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FORMATION OF IMAGES IN A DIGITAL RADAR

SEMEN CHEHOVICH, VIKTAR YANUSHKEVICH
Polotsk State University, Belarus

This article shows an algorithm for creating images in digital radars with synthesized aperture using the example of a radio hologram constructed with the help of the MATLAB environment. A linearly frequency-modulated pulse is used as the probing signal. The main parameters for the formation of a radio hologram are calculated.

Satellite radar is currently one of the most important and dynamically developing directions of remote sensing.

The basis of satellite radar is the development of methods and equipment that provide the formation of radar images of the earth's surface with high spatial resolution, which serve as information support for solving a wide range of scientific, economic and defense problems [1].

In modern conditions, radar facilities for remote sensing of the Earth, using radars with a synthetic aperture of aircraft and space based systems, have wide application in the world practice.

The method of synthesized antenna aperture is a special case of information processing methods used in holography. The peculiarity of holography is the registration of not the direct image of an object, like a photograph, but the Fourier transform that determines the structure of an image. The synthesized aperture is formed sequentially in time, at each given moment, the EMV is received by a real antenna, and the synthesized aperture is the result of a time-based reception of the EMV by a real aperture at its different position relative to the EMW source [2].

Remembering a series of signals sequentially received by the radar antenna at each point on the path section, coherently summing them, we obtain a narrow DN of the artificially generated antenna array. The lattice size is equal to the length of the trajectory section, on which the storage and coherent summation of the signals is made.

In the digital radar model, a pulsed radar method will be used: the radar transmitter emits energy briefly, with repetitive pulses, in pauses; the receiving pulses are received by the receiving unit of the same radar. The measurement of the range to the target is reduced to measuring the time interval between the moment of the pulse emission and the moment of reception, that is, the time of the pulse movement to the target and back.

To ensure a sufficiently high resolution in range, it is necessary to emit probing pulses of 0.1 µs duration, however such short pulses have low energy. Therefore, the apparatus with a mode of operation of short pulses has a short range. Increasing the range is achieved using the technique of pulse compression. The transmitter emits a pulse of tens of microseconds, which provides a large pulse energy, and hence a longer range. High resolution is provided by compression - reducing the pulse width in the receiver due to the use of intrapulse modulation.

The frequency inside the radiated pulse increases linearly with time. Reflecting from the target, the chirp pulse comes after amplification in the receiver in the compression filter. The principle of the filter is. That the lower the frequency of the received signal. The more time he lingers in the filter. As a result, at the moment of the end of the pulse, all of its energy is concentrated at the output of the filter - the pulse is compressed. [3]

We form a probing chirp pulse duration 1µs and amplitude 1 according to the formula:

$$S_{LFM}(t) = S_0 \cos\left\{\varphi_0 + 2\pi\left(f_0 t + \frac{b}{2}t^2\right)\right\} \quad (1)$$

where S_0 - signal amplitude

φ_0 - initial phase

f_0 - central carrier frequency

b - signal duration

The plot of the sounding signal built in the matlab environment (fig. 1).

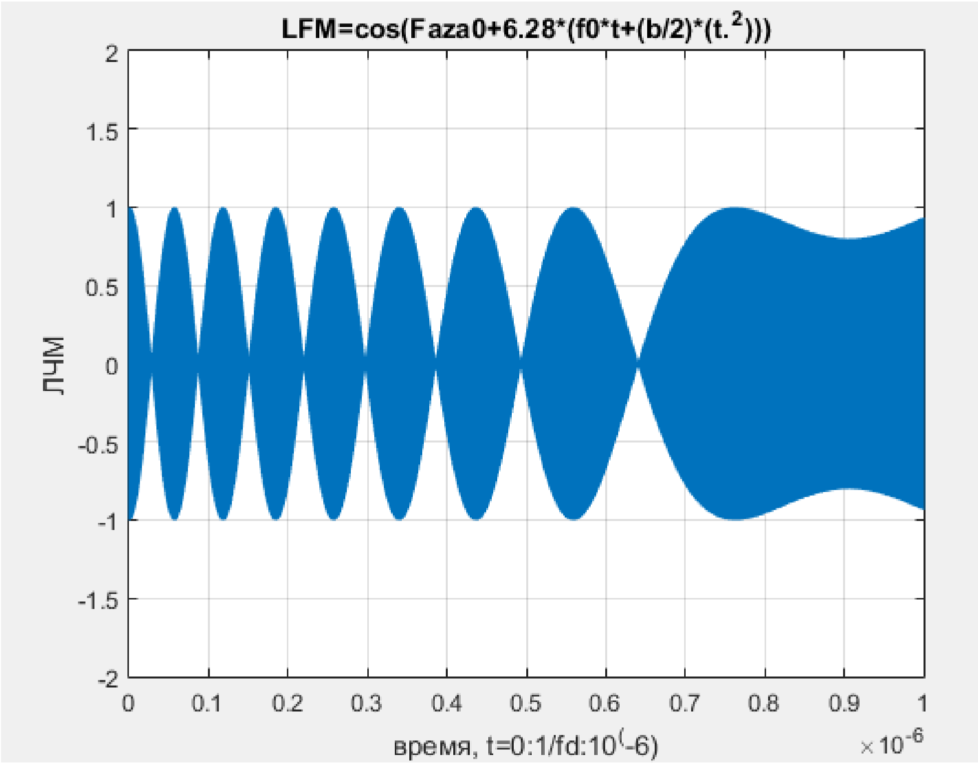

Fig. 1. Probing signal plot

The sounding signal reflected from the ground goes to the receiver. With the help of the filter, the carrier frequency of the reflected signal is removed and the signal is divided into a real and imaginary part. In order to model the unevenness of the relief, we set the signal shift by 100 samples.

Make convolution - take a copy of the signal without shifting from the array of the signal in the form of an entire line and multiply with the signal from the array in which the calculation of the signal shift during the flight is realized. And already from this array a radio hologram is being built.

The received radar information in digital form represents a complex radar image (each element (pixel) of which is characterized by a complex number - real and imaginary components or amplitude and phase, the numerical value of which determines the parameters of the signal received from the corresponding element on the earth's surface.

Using arrays of the reflected signal data without a shift and with a shift and azimuth resolution, we construct radio holograms. For an interval of time of observation the antenna moves in space on distance of resolving ability on an azimuth from an extreme to an extreme point which is called the length of the synthesized aperture

$$L_a=R_0 \cdot f/2c \cdot DN \quad (2)$$

where *DN* – this is the resolving power in azimuth, i.e. DN

c – speed of light

f - frequency

R_0 – distance from the satellite to the target

Using the available data, we construct a radio hologram in the motlab medium (fig. 2).

Based on the radio hologram received, we can see the change in the terrain from the target point target that we took as an object of research.

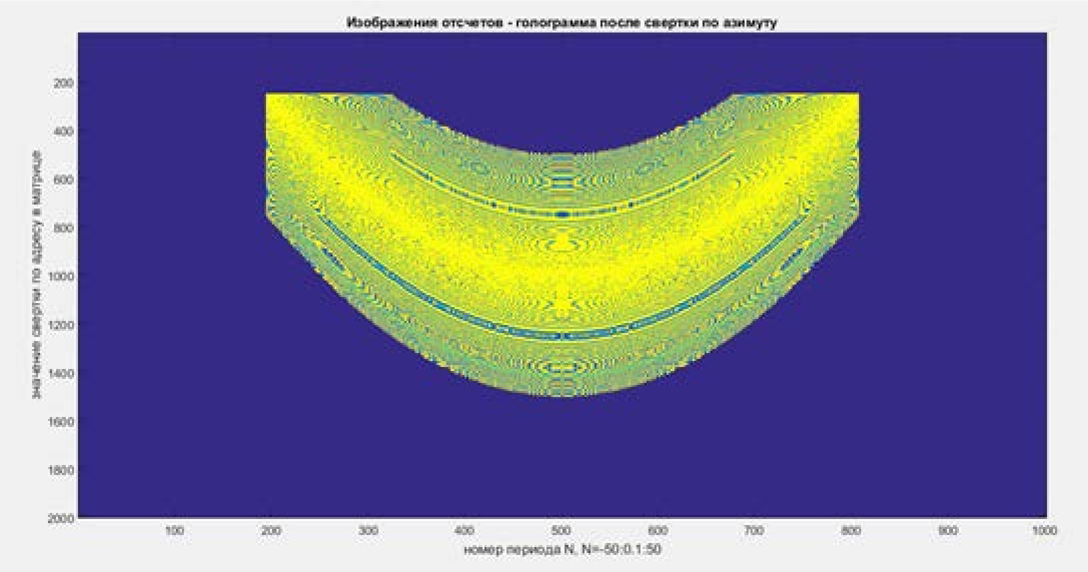

Fig. 2. Radiogollogramma routing mode

Thus, the carried-out analysis showed that application of different operation modes will allow to carry out surface shooting of sections of the Earth's surface with high resolution, determined by requirements to the sizes, definition of delimitation of objects, necessary structure and quality of an observed surface, assignment of the obtained information. The algorithm of formation of radio holograms on the basis of use of an impulse method of radiolocation in relation to X – the range with frequencies of bearing oscillations of 9, 5 - 9,8 GHz is considered. The results of the research can be applied in systems of remote sensing of the Earth.

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