data pre-processed by the pre-processing unit; and a dielectric boundary surface estimating unit estimating a boundary surface between areas having different dielectric constants to each other using the wave data on which the three-dimensional synthetic aperture processing is performed by the three-dimensional synthetic aperture processing unit and calculating a width and a thickness of the boundary surface. The dielectric boundary surface estimating unit performs division of the wave data on which the three-dimensional synthetic aperture processing unit performs the three-dimensional synthetic aperture processing in an azimuth direction and an elevation direction, performs three-dimensional inverse Fourier transform on the wave data after the division, extracts a trajectory of low-dielectric constant side boundary points corresponding to a low-dielectric constant side boundary surface and a trajectory of high-dielectric constant side boundary points corresponding to a high-dielectric constant side boundary surface out of the wave data after the division subjected to the three-dimensional inverse Fourier transform, calculates a width of the high-dielectric constant side boundary surface or a width of the low-dielectric constant side boundary surface from the trajectory of the high-dielectric constant side boundary points or the trajectory of the low-dielectric constant side boundary points, and calculates a thickness from the high-dielectric constant side boundary surface to the low-dielectric constant side boundary surface on a basis of a distance between a center of the trajectory of the high-dielectric constant side boundary points and a center of the trajectory of the low-dielectric constant side boundary points.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to the present invention, since a dielectric boundary surface is estimated using wave data subjected to three-dimensional synthetic aperture processing, it is possible to accurately estimate a width and a thickness of a dielectric boundary surface.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. 1 is a functional configuration diagram illustrating a configuration example of a dielectric boundary surface estimation device according to a first embodiment of the present invention;

FIG. 2 is a hardware configuration diagram illustrating a configuration example of the dielectric boundary surface estimation device according to the first embodiment of the present invention;

FIG. 3 is a flowchart illustrating processing performed by a pre-processing unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention;

FIG. 4 is a flowchart illustrating processing performed by a three-dimensional synthetic aperture processing unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention;

FIG. 5 is a flowchart illustrating processing performed by a dielectric boundary surface estimating unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention;

FIG. 6 is a view illustrating a situation when wave data stored in a wave data storing unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention is observed;

FIG. 7 is a view illustrating the wave data after the three-dimensional synthetic aperture processing unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention performed three-dimensional synthetic aperture processing;

FIG. 8 is a view illustrating the wave data after the dielectric boundary surface estimating unit of the dielectric boundary surface estimation device according to the first embodiment of the present invention performed aperture division and three-dimensional inverse fast Fourier transform;

FIG. 9 is a view illustrating a high-dielectric constant side boundary point trajectory and a low-floating constant side boundary point trajectory calculated by the

CLAIMS

1. A dielectric boundary surface estimation device comprising:

a pre-processing unit pre-processing wave data obtained by observing a dielectric by a radar device;

a three-dimensional synthetic aperture processing unit performing three-dimensional synthetic aperture processing on the wave data pre-processed by the pre-processing unit; and

a dielectric boundary surface estimating unit estimating a boundary surface between areas having different dielectric constants to each other using the wave data on which the three-dimensional synthetic aperture processing is performed by the three-dimensional synthetic aperture processing unit and calculating a width and a thickness of the boundary surface,

wherein the dielectric boundary surface estimating unit performs division of the wave data on which the three-dimensional synthetic aperture processing unit performs the three-dimensional synthetic aperture processing in an azimuth direction and an elevation direction, performs three-dimensional inverse Fourier transform on the wave data after the division, extracts a trajectory of low-dielectric constant side boundary points corresponding to a low-dielectric constant side boundary surface and a trajectory of high-dielectric constant side boundary points corresponding to a high-dielectric constant side boundary surface out of the wave data after the division subjected to the three-dimensional inverse Fourier transform, calculates a width of the high-dielectric constant side boundary surface or a width of the low-dielectric constant side boundary surface from the trajectory of the high-dielectric constant side boundary points or the trajectory of the low-dielectric constant side boundary points, and calculates a thickness from the high-dielectric constant side boundary surface to the low-dielectric constant side boundary surface on a basis of a distance between a center of the trajectory of the high-dielectric constant side boundary points and a center of the trajectory of the low-dielectric constant side boundary points.

2. The dielectric boundary surface estimation device according to claim 1,

wherein the three-dimensional synthetic aperture processing unit performs three-dimensional Fourier transform on the wave data pre-processed by the pre-processing unit, performs azimuth bulk compression to make a wave surface uniform on the wave data subjected to the three-dimensional Fourier transform, and thereafter performs interpolation to orthogonalize a wave transmitting direction.

3. The dielectric boundary surface estimation device according to claim 1,

wherein the pre-processing unit removes a DC component in a range direction

and a DC component in an azimuth direction from the wave data obtained by observing the dielectric by the radar device, and corrects attenuation of the wave when passing through the dielectric.