple registration.

Referring again to FIG. 2*b*, it should be recognized that each of the points a_{ij}, b_{ij}, c_{ij}, d_{ij} corresponds to a word of video data which may be stored in the memory of a computer. The word corresponding to each of the points a_{ij}, b_{ij}, c_{ij}, d_{ij} may take on any number in a range of values corresponding to an analog value of the radiation intensity sensed at that point by the camera **5**. Alternatively, in a low performance system, each word may simply be a binary value (black or white, on or off). However, it is contemplated in this invention that each word represents an analog value corresponding to the intensity of radiation sensed by the imager at the corresponding center joint a_{ij}, b_{ij}, etc.

Image Interpolation and Zoom

It may not be possible to use multiple image registration to generate subpixel video data. This may occur, for example, when objects to be viewed in the scene are moving so fast in comparison with the rate at which subsequent video frames are generated, that there is insufficient correlation of the fast moving objects between subsequent video frames. In this special situation, image interpolation and zoom may be used to generate the subpixels, instead of multiple image registration.

Referring to FIG. **4**, a subpixel of video data is generated from a single video frame. The exemplary portion of the video frame a of FIG. **4** comprises a plurality of stored words of video data in which only the words corresponding to pixel center points a_{12}, a_{21} and a_{32} represent a non-zero intensity, corresponding to the shaded areas of the video frame a of FIG. **4**.