over each of the linear arrays (**22**). The color filters (**26**) are configured to pass only a particular portion of the color spectrum which may include multiple wavelengths of visible light. When the array (**24**) is swept, each linear array (**22**) produces images of the same object in different color bands. The filters (**26**) are fabricated by depositing optical coatings on transparent substrates, which are then placed over each of the linear arrays (**22**). This process is well known.

In Staring systems, the multiple color-band data is created by incorporating a beam splitter in the optical system (**12**) and using multiple detector arrays. Such a configuration is illustrated in FIG. **8**. The beam splitter (**28**) splits the incoming light (**32**) into multiple beams (**34**); FIG. **8** shows the basic idea using a two-beam system. Due to the operation of the beam splitter (**28**) each light beam (**34**) includes a different part of the color spectrum which may include one or more different bands of visible or infrared light. Each light beam is directed to one of the detector arrays (**30**) producing images of the same object in different color bands.

In Case four, the sensor (**10**) is a combination of the three previously described cases. This is accomplished by combining the principles discussed above with regard to Cases one, two or three. In all three cases the sensor must be designed to have a signal to noise ratio which is high as possible. This is done either by increasing the integration time of the detectors (**14**) or by slowing down the scan speed as much as possible for scanning systems. For Case two, the system's design, or its operation mode, or both, are changed in order to take the required multiple images in a known pattern displaced by a known distance that is not a multiple of a pixel, but rather is a multiple of a pixel plus a known fraction of a pixel.

Referring back to FIG. **1**, coupled to the detectors (**14**) is a processor (**16**) which processes the image data to achieve the higher resolution. This done by recovering "lost" information from the image data. Even though the diffraction blur destroys the required spatial resolution, some of the "lost" spatial information still exists spread across the focal plane. The small-size detectors described above are used to sample at a 5 to 10 times higher rate than is customary in these sorts of optical systems in conjunction with processing enabling much of this "lost" information to be recovered and thus restoring the image to a higher level of resolution than classical diffraction theory would allow.

The processor (**16**) uses one of two image processing techniques a Non-linear Reconstruction method using a modified Richardson-Lucy Enhancement technique, and a background reconstruction approach using a linear algebra technique.

One reasonable extension of the previously described imaging techniques is to use phase retrieval or wave front phase information to reconstruct the image and thus achieve higher resolution. Another reasonable extension of the previously described technique is to use prior knowledge of the background scene to help resolve objects that have recently moved into the scene. The processor (**16**) in addition to using one of the above described primary data processing techniques, also uses other techniques to process further the imaging data. This further processing is accomplished by standard image enhancement techniques which can be used to improve the reconstructed image. Such techniques include, but are not limited to, edge sharpening, contrast stretching or other contrast enhancement techniques.

The Non-linear Background Reconstruction method using a modified Richardson-Lucy Enhancement Technique is described as follows. In FIG. **9**A, there is shown a scene (**10**) comprising a localized object (**20**) such as a tractor within a noisy blurred background (**30**). In FIG. **9**B, input data D**2** (Block **20**), representing the noisy blurred background data, is input into module **30** to remove the noise from D**2** using a modified version of the method of sieves. Note that the input data D**1** and D**2** indicated in block **20** has been sampled at the Nyquist rate (S times the customary image sampling rate) and preferably at twice the Nyquist rate (ten times the customary sampling rate) to obtain robust input data.

The modified method of sieves removes noise by averaging adjacent pixels of the noisy blurred background data D**2** of the same scene together, using two and three pixel wide point spread functions. Array h_0 in equation (**9***a*) of module **30** represents the optical system PSF, which is the Fourier transform of the OTF input.

The output of module **30** thus provides separate pictures the optical system image I(x) and the modified background data images D**3**(x) and D**4**(x). As shown in block **40**, new point spread functions h_{3T} and h_{4T} have been constructed to account for the combined effect of the method of sieves and the optical system. These new point spread functions use both the two and three pixel wide point spread functions, h_3 and h_4, previously identified, as well as the optical system PSF h_0, as shown in equation **9**(*d*) and (e), to arrive at the new PSF's.

As shown in block **50**, the Richardson-Lucy method is then used to reconstruct the background scene data, D**2**, with the reconstructed data defined to be I_r (X). FIG. **10** shows an exploded view of the processing steps for reconstructing the background scene to obtain the reconstructed background I_r(x) .

In FIG. **10** the noise suppressed data D**2** from block **20** of FIG. **9**B, is used as the first estimate of the true background scene, I_n(x) (Module **100**). As shown in module **110**, this estimate of the true background scene is then blurred using the combined method of sieves and optical system point spread functions to obtain two picture representations I**3**(x) and I**4**(x), where I**3**(x) is given by equation **10**(*a*) and I**4**(x) is given by equation **10**(*b*). Two new arrays, as shown in module **120**, are then created by dividing pixel by pixel the noisy scene data, D**3**(x) and D**4**(x), by the blurred estimate of the true background scene, I**3**(x) and I**4**(x), as shown in equations **10**(*c*) and (*d*) respectively. The new arrays T**3**(x) and T**4**(x) are then correlated with the combined method of sieves and optical system PSF's and the result is multiplied pixel by pixel with the current estimate of the true background scene. In this manner a new estimate of the true background scene, Z(x), is obtained as shown in module **130** and by equations **10**(*e*)–(*g*).

The processor then determines whether a predetermined number of iterations have been performed, as shown in block **140**. If the predetermined number has not been performed, the current estimate of the true background is replaced by the new estimate of the true background (Z(x)) and the processing sequence of modules **110**–**140** are repeated. If, however, the predetermined number has been reached, then the latest estimate of the true background scene is taken to be the reconstructed background scenes; that is, I_r(x) is taken to equal Z(x) as shown in block **160**. Note that for the optical systems described above the predetermined number of iterations is preferably between one thousand and two thousand.

In FIG. **9**B the reconstructed background I_r(x) (equal to Z(x)) is then input to module **60**, where the background