УДК 621.396.96

USE OF WIDEBAND SIGNALS IN RADIOLOCATION SYSTEMS OF DISTANCE MEASUREMENT

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Keywords: radar, radio navigation, distance measurement.

In the conditions of high intensity of air traffic, the performance of safe and regular aircraft flights requires the use of a large number of radio equipment. One such device is a radio rangefinder.

The object of research is the process of forming and processing wideband signals in radar range measurement systems. For scientific substantiation of the results of studies of the formation and processing of signals in radio rangefinders, the method of computer modeling was used to calculate the intercorrelation functions of signals.

In work [1] it is stated that there are three methods of height measurement, which are based on determining the time delay of the probing signal in space: amplitude, frequency and phase. The main disadvantage of the amplitude method is the large minimum measured range, the phase method – the lack of range resolution, the frequency method – the need for high linearity of the frequency change. Currently, the j-correlation method of distance measurement has been developed [2], which does not have these disadvantages. In this method, the probing signal is an oscillation that is frequency modulated by a single-tone harmonic component (fig. 1):

$$U_1(t) = U_{c1} \cdot \sin(2\pi \cdot w_{c1} \cdot (t + \tau_1) + \beta_1 \cdot \cos(2\pi \cdot w_{s1} \cdot (t + \tau_1))) \quad (15)$$

$$U_2(t) = U_{c1} \cdot \sin(2\pi \cdot w_{c1} \cdot (t + \tau_2) + \beta_1 \cdot \cos(2\pi \cdot w_{s1} \cdot (t + \tau_2))) \quad (16)$$

where $U_{c1} = 1$ В – signal amplitude, $w_{c1} = 400$ kHz – carrier frequency, $\beta_1 = 1$ – modulation index, $w_{s1} = 1$кГц – modulation frequency, $\tau_1 = 0{,}2$ ms – time delay of the first target, $\tau_2 = 0{,}21$ ms – time delay of the second target.

According to [3], it is possible to increase the accuracy of radio rangefinder measurements by expanding the spectrum of the probing signal. Now consider signals with linear frequency modulation (LFM) $U_3(t)$ and $U_4(t)$ (fig. 2), which have a wider spectrum and are written as:

$$U_3(t) = U_{c2} \cdot \sin(2\pi \cdot w_{c2} \cdot (t + \tau_1) + \beta_2 \cdot \cos(2\pi \cdot (\frac{F_{max} - w_{c2}}{T_r}) \cdot \frac{(t+\tau_1)^2}{2})) \quad (17)$$

$$U_4(t) = U_{c2} \cdot \sin(2\pi \cdot w_{c2} \cdot (t + \tau_2) + \beta_2 \cdot \cos(2\pi \cdot (\frac{F_{max} - w_{c2}}{T_r}) \cdot \frac{(t+\tau_2)^2}{2})) \quad (18)$$

where $U_{c2} = 1$ V – signal amplitude, $w_{c2} = 400$ kHz – initial frequency, $\beta_2 = 1$ – modulation index, $F_{max} = 500$ kHz– maximum signal frequency, $\tau_1 = 0{,}2$ ms – time delay of the first target, $\tau_2 = 0{,}21$ ms – time delay of the second target.

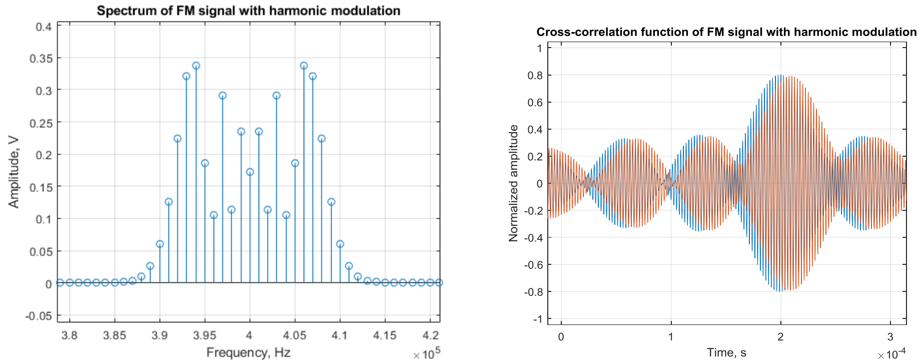

Fig. 1. Spectrum of an FM signal with a harmonic component (left) and its cross-correlation function (right)

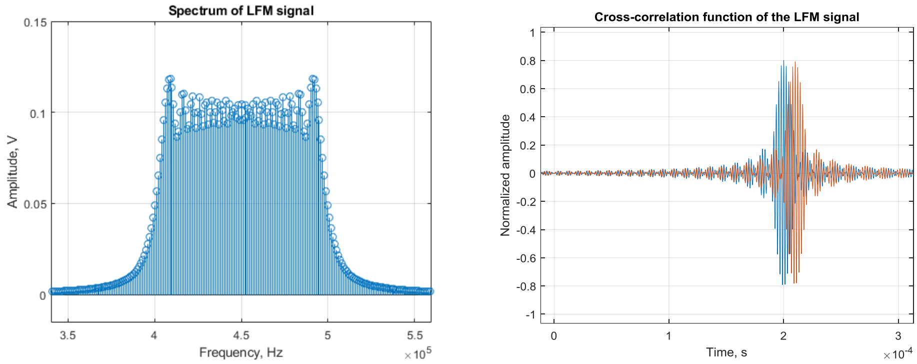

Fig. 2. The spectrum of the LFM signal with a harmonic component (left) and its cross-correlation function (right)

Conclusion

From the comparison of fig. 1 and fig. 2 it follows that the broadening of the signal spectrum narrows the correlation function around the delay points $\tau_1 = 0{,}2$ ms and $\tau_2 = 0{,}21$ ms , which makes it possible to separate the maxima of the cross-correlation function at these points from each other. Thus, the use of a broadband sounding signal with correlation processing allows to increase the accuracy and resolution of the radio range finder.

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