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SPECTRAL METHOD OF DERIVATIVES NUMERICAL CALCULATION IN SUBSURFACE RADAR SOUNDING SIGNALS DIGITAL PROCESSING PROBLEM

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The task of high accuracy numerical differentiation of discrete data has significant applied meaning not only in such known areas of the applied sciences as partial differential equations solution methods, but also in solution some specific tasks, namely, when analyzing signals of subsurface radio location sounding of ground surface segments. Thus, when using morphologic method of geological radar data processing [1], based on the analysis of structural peculiarities of the reflected signals, the task is add up to the mapping of each realization of the sounding pulse on the space curve (complex analytical signal) and further classification of signal points. Tranquilities of such process form the surface of the following view:

$$F(a,b,t)=0, \quad a=U'=\frac{dU(t)}{dt}, \quad b=U\cdot\Phi'=U(t)\cdot\frac{d\Phi(t)}{dt} \tag{1}$$

where $U(t)$ and $\Phi(t)$ - envelope and instantaneous phase of complex analytical signal. The group of reflections generates catastrophe casp-type A_3 according Arnold classification [1]. Then, position of points on the surface (a,b) relatively semi cubic parabola

$$\left(\frac{a}{3}\right)^3+\left(\frac{b}{2}\right)^2=0 \tag{2}$$

gives classification of points and helps defining the position of targets.

This method has special requirements to the quality of numerical differentiation compiling the main operation in expressions (1). Usual differences schemes turn out to be unacceptable, therefore spectrum analogue of central difference scheme has been implemented using technique of fast Furrier transform [2]:

$$x'(t)=\frac{dx}{dt}=\frac{1}{\Delta t}F^{-1}\{j\sin(\omega)\cdot F\{x(t)\}\}, \tag{3}$$

where $F\{\}$ and $F^{-1}\{\}$ - operator of direct and inverse fast Furrier transformation (FFT) accordingly, and $\omega=\nu\cdot\Delta f$, $\nu=0,1,\ldots,N-1$ - discrete variable in frequency domain. For increase of differentiation accuracy and escape of edge effects the operation has been held on the double transformation format with mirror placement of signals. The results of application of the given algorithm to the processing of subsurface radiolocation sounding data by morphologic method are presented here.

REFERENCES

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