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RADIOTOMOGRAPHY BASED ON MOVABLE FOCUSING REFLECTOR

We propose a tomography method based on the moving parabolic reflector that provides field focusing in an object area. Resolution along the axis of the cylinder is achieved through the use of a linear radar array of magnitude detectors. Results of numerical simulation for monochromatic sensing are presented.

Keywords*: *radiovision, radiotomography, reflector.

Introduction

One of the intensive developing methods of tomography and introscopy is a radiowave tomography [1-2]. It is used in underground sensing [3], flaw detection of pavement, archeology, utilities, and inspection systems. Most radio tomography systems of high resolution are based on the technology of synthetic aperture radar. However, for the synthesis of the aperture is necessary to measure the phase of the wave field, that is difficult technical problem, especially if you are using antenna arrays. The main problems in the development of modern systems of radiovision are to increase the measurement speed and reducing the cost of construction. Measuring of the field amplitude technically is much easier than measuring the amplitude and phase both. To make the amplitude of the field sufficient for restoration of the image of investigated objects, without additional processing, it is necessary to provide focusing of each object point field on a separate antenna element. It is proposed to apply the movable reflector in the shape of a focusing surface and a linear receiving array of detecting antenna for imaging of scattering objects.

Formulation of the problem

It is proposed to consider the sensing scheme using two parabolic reflectors (fig. 1). One of the reflectors is stationary and provides a focus of a plane wave to the receiving antenna. The second reflector mobile and provides the conversion of a spherical wave from investigated scatterer to a plane wave incident on the first reflector. Movement of the second reflector in combination with the use of linear receiver array helps to restore plane radioimage. The object may be irradiated by an external source, and moreover, thanks to the physical focusing is possible to visualize sources of own radiation.

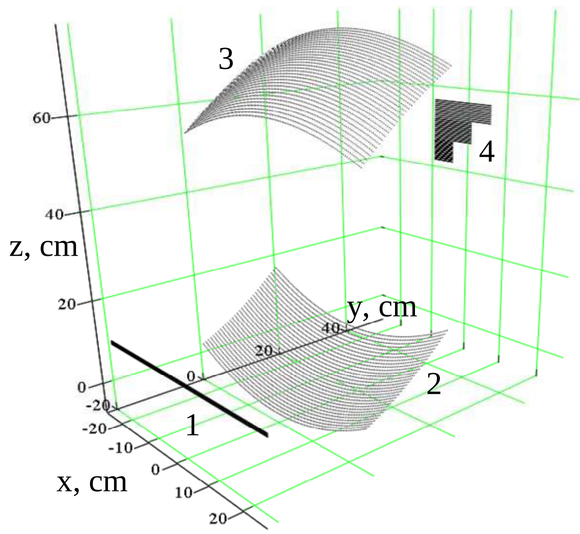
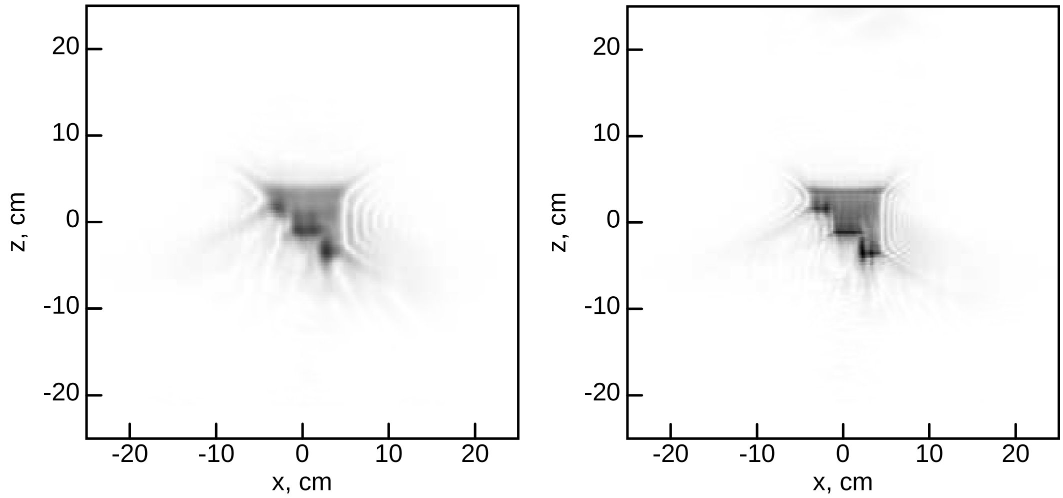


Fig.1. The measurement scheme (1 - array of receivers; 2- a fixed reflector; 3- movable reflector; 4 - investigated object)

The numerical simulation of distributed source of monochromatic waves visualization was made. The simulation of reflectors is produced by a variety of point scatterers. To speed up the computing process the parallel programming on graphics processors OpenCL used. We considered a test object in a form of a stepped polygon with dimensions 15 x 15 cm at a distance of 50 cm from the scanning plane. The object is irradiated by a plane wave falling normally. Different positions of the movable reflector were used for calculating the amplitude of the field at the reception array. For sensing frequency 24 GHz and 48 GHz were obtained images of the object, which are shown in Fig. 2. Along the z axis coordinate is plotted the movable reflector position, and the x-axis is a coordinate of the receiving antenna in a linear array. At higher frequencies, resolution is better. Thanks to the use of reflectors in the paraboloid form, the focus will independent of frequency of the radiation, and thus it is possible to visualize sources with random and not previously known frequency. At different frequencies the image has been restored. Note, however, that the two images of the object does not match the size of the object. They are looking smaller than their real size and its image mirror relative to the plane YOZ. This image is received thanks to exact match of the movable reflector focus with the object plane. If the object moves out of focus, the image resolution is deteriorating.



a б

Fig.2. The simulation results of the restored image of the object at a distance of 50 cm
(a - 24 GHz, b - at a frequency of 48 GHz)

If you move the object closer to the probing system and accordingly change the focal length of the movable reflector, the reconstructed image will be distorted. For example, if to move an object at a distance of 30 cm, it will increase the image and will shift it (fig.3).

For correct reconstruction of the objects shape it is necessary to carry out the transformation of the coordinate system of the images, taking into account the distance to the object. Also we shall note that the best focusing is achieved in the central region of the image, because the focus of the parabola of the reflectors located in the plane $x = 0$. At displacement the object from the focus plane the object image is distorted.

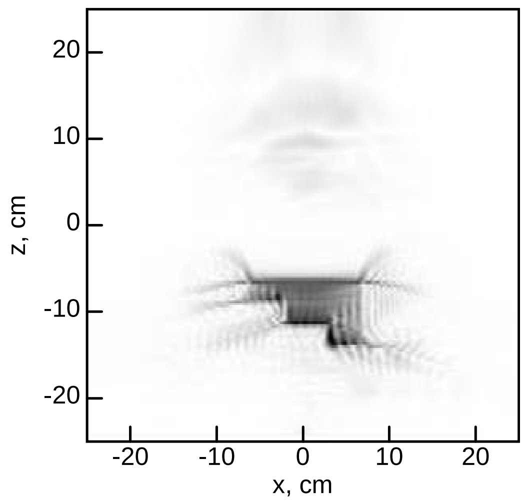


Fig.3. The simulation results of the restored image of the object at a distance
of 30 cm at a frequency of 48 GHz

Conclusion

The use movable parabolic reflector in conjunction with a fixed parabolic reflector makes it possible to focus the field scattered by the object under investigation on the linear array of receiving antennas and restore the image of the object. This system provides a focus only on the fixed distance. The best resolution is provided near the center of the system aperture. Obtained images has geometric distortions relatively to the true image of the objects.

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РАДИОТОМОГРАФИЯ НА ОСНОВЕ ПОДВИЖНОГО ФОКУСИРУЮЩЕГО РЕФЛЕКТОРА

Предлагается метод радиотомографии на основе подвижного рефлектора в форме параболоида, обеспечивающего фокусировку поля в область исследуемого объекта. Разрешение вдоль оси цилиндра достигается за счёт применения линейной решётки амплитудных детекторов. Приводятся результаты численного моделирования для монохроматического зондирования.

Ключевые слова: *радиовидение, радиотомография, рефлектор.*

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