employed for generating the visual image are the same used for diagnostic, therapeutic, and surgical procedures. The method for imaging not only can match the image quality requirements for MIMPs, but can also achieve higher resolutions in a smaller package than existing imaging technology, so that a single, smaller, and more flexible system can be used for MIMPs. The relatively smaller scanning system reduces tissue trauma and expands the reach of MIMPs for use within adult, pediatric, and small animals. The directed optical illumination employed for image acquisition enables the most sophisticated diagnoses and therapies to be integrated into this single imaging system, (sharing the scan engine, display, and user interface). Integration may actually lower the cost of the equipment that would otherwise be required and/or decrease the time required to perform endoscopic MIMPs. The same benefits apply to each of the embodiments of the scanning system disclosed herein.

[0058] **FIG. 1D** illustrates a scanning optical beam illuminator **40**' that also includes scanning optical fiber **42**, just as the embodiment shown in **FIG. 1C**. However, instead of using imaging lenses, scanning optical beam illuminator **40**' employs a collimating lens **43** that is attached to the distal end of the scanning optical fiber and a scan lens **44**'. The light conveyed through optical fiber **42** is collimated by collimating lens **43** and then focused onto a flat illumination plane **33***b*, or a curved illumination plane **33***c*, each corresponding to the ROI within a patient's body. Light reflected from each successive point that is scanned as the scanning optical fiber moves passes back through scan lens **44**' and is detected by RGB detectors **45***r*, **45***g*, and **45***b*, which respectively provide the RGB signals over lines **48** used to produce an image, with data accumulated pixel by pixel.

[0059] At the illumination plane, the beam of optical radiation is focused to achieve maximum intensity and/or optical quality, which is the goal for all modes of scanning. When tissue is coincident with the illumination plane, the optical irradiance is a function of the optical power and size of the light spot on the tissue. Thus, with regard to imaging, diagnoses, and therapy, the resolution of the MIMP is determined by this spot size at the image plane. With regard to image acquisition, the image resolution is determined by the illumination spot size, detector bandwidth (and scan rate), and signal-to-noise ratio (illumination intensity and collection efficiency), while image resolution is not limited by the physical size or number of the photon detectors.

[0060] Since diagnoses and therapies require accurate spatial discrimination, there is a need for directed illumination that is pre-calibrated before delivery. By integrating the optical imaging with diagnostic and therapeutic scanning, a medical practitioner can easily see the spatial discrimination of the optical scanning by viewing the displayed image before proceeding to diagnostic or therapeutic applications. Finally, the integration of computer image capture electronics and image processing software enables the image, diagnostic, and therapeutic data to be analyzed on a pixel-by-pixel basis. Since each pixel corresponds to the same area or volume of tissue, the single fiber integrated system maintains spatial registration for all three functions, imaging, diagnosis, and therapy. Consistent spatial registration from the same point of view for all three functions makes the single fiber system highly accurate and easy to use by medical practitioners of minimally invasive procedures.

[0061] The advantages afforded by using the integrated scanning device of the present invention for MIMPs are:

[0062] Smaller size with integration;

[0063] Lower cost with integration and use of low cost components;

[0064] Lower flexural rigidity to allow greater access within the body;

[0065] Faster procedural times, especially if requiring reiterations of therapy;

[0066] Greater accuracy with integrated high-resolution imager and interactive display;

[0067] Additional features with scanning optical system, such as variable resolution (real-time zooming) and enhanced stereo effects (such as shading);

[0068] Additional functionality with integrated non-visible optical sources and detectors;

[0069] Lower risk to patient for infection from multiple tools or multiple incisions; and

[0070] Faster recovery times for patient with less healthy tissue damage and less anesthetics.

[0071] System Processing Overview

[0072] **FIG. 2** illustrates a system **50** that shows how the signals produced by various components that are inside a patient's body are processed with external instrumentation and how signals used for controlling the system are input to the components that are inside the patient's body. In order to provide integrated imaging and other functionality, system **50** is thus divided into the components that remain external to the patient's body, and those which are used internally (i.e., the components within a dash line **52**). A block **54** lists the functional components disposed at the distal end of the scanning optical fiber system. As indicated therein, these components include illumination optics, one or more electromechanical scan actuator(s), one or more scanner control actuator(s), one or more scanner motion detector(s) for control of the scanner motion, photon detectors for imaging the ROI, and optionally, additional photon detectors for diagnostic purposes and for therapy and monitoring purposes. It should be noted that in regard to system **50**, only the functional components actually required for a specific application may be included. Also, the additional functions besides imaging can be diagnostic, or therapy, or a combination of these functions.

[0073] Externally, the illumination optics are supplied light from illumination sources and modulators as shown in a block **56**. Further details concerning several preferred embodiments of external light source systems for producing RGB, UV, IR, and/or high intensity light conveyed to the distal end of an optical fiber system are disclosed below. A block **58** indicates that illumination sources, modulators, filters, and detectors are optionally coupled to the electromechanical scan actuator(s) inside the patient's body and to the scanner control actuators. Scanner motion detectors are used for controlling the scanning and produce a signal that is fed back to the scanner actuators, illumination source, and modulators to implement scanning control.