ISSN 0735-2727, Radioelectronics and Communications Systems, 2015, Vol. 58, No. 9, pp. 385–403. © Allerton Press, Inc., 2015.
Original Russian Text © D.I. Lekhovytskiy, D.V. Atamanskiy, D.S. Rachkov, A.V. Semeniaka, 2015, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2015, Vol. 58, No. 9, pp. 3–22.

Improvement of Accuracy of Meteorological Objects Velocity Unambiguous Measurement in Doppler Weather Radars with Staggered Pulse Repetition Times

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Received in final form June 9, 2015

Abstract—In this article we investigate the procedures intended for meteorological objects (MO) mean radial velocity unambiguous estimation in pulse Doppler weather radars with constant and staggered pulse repetition times (PRT). It has been demonstrated that the fulfillment of the requirements to the unambiguous velocity measurement range by means of PRT staggering can be accompanied by the undesirable increase of velocity estimation errors. The causes, which yield this drawback in the known algorithms of velocity unambiguous measurement [1–4], have been determined. We demonstrate the possibility to decrease this drawback using modified estimation of the radial velocity. An influence of various factors (namely staggering principle; the width of the spectrum and the order of autoregressive process, which approximates weather echoes; training sample size; and the variant of final velocity estimation) on the accuracy of modified estimation of radial velocity has been investigated. Reasonable parameters of modified procedure and scheme for its practical implementation have been proven.

DOI: 10.3103/S0735272715090010

INTRODUCTION AND PROBLEM STATEMENT

One of the main objectives of pulse Doppler weather radars (PDWR) consists in the recognition of dangerous meteorological phenomena caused by the wind. The quality of its solution in particular depends on the accuracy of determination of meteorological objects (MO) velocity in given elements of space, which can be measured in various ways [1–6]. Most of PDWR utilize autocovariance ("pulse-pair" [1–4, 7]) measurement technique, in which as the radial component V_r of this velocity one uses the estimation $\hat{V}_r$ of the value

$$V_r = c\arg(r), \tag{1a}$$

$$c = \lambda / (4\pi T), \tag{1b}$$

where

$$\arg(r) = \varphi_T = \arctan(r'' / r') \tag{2}$$

denotes the argument (phase) of the complex correlation coefficient (CC)

$$r = r' + \mathrm{j}r'' = R\exp(\mathrm{j}\varphi_T), \;\; \mathrm{j} = \sqrt{-1},$$

$$R = \sqrt{(r')^2 + (r'')^2} \tag{3}$$