



RF Device for Acquiring Images of the Human Body

This portable, simple system using a ring-shaped antenna array and planar circuit technology can serve as security in airports, mass transit locations, and power plants.

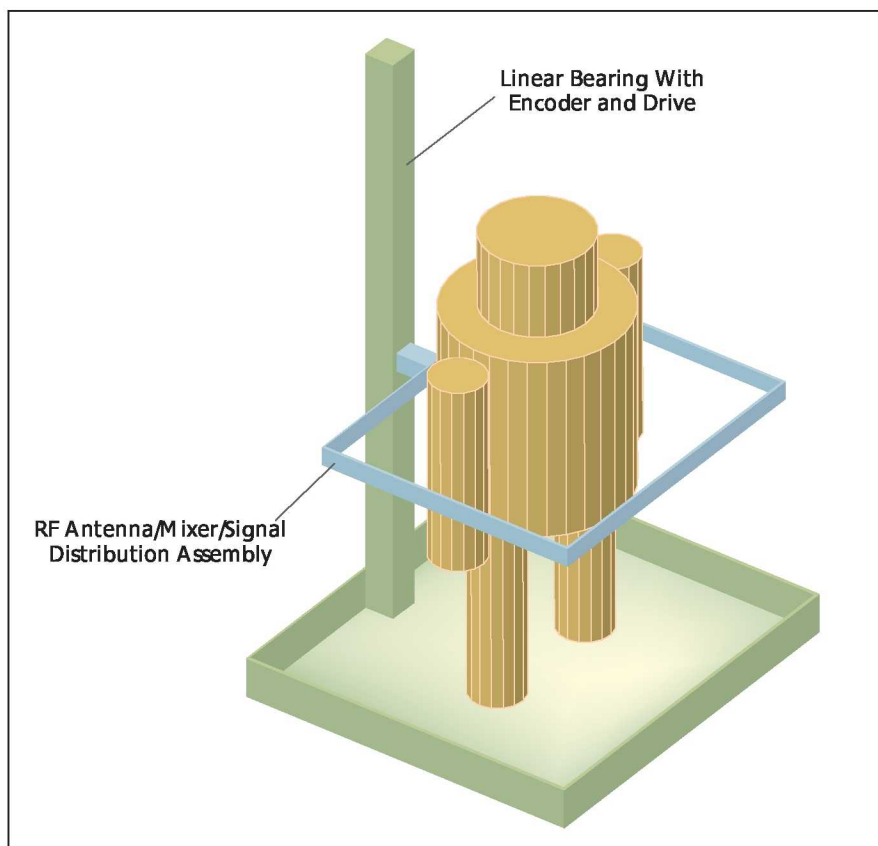
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A safe, non-invasive method for forming images through clothing of large groups of people, in order to search for concealed weapons either made of metal or not, has been developed. A millimeter wavelength scanner designed in a unique, ring-shaped configuration can obtain a full 360° image of the body with a resolution of less than a millimeter in only a few seconds. Millimeter waves readily penetrate normal clothing, but are highly reflected by the human body and concealed objects. Millimeter wave signals are non-ionizing and are harmless to human tissues when used at low power levels.

The imager (see figure) consists of a thin base that supports a small-diameter vertical post about 7 ft (≈ 2.13 m) tall. Attached to the post is a square-shaped ring 2 in. (≈ 5 cm) wide and 3 ft (≈ 91 cm) on a side. The ring is oriented horizontally, and is supported halfway along one side by a connection to a linear bearing on the vertical post. A planar RF circuit board is mounted to the inside of each side of the ring.

Each circuit board contains an array of 30 receivers, one transmitter, and digitization electronics. Each array element has a printed-circuit patch antenna coupled to a pair of mixers by a 90° coupler. The mixers receive a reference local oscillator signal to a subharmonic of the transmitter frequency. A single local oscillator line feeds all 30 receivers on the board. The resulting MHz IF signals are amplified and carried to the edge of the board where they are demodulated and digitized. The transmitted signal is derived from the local oscillator at a frequency offset determined by a crystal oscillator.

One antenna centrally located on each side of the square ring provides the source illumination power. The total transmitted power is less than 100 mW,



The **RF Imaging Device** can be used in security surveillance of large groups of people to detect concealed metal and non-metal weapons.

resulting in an exposure level that is completely safe to humans. The output signals from all four circuit boards are fed via serial connection to a data processing computer. The computer processes the approximately 1-MB data set into a three-dimensional image in a matter of seconds.

The innovation is to configure the receiver array in a ring topology surrounding the scanned object. The ring is then scanned vertically to cover the necessary two-dimensional surface. This fabrica-

tion of the ring is made possible by using planar antenna and circuit technology. A planar circuit board serves as a medium for both antennas and signal-processing components. Using this technique, parts counts are kept low, and the cost per element is a small fraction of a waveguide-based system.

This work was done by Todd C. Gaier and William R. McGrath of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42662