all the points in the target space. The techniques for combining the information from two-dimension sources into three-dimensional content are well known (see for instance, U.S. Pat. No. 6,816,629 to Redlich). The techniques for moving physical calibration objects to obtain a sufficient number of points to calibrate the target space are also well known (see for instance, U.S. Pat. No. 6,822,748 to Johnston et al). Current calibration techniques using real objects moved through all the calibration points of the target space do not provide continuous real time calibration since optical properties of the optical recorders change with zoom adjustments, wear, or mechanical deformation under acceleration.

[0011] The prior art describes three-dimensional image scanners which capture shapes of objects in the target space (see, for instance, U.S. Pat. No. 5,936,739 to Cameron, U.S. Pat. No. 5,585,913 to Hariharan, and U.S. Pat. No. 6,445,491 to Sucha). Such three-dimensional image scanners are not able to capture both shape and color.

SUMMARY OF THE INVENTION

[0012] The present invention overcomes the disadvantages and shortcomings of the prior art discussed above by providing a three-dimensional imaging system, which includes a three-dimensional display, an image scanning device for capturing a three-dimensional image to be displayed on the three-dimensional display, and three-dimensional calibration equipment for calibrating the image scanning device. Both the three-dimensional display and the image scanning device employ optical pulses and non-linear optics to display and record, respectively, a three-dimensional image. The image scanning device may be two-dimensional or three-dimensional.

[0013] The three-dimensional display includes at least three pulsed optical sources; and an optical mixer movable in a display space, wherein the at least three pulsed optical sources are spatially separated so as to permit pulses emanating therefrom to overlap in a voxel within the display space and intersecting the optical mixer at a selected position, whereby a first-order non-linear interaction of the pulses causes the optical mixer to produce at least one pre-determined wavelength of electromagnetic waves.

[0014] The three-dimensional image scanner captures a three-dimensional image of an object. The three-dimensional image scanner includes a first pulsed optical source for generating an illuminating optical pulse at an illumination wavelength, the first pulsed optical source directing the illuminating optical pulse toward the object; a second pulsed optical source for generating a gating optical pulse at a gating wavelength; an optical mixer positioned to receive light reflected from the object at a single wavelength in response to interaction of the illuminating optical pulse with the object, a portion of the illuminating optical pulse and a portion of the gating optical pulse spatially and temporally overlapping each other within the optical mixer, thereby producing a first optical pulse indicative of the shape of the object and a second optical pulse indicative of the color of the object; and an optical recorder having a plurality of pixels responsive to output light emitted by the optical mixer, a first portion of the plurality of pixels having an associated filter which passes the first optical pulse and which blocks the second optical pulse, and a second portion of the plurality of pixels being unfiltered.

[0015] The three-dimensional calibration equipment includes acquiring means for acquiring an optical image of a desired object from at least two positions, the acquiring means being either at least two optical recorders placed at least two different positions or a single optical recorder that is moved between several positions. The three-dimensional calibration equipment also includes a holographic calibration plate placed between the acquiring means and the desired object, and a light source of at least one of a set of calibration wavelengths for illuminating the holographic calibration plate so as to project at least one virtual calibration pattern in the field of view of the acquiring means and in the vicinity of the desired object. An alternative embodiment of the three-dimensional calibration equipment includes at least two optical recorders and a light source of at least one of a set of calibration wavelengths for illuminating at least three reference points relative to the desired object to be recorded by the at least two optical recorders.

[0016] A method for calibrating the three-dimensional imaging system using the three-dimensional imaging equipment mentioned above includes the steps of projecting a virtual calibration pattern in the field of view of the optical recorder(s); choosing one position of one optical recorder as a reference position; assigning coordinates of a coordinate system relative to either the virtual calibration pattern or the reference position; measuring the differences in the virtual calibration pattern from a second position of the optical recorder(s); calculating calibration corrections relative to the reference position based on the differences measured; and adjusting the optical recorder(s) based on the calibration corrections.

[0017] An alternative method of calibrating a three-dimensional imaging system using the three-dimensional imaging equipment mentioned above for calibrating optical recorder(s) includes the steps of projecting a calibration pattern at a calibration wavelength on a plane that is tangent to the nearest point of a desired object as measured from the optical recorder; labeling an intersection point P between the calibration pattern and the desired object; positioning the end of a laser light beam operating at the calibration wavelength at the point P; measuring the distance from the point P to the calibration pattern; generating a second calibration pattern at a greater distance from the reference optical recorder; and repeating the steps of labeling, positioning, and measuring when the calibration pattern intersects the desired object.

[0018] Another alternative method of calibrating a three-dimensional imaging system using the three-dimensional imaging equipment mentioned above which includes at least two optical recorders to be calibrated and two holographic calibration plates placed in the field of view of a respective one of the optical recorders where each of the holographic calibration plates contains the same hologram, includes the steps of positioning the calibration plates relative to each other to approximate a monolithic calibration plate; projecting a calibration pattern in the field of view of a desired object through each of the calibration plates; determining the position of at least three reference points in the vicinity of the desired object relative to each of the optical recorders; determining a corresponding position on the calibration pattern corresponding to each reference point; determining the misalignment of the virtual calibration pattern; determining the correction factors as a function of position of the desired object relative to each optical recorder; and applying the correction factors to each optical recorder.