Band Limited Radar Images Nonlinear Restoration Method

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***Abstract* — The paper is devoted to the solution of the spectra extrapolation inverse problem. The regularization procedure influence on image spectra extrapolation was shown.**

I. INTRODUCTION

DURING radar images forming the different distortions caused by forming system have been occurred. To this distortions the image spectra diffraction limitations and image spatial harmonics amplitudes artifacts, caused by the irregularity of spatial-frequency characteristics of formation system belong.

II. MAIN PART

Generally the image forming process for the system with no coherent processing may be described by the Fredholm equation of the first order [3].

Because of final size of antenna system her spatial spectra in limited and in the received image the spectral components from the fixed product to the limited spatial frequency ω_{lim} may be present. Besides sparse antenna arrays application leads to irregularity occurrence and also antenna array spatial spectra in some frequency intervals is equal to zero. All this factors influenced on the image forming process and in most cases this influence is negative.

For the problem stable solution insurance at the high spatial frequencies under noise influence it's rational to use stabilizer and also limitations on the image extended spectra.

The step-by-step approximation method is very suitable for PC realization. This approach is based on the iteration equation:

$$f^{k+1} = \Im f^{k}$$

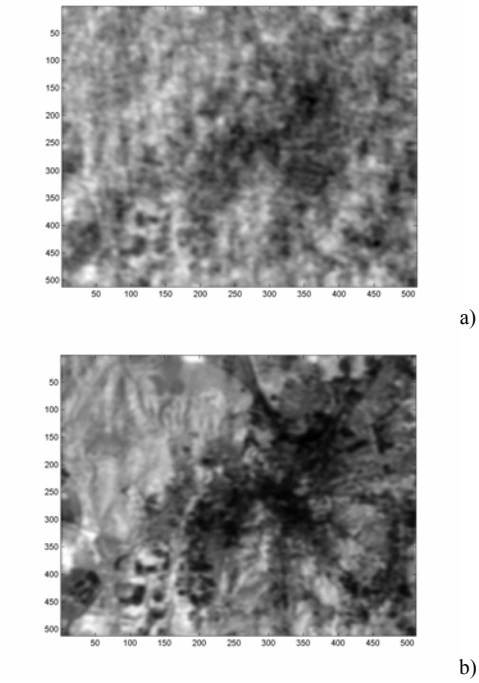
$\Im$ — alignment operator. It's not obligatory that $\Im$ operator depends only from **H.** In general case iteration equation isn't unique for the specified distortion operator and factors set that limitate signal, the several iteration equations may be developed.

Proposed method of lost spectral components approximation under the diffraction distortions is based on new spectral harmonics generation with application of solution limitations and theirs selection due to the prior information. Approach provides selection of generated spatial spectral components in such regions of spectrum where spatial-frequency characteristics of forming system are equal or close to zero. It's provided with help of operator $(I - D)$ action on image. D operator support dating with out image spectral components attenuation where spatial-frequency characteristic isn't equal to zero [1,2]:

$$f_e^{k+1} = DF^{-1}\left(F(g)\middle/(F(h)+\alpha)\right) + (I - D)Nf_e^{k}$$

f_e^{k} —image on the k iteration; g —formed image; h—system function; I—unit operator; D—mask operator; N—nonlinear operator; α—regularization parameter.

Because of the absence of limitation influence on the non-distorted spectra regions, noise influence on the solution will be smaller, in comparison of Van-Cittert algorithm. The example of real radar image restoration by proposed method is



a)

b)

Fig. 1. Formed (a) and restored (b) radar image.

In order that regularization impair extrapolation properties of non-linear methods the influence of regularization on stable spectral signal components

III. CONCLUSIONS

During application of nonlinear methods of image quality improvement with spectra extrapolation the most effective method of regularization is reducing only those spectra parts that cause solution instability.

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