INTERROGATION OF AN OBJECT FOR DIMENSIONAL AND TOPOGRAPHICAL INFORMATION

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 09/810,054 filed Mar. 16, 2001 U.S. Pat. No. 6,507,309, which is hereby incorporated by reference in its entirety.

GOVERNMENT RIGHTS

This invention was made with Government support under Contract Number DE-AC0676RLO1830 awarded by the U.S. Department of Energy. The Government has certain rights in the invention.

BACKGROUND

The present invention relates to interrogation of an object with electromagnetic radiation, and more particularly, but not exclusively relates to determining dimensional and topographical information about a person's body.

Schemes from the common tape measure to visible light laser scanning have been employed to obtain measurements of a person's body. Unfortunately, these schemes often require a significant degree of mechanical intervention or preparation, such as the placement of a measuring device or marker on the person and/or removal of the person's clothing. Moreover, it is typically desirable to nonintrusively interrogate an object for dimensional information with less object handling, reduced interrogation time, and/or greater resolution relative to existing schemes. Another goal that is sometimes related to object mensuration is the desire to determine the topography of an object's surface. Thus, there is a demand for further contributions in this area of technology, including new ways to obtain dimensional and/or topographical information.

SUMMARY OF INVENTION

One embodiment of the present invention is a unique technique to obtain one or more body measurements of a person. Other embodiments include unique systems, devices, methods, and apparatus to determine dimensional, topographical, and/or image information about an object. Still other embodiments include unique ways to utilize such information.

In a further embodiment of the present invention, electromagnetic radiation interrogates an object to determine dimensional information about the object. This interrogation can include determining a measurement of one or more features at least partially covered by a substance that is penetrated by the electromagnetic radiation. In one form, the electromagnetic radiation is of a nonionizing type that can penetrate the clothing of a person to determine one or more body measurements corresponding to a skin surface that is at least partially covered by the clothing. In another form, the invention may be applied to determine dimensional information concerning a body surface that is not covered by clothing or the like.

Still another embodiment includes irradiating a body at least partially covered with clothing and detecting electromagnetic radiation returned from a surface of the body through the clothing in response to this irradiation. A measurement of the body is determined from the electromagnetic radiation that corresponds to this surface. The body can be of a person with the surface corresponding to the person's skin. In one preferred form of this embodiment, the electromagnetic radiation includes at least one frequency in a frequency range of about 200 Megahertz (MHz) to about 1 Terahertz (THz). In a more preferred form, the electromagnetic radiation is in a frequency range of about 1 Gigahertz (GHz) to about 300 GHz. In a most preferred form, the electromagnetic radiation is in a frequency range of about 5 GHz to about 110 GHz.

Yet a further embodiment of the present invention is directed to irradiation of an object to obtain data corresponding to a number of different images of the object. A topographical representation is determined from the data. This representation can be used to generate a desired output, such as one or more images of the object. In one preferred form, the electromagnetic radiation is in a frequency range of about 200 Megahertz (MHz) to about 1 Terahertz (THz). In a more preferred form, the electromagnetic radiation is in a frequency range of about 1 GHz to about 300 GHz. In a most preferred form, the electromagnetic radiation is in a range of about 5 GHz to about 110 GHz.

For another embodiment, a system includes an array to interrogate a person with electromagnetic radiation. One or more processors are included that respond to signals from the array to determine a body measurement of the person. The body measurement corresponds to a skin surface of the person that is at least partially covered by clothing during interrogation with the array. In one preferred form, the electromagnetic radiation includes one or more wavelengths in the range from about 300 micrometers (μm) to about 1.5 meters (m). In a more preferred form, the electromagnetic radiation includes one or more wavelengths in the range from about 2 millimeters (mm) to about 1 centimeter (cm).

Still another embodiment includes a device carrying one or more signals that comprise logic to operate one or more processors. This logic is operable to process a number of data sets each corresponding to a different portion of a body interrogated with electromagnetic radiation. The logic is further operable to provide a volumetric and/or topographical representation of the body from the data sets and determine one or more body measurements from such representation(s).

In yet another embodiment, a system includes at least one array to interrogate an object with electromagnetic radiation at one or more frequencies in a range of about 200 MHz to about 1 THz. Also included are one or more processors responsive to this array that are operable to: establish a number of data sets each representative of a three-dimensional image of a different one of a number of portions of the object; map the data sets to a volumetric representation of the object, the volumetric representation corresponding to a volume of the object defined by each of the portions of the object; and process the volumetric representation to provide an output. The system can further include a display device responsive to this output.

Another embodiment includes irradiating an object and detecting electromagnetic radiation reflected by the object in response to this irradiation. This electromagnetic radiation is in a frequency range of about 200 MHz to about 1 THz. Data determined from the electromagnetic radiation detection is used to generate a volumetric or topographical representation of the object. This representation can define at least one circumference of the object from which a circumferential measurement of the object can be determined.

Among other embodiments of the present invention is: providing a sensing array and one or more processors