inside a background scene containing primarily low and/or ultra-high spatial frequencies such as a cornfield. Typically, the imaging system cannot pass either the high spatial frequencies of the object or the ultra-high spatial frequencies of the background. This invention uses the background images' low spatial frequencies to reconstruct the background scene in which the localized object is situated. This reconstructed background and the space limited nature of the localized object (that is, the object is present in only part of the scene rather than the entire scene) can be used to restore the high spatial frequencies that did not pass through the optical system, thereby reconstructing a detailed image of the localized object.

In accordance with alternative embodiments of the present invention, both linear and nonlinear methods for reconstructing localized objects and backgrounds to produce super-resolved images are described.

Referring to FIG. **1**, there is shown a general block diagram of an optical sensor accommodating the present invention. The sensor **(10)** as in conventional devices includes an optical system **(12)** and detectors **(14)**. The optical system **(12)** which includes various combinations of lenses, mirrors and filters depending on the type of application is used to focus light onto a focal plane where the detectors **(14)** are located. The optical system **(12)** also includes a predetermined aperture size corresponding to a particular Numeral aperture (NA) which, in conventional diffraction-limited devices, limits the amount of spatial resolution that is attainable. This is, as previously described, due to diffraction blurring effects.

The optical system **(12)** can be described by an optical transfer function (OTF) which represents the complete image forming system, and which can be used to characterize that system.

The detectors **(14)** convert the light received from the optical system **(12)** into the electrical signals which become the data used to generate images. In conventional sensors the detectors are configured in a linear array for Scanning Systems or in a matrix array for Staring systems. In Scanning systems, the detector linear array is swept in a direction perpendicular to the length of the array generating data one scan line at a time with each line corresponding to one line of the image. In Staring systems the matrix array is not moved and generates all of the imaging data simultaneously. Thus each detector of the matrix array corresponds to one pixel of the image. It is intended that the detectors **(14)** of the present invention will be configured as a linear array or a matrix array depending on the type of system being used.

The detectors **(14)** take many different forms depending on the wavelength of light used by the present invention. For example, in the ultraviolet and X-Ray ranges such detectors as semitransparent photocathodes and opaque photocathodes can be used. In the visible range such detectors as vacuum phototubes, photomultipliers, photoconductors, and photodiodes can be used. In the infrared range, such detectors as photoconductors, photodiodes, pyroelectric, photon drag and golay cell devices can be used.

In the present invention various elements of the sensor **(10)** must be optimized to be used with a particular image-processing technique. The type of optimization depends on the image-processing technique. As will be described in detail later, the present invention includes two alternative image-processing techniques. Each of these two super-resolution methods may be used with the sensor configurations as described below.

In case one, the mentor **(10)** must include detectors **(14)** that have an "instantaneous field of view" that is equal to or less than the desired level of spatial resolution. If, for example, the required resolution is one meter or less then the "instantaneous field of view" of the detectors must be one meter or less (even though the central lobe of the diffraction pattern is much larger). This makes the pixel size of the image produced by the sensor **(10)** smaller than the central diffraction lobe. (Note that, such a configuration adds additional cost to the sensors. However, for large systems the increase in cost is less than the cost of a larger aperture.)

The sensor **(10)** can obey this rule in one of two ways. One way is to use more smaller-size detectors **(14)**. In conventional sensors the number of detectors used varies anywhere from one to millions depending on the application.

In one embodiment of the present invention at least five timers more detectors **(14)** than normal are required to achieve the desired resolution. A diagram of a linear detector array to be used with the present invention is shown in FIG. **2**, while a diagram of a matrix detector array to be used with the present invention is shown in FIG. **3**. The number of detectors **(14)** included in these arrays **(28)**, **(30)** depends on the application. However, as previously pointed out to achieve the higher resolution these arrays **(28)**, **(38)** will include at least five times more detectors **(14)** than conventional sensors for a given application.

In conventional sensors, the size of the individual detector is never smaller than the size of the central diffraction lobe. This is because utilizing smaller sensors serves no purpose since the resolution is limited by the optical aperture. In the present invention, the size of the individual detectors **(14)** must be smaller than the size of the central diffraction lobe **(18)**, as shown in FIG. **4**.

Another way of configuring the sensor **(10)** according to Case one is again to use a larger number of detectors **(14)**, but instead of using smaller detectors configure the optical system **(12)** so that more than one detector is spread across the central diffraction lobe. This allows conventional size detectors **(14)** to be used. The number of detectors **(14)** used again mu at be five times or more than required in conventional sensors. In order to configure the optical system **(12)** as described above the back focal length must be adjusted so that five or more detectors **(14)** spread across the central diffraction lobe **(18)**, as shown in FIG. **5**.

In Scanning systems, it is difficult to generate multiple image data by viewing the object at different times. This is because the optical system assumes that the object remains stationary while being scanned. The solution is to use detectors **(14)** configured in a multi-linear array as shown in FIG. **6**. The multi-linear array **(20)** includes a number of individual linear arrays **(22)** shifted parallel to each other by a distance (d) which is a fraction of a pixel. When the array **(20)** is swept each linear array **(22)** generates imaging data corresponding to one scan line of each of the images. Thus each linear array **(22)** creates one of the images being produced. In the preferred configuration, the array **(20)** includes ten or more individual linear arrays **22** which are capable of producing ten or more different images.

Now two more examples of this technique are discussed. These examples are labeled Case three and Case four.

In Case three, the sensor **(10)** is configured to take images of objects in multiple color bands. In Scanning systems, this is accomplished by utilizing a multi-linear array, as shown in FIG. **7**. The multi-linear array **(24)** also includes a number of individual linear arrays **(22)** arranged in a parallel configuration shifted parallel to each other by a distance (d) which is a fraction of a pixel. A color filter **(26)** is disposed