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EARLY BREAST CANCER DETECTION

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Early breast cancer detection is now one of the most topical problems in medical diagnostics. In some countries this pathology is the leading cause of death among the women.
Every 9th female in the USA is under the risk of this highly dangerous disease. As a rule, the routine diagnostic procedure consists of individual examination by doctors and mammography or ultrasound screening. Screening for early detection of breast cancer is conducted by these methods at 12-24 month intervals, which cannot guarantee identification of aggressive tumors [1]. Also, however rarely, such methods as computed tomography, positron-emission tomography, magnetic resonance imaging, all kinds of biopsy are applied. They allow to purposefully look for certain changes in the mammary glands and specify their cause, nature and prevalence. However, none of them is applicable for routine scanning because of high cost, prolonged time of a diagnostic procedure and invasiveness (for biopsy). Therefore, it is advisable to complete a routine diagnostic procedure using a different noninvasive screening method, which could detect tumors at the earliest possible stage. This problem can be solved with the help of a holographic radar, which detects dielectric inhomogeneities [2]. It is known that the dielectric properties of normal and malignant breast tissues differ even at the earliest stage of tumor genesis. Thus, frequent scans with a holographic radar could be used for safe early stage breast tumor detection. Although at present there is a growing interest in literature in the usage of ultra-wideband radars for breast malignant tumors detection, these devices have not yet achieved the necessary accuracy and specificity when applied on realistic breast phantoms. Holographic radars had not been used for this purpose until recently.

In this paper holographic radar RASCAN is proposed for breast screening. A special realistic phantom of a breast is proposed, which allows creating phantoms with different displacement of neoplasm (Fig.1). Both of them operate at five probing frequencies and two types of polarization (transversal and parallel).

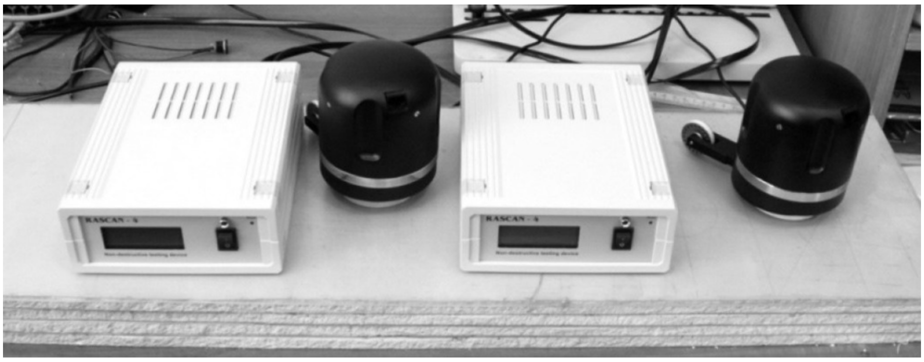

Fig. 1. Radars used in the experiments

Since the reflection of electromagnetic wave radiated by the radar takes place on the boundaries of objects with different dielectric properties, the device can detect tumors by presence of such re-scattered waves. To prove the fact several experiments were carried out on a special breast phantom. Used in this study is an easy-to-use model of the experimental breast phantom (Fig. 2).

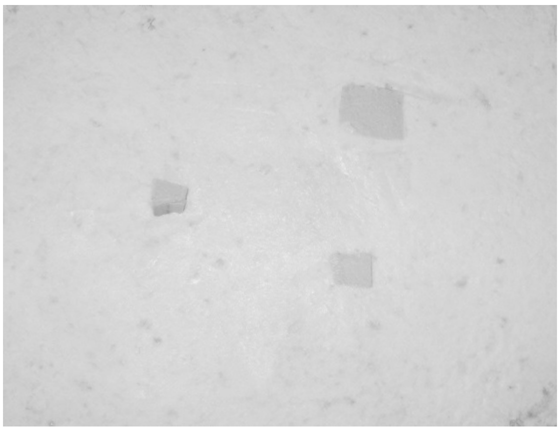

Fig. 2. Photo of the experimental model

In the experimental phantom normal breast tissue was assumed to have the same dielectric properties as adipose tissue (dielectric constant is about 4.6 and conductivity 0.4 Sm/m [7]). It was simulated by lard and neoplasm (dielectric constant is about 56 and conductivity 5 Sm/m [7]) - by pudding. The radar head was connected to a control unit and through it to a PC.

After that a scanning procedure was carried out by moving a radar over experimental model for the full coverage of the experimental model.

During experiments two types of multi-frequency holographic radar RASCAN were compared: RASCAN-4/4000 with the frequency of 3.6 to 4.0 GHz and RASCAN-4/15000 with the frequency ranging from 14.6 to 15 GHz, which were designed at Bauman Moscow State Technical University [6]. They were intended for sounding of building constructions with the high resolution.

For two of the RASCAN radars the experiments were conducted for the following configurations of the breast phantom:

- phantom without inclusion;
- phantom with inclusion on the surface;
- phantom with inclusion 1-2 mm under the surface;
- phantom with inclusion 10 mm under the surface;

For every experiment 2 images for each of the five probing frequencies are obtained (10 images in total). In this paper only the most informative of them are given. (Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7).

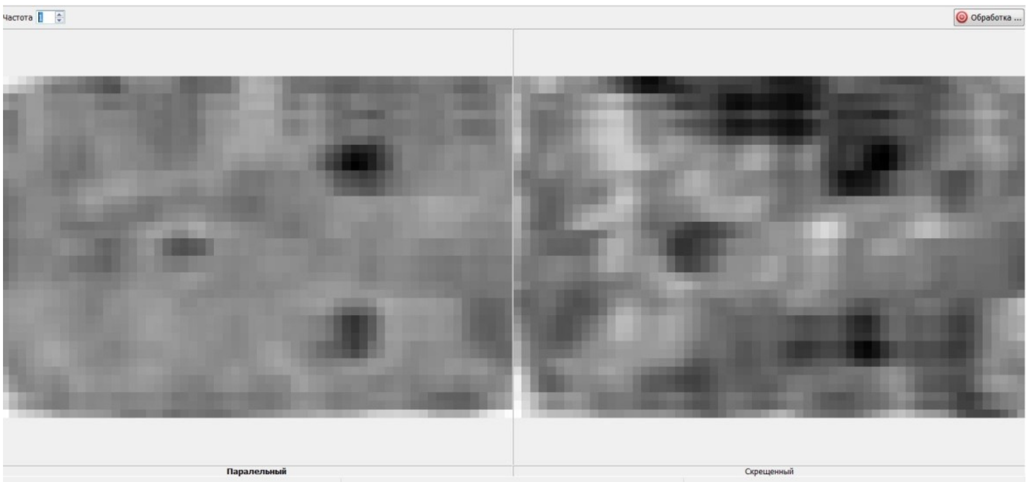

Fig. 3. Holographic image of the phantom with tumors on the surface (4 GHz)

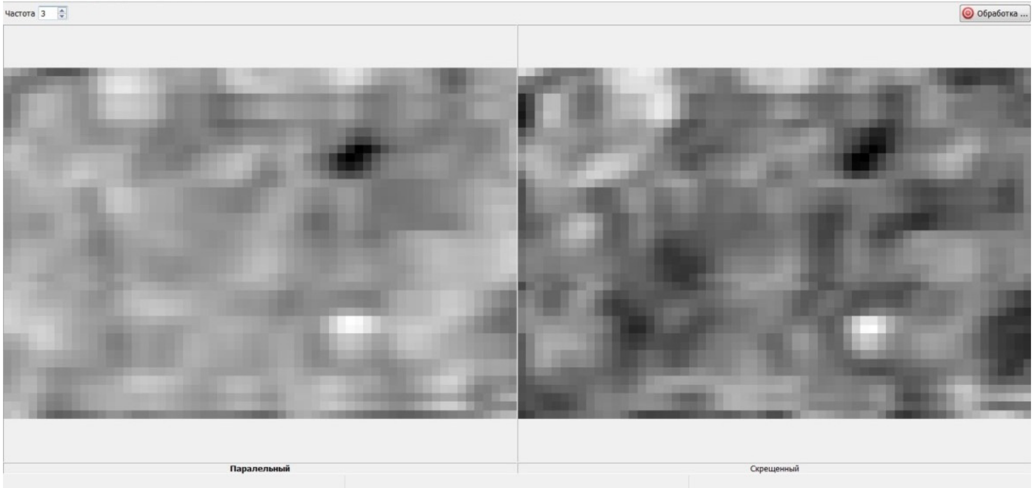

Fig. 4. Holographic image of the phantom with tumors 1-2 mm under the surface (4 GHz)

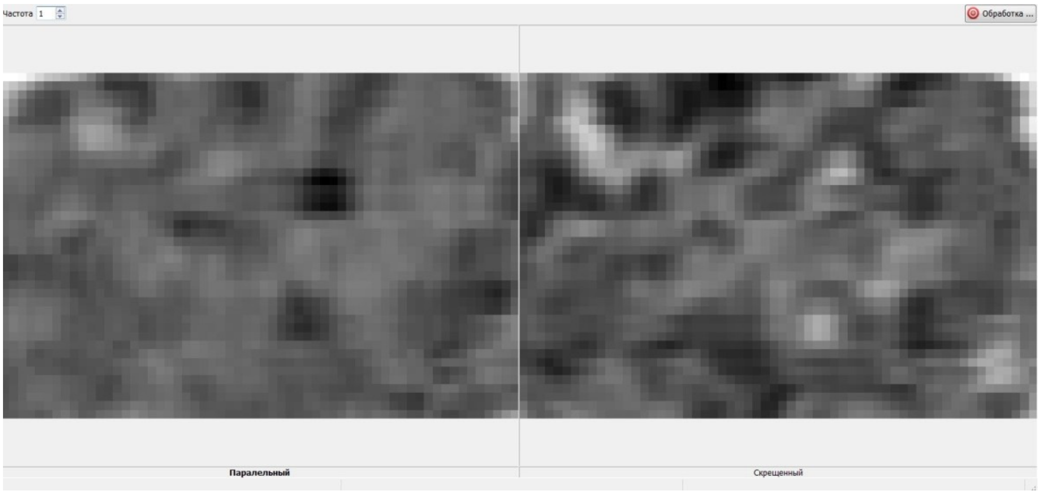

Fig. 5. Holographic image of the phantom with tumors 10 mm under the surface (4 GHz)

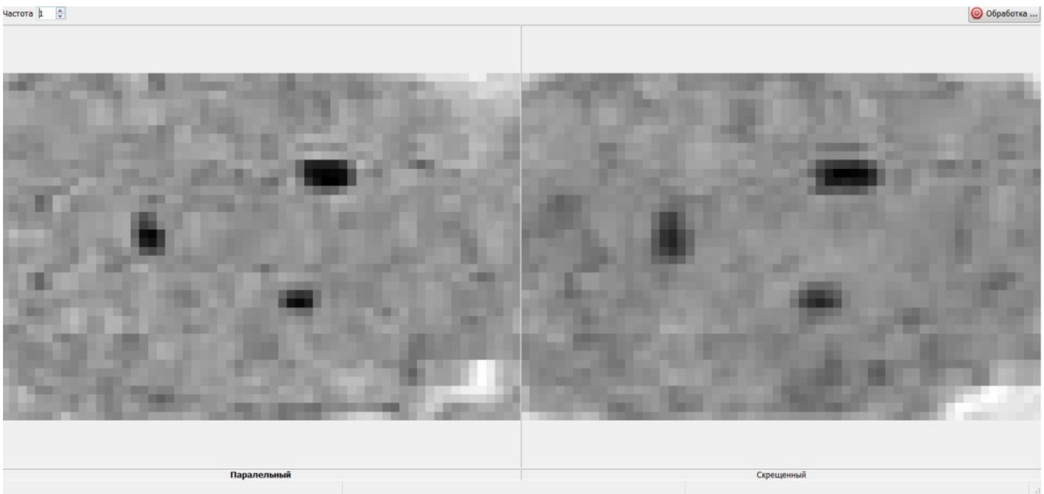

Fig. 6. Holographic image of the phantom with tumors on the surface (15 GHz)

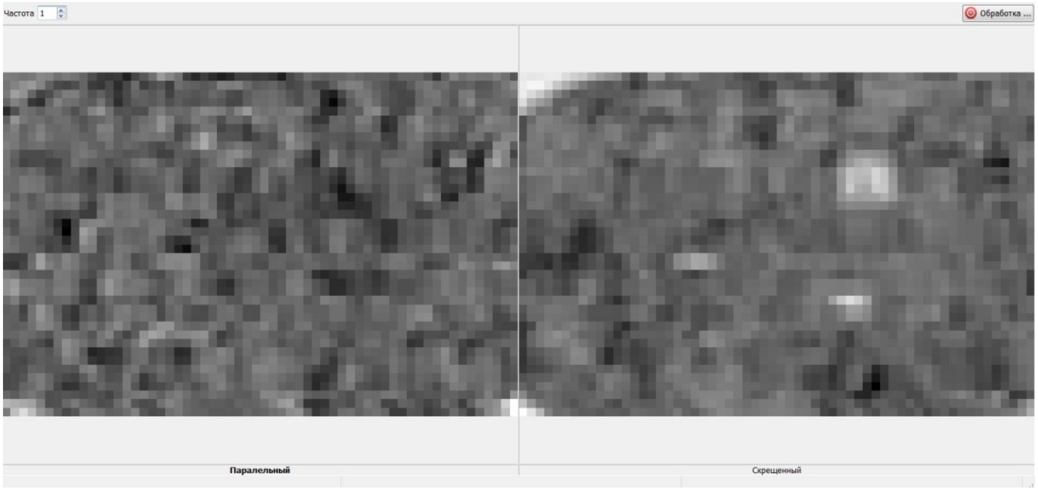

Fig. 7. Holographic image of the phantom with the tumors 1-2 mm under the surface (15 GHz)

Conclusion

Experimental results showed that holographic radars RASCAN used in the experiments allow detection of dielectric inhomogeneity in biological tissues, e.g. tumor in normal breast tissue, due to significant differences in dielectric properties. It was found that holographic radars operating at 4 and 15 GHz can detect a tumor at the depth of 10 and 5 mm. In further work it is proposed to apply reconstruction algorithms to the holograms, which may significantly improve the quality of the image and its resolution.

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