[0074] In a block **60**, image signal filtering, buffering, scan conversion, amplification, and other processing functions are implemented using the electronic signals produced by the imaging photon detectors and for the other photon detectors employed for diagnosis/therapy, and monitoring purposes. Blocks **56**, **58**, and **60** are interconnected bi-directionally to convey signals that facilitate the functions performed by each respective block. Similarly, each of these blocks is bi-directionally coupled in communication with a block **62** in which analog-to-digital (A/D) and digital-to-analog (D/A) converters are provided for processing signals that are supplied to a computer workstation user interface employed for image acquisition, processing, for executing related programs, and for other functions. Control signals from the computer workstation are fed back to block **62** and converted into analog signals, where appropriate, for controlling or actuating each of the functions provided in blocks **56**, **58**, and **60**. The A/D converters and D/A converters within block **62** are also coupled bi-directionally to a block **64** in which data storage is provided, and to a block **66**. Block **66** represents a user interface for maneuvering, positioning, and stabilizing the end of the scanning optical fiber within a patient's body. Further description of a system for providing the stabilizing functions performed in this block are discussed below.

[0075] In block **64**, the data storage is used for storing the image data produced by the detectors within a patient's body, and for storing other data related to the imaging and functions implemented by the scanning optical fiber. Block **64** is also coupled bi-directionally to the computer workstation and to interactive display monitor(s) in a block **70**. Block **70** receives an input from block **60**, enabling images of the ROI to be displayed interactively. In addition, one or more passive video display monitors may be included within the system, as indicated in a block **72**. Other types of display devices, for example, a head-mounted display (HMD) system, can also be provided, enabling medical personnel to view an ROI as a pseudo-stereo image.

[0076] Cantilevered Scanning Optical Fibers

[0077] A "zigzag" or rectilinear scanning optical fiber **80** is shown in **FIGS. 3A and 3B**. The scanning optical fiber includes a stationary mechanical support portion **82** that is biocompatible or has a bio-compatible coating **84** surrounding a mechanical base **86**. Extending from the distal end of mechanical base **86** is a bimorph piezoelectric bender **88**, which responds to an electrical voltage applied across its opposite faces by bending in opposite directions, as indicated by an arrow **96**. A plurality of photon detectors **92** are arrayed around a central cantilevered optical fiber or waveguide **94** and are mounted on a secondary support disk **93**. Cantilevered optical fiber **94** is caused to move in the direction indicated by an arrow **98** by a tube piezoelectric actuator **95** through which the optical fiber extends. A plurality of electrical leads **90***a* and **90***b* extend along the sides of bimorph piezoelectric binder **88** and convey signals from the plurality of photon detectors to components disposed outside the patient's body as shown in system **50** of **FIG. 2**. As noted in **FIGS. 3A and 3B**, arrows **96** and **98** are substantially orthogonal to each other, enabling the scanning of cantilevered optical fiber **94** to be implemented in a zigzag or rectilinear manner so that an ROI can be scanned by row and by column. Not shown is the overall enclosure containing the biocompatible sleeve and distal lenses.

[0078] The zigzag or rectilinear embodiment shown in **FIGS. 3A and 3B** is less preferred than other embodiments disclosed below, because of its substantially larger physical size and the required movement of the photon detectors. For example, cantilevered optical fiber **94** is typically approximately 0.1 mm in diameter, and the overall diameter of stationary mechanical support **82** can be several millimeters in diameter.

[0079] Scanning actuators other than piezoelectric actuators can be employed to cause an optical fiber to move in a scanning mode. For example, **FIG. 3C** illustrates a scanning optical fiber driver **100** that includes a cantilevered optical fiber **102** having a ferrous bar **103** attached to one side so that an electromechanical actuator **110**, when energized with an electrical current flowing through a coil **112** that is wound around a core **114** attracts the ferrous bar, causing the optical fiber to scan in a 2D manner, as indicated in the Figure. Preferably, the scanning optical fiber is driven at one or more frequencies that are harmonics of its resonant frequency, to achieve optimum efficiency. However, it is also contemplated that the optical fiber can be driven at a non-resonant frequency. Although not shown, a second electromechanical actuator can be included to provide a force in a direction orthogonal to that of electromechanical actuator **110** to cause cantilevered optical fiber **102** to scan in a direction orthogonal to that indicated in **FIG. 3C**. Thus, by controlling the current supply to each of an orthogonal pair of electromechanical actuators, the scan position of cantilevered optical fiber **102** can be precisely controlled.

[0080] The cantilevered optical fiber emits light that passes through an imaging lens **104** and is focused on an imaging plane **106** corresponding to the ROI within a patient's body, producing a PSF **108** as indicated. As the cantilevered optical fiber is caused to move by electromechanical actuator **110**, a PSF **108**' is formed at a different location on imaging plane **106**.

[0081] In **FIG. 3**D, yet another embodiment **120** is illustrated in which a scanner **122** comprises an electromechanical device or piezoceramic tube actuator that causes a first mode of vibratory resonance in a cantilevered optical fiber **124**. In this case, the cantilevered optical fiber includes a collimating lens **126** at its distal end and a scan lens **128** that re-images light that has passed through the collimating lens, onto an illumination plane **132**. Light focused by scan lens **128** forms a PSF **134** on illumination plane **132** and as the cantilevered optical fiber moves, a PSF **134**' moves over the illumination plane. Although cantilevered optical fiber **124** can be limited to scanning along a single axis as indicated by arrows **130**, it is also possible to use an actuator that moves the optical fiber so that it scans along an orthogonal axis (i.e., in and out of the plane of the drawing figure). However, at high amplitude resonance vibration driven by a linear single axis actuator, the resulting motion of the optical fiber can be in two dimensions due to nonlinear cross-coupling of mechanical forces. Thus, two axis actuators are not required for 2D scanning.

[0082] Scanning Thin Film Light Waveguide Embodiments

[0083] It should be apparent that it is desirable to produce a scanning optical fiber with a smaller cross-sectional area than that shown in the embodiments of **FIGS. 3A and 3B** and also to produce such a device at relatively low cost and