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APPLICATION OF SUMMARIZED FUNCTIONS FOR INFORMATION SOURCE PROTECTION

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***Abstract**: Probing signals are succession of impulses with defined frequency and amplitude. The succession itself could be "masked" using changing functions (from the main carrying) under specific laws. The sequence of impulses could be described by summarized functions of different type.*

***Key words**: summarized functions, carrier frequency, pseudorandom sequence.*

I. Introduction

Summarized function of the following type

(1) $f(x) = \frac{1}{x}, x \neq 0$

could not be locally integrable in the vicinity of the beginning of the coordinate system. Ignoring the area containing the beginning of the coordinate system, locally integrable function can be received. Its graphic will consist of two equilateral hyperbolas with asymptotes corresponding axis Ox and Oy. (Fig. 1)

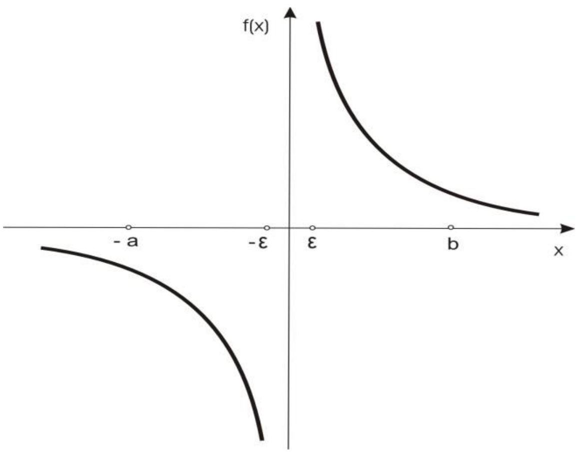


Fig. 1. Graphical interpretation of summarized function f(x) in Cartesian coordinate system xOy

II. Ist order summarized function, describing the probing signal

The probing signal can be described mathematically if a concept of fundamental importance is introduced in sense of Cauchy it can be defined as: [1]

(2) $$V_s \int_{-a}^{b} \frac{1}{x} dx = \lim_{\varepsilon \to +0} \left(\int_{-\alpha}^{-\infty^{-\varepsilon}} \frac{dx}{x} + \int_{\varepsilon}^{b} \frac{dx}{x} \right)$$

Calculating the right side leads to

(3) $$V_s \int_{-a}^{b} \frac{1}{x} = \ln \frac{b}{a} \left[V_s \left(\frac{1}{x} \right) \frac{1}{x}, \quad \varphi(x) \right] = V_s \int \frac{\varphi(x)}{x} dx \in ,$$

where a and b are parameters > 0

In private case

(4) $$V_s \int_{-a}^{b} \frac{dx}{x} = 0, \quad V_s \int_{-\infty}^{\infty} \frac{dx}{x} = 0$$

If the ratios (4) are placed in equation (2) then it can be written:

(5) $$\left[V_s \frac{1}{x}, \quad \varphi(x) \right] = V_s \int \frac{\varphi(x)}{x} dx ,$$

where $\varphi(x) \in$ k, k – Euclidean space

The determined functional is linear and continuous and represents summarized function. The summarized function $V_s \left(\frac{1}{x} \right)$ matches with $\frac{1}{x}$ everywhere except the beginning the coordinate system xOy.

For $\varphi(x) \in$ k can be written

(6) $$(xV_s, \varphi(x)) = (V_s \frac{1}{x}, x\varphi(x)) = V_s \int_R \varphi(x) dx = \int_R \varphi(x) dx = (1, \varphi(x))$$

Thereof $xV_s \frac{1}{x} = 1$, which preserved the main property of this function.

III. Probing signal described by IInd order function

Let us consider function of the following type [2]:

(7) $$f(x) = \frac{1}{x}, \quad at \quad x \neq 0$$

and then is presented like summarized function

$V_s(\frac{1}{x^2})$, which is written analytical:

(8) $$\left[V_s \frac{1}{x^2}, \varphi(x) \right] = V_s \int_R \frac{\varphi(x) - \varphi(0)}{x^2} dx$$

It can be marked that:

(9) $$\left[x^2 V_s \frac{1}{x^2}, \varphi(x) \right] = \left[V_s \frac{1}{x^2}, x^2 \varphi(x) \right] = V_s \int_R \varphi(x) dx = \int_R \varphi(x) dx = (1, \varphi(x))$$

It follows that $x^2 V_s \frac{1}{x^2} = 1$ preserves the property of probing impulses in the corresponding frequent range.

IV. Probing signal with function of IIIrd order

(10) $f(x) = \frac{1}{|x|}$, where $x \neq 0$, $x \in R$

R - multitude of real values

The summarized function $w\left(\frac{1}{|x|}\right)$ for which is written [3]:

$$(11)\ w\left(\frac{1}{|x|},\varphi(x)\right)=\int_{|x|>1}\frac{\varphi(x)}{|x|}dx+\int_{|x|<1}\frac{\varphi(x)-\varphi(0)}{|x|}dx$$

If we consider that $x\in R^n$, i.e. $r=\sqrt{x^2+y^2}$ is introduced, then for the summarized function can be marked:

$$(12)\ \left(w\frac{1}{r},\varphi(x,y)\right)=\iint_{r<1}\frac{\varphi(x,y)-\varphi(0,0)}{r}dxdy+\iint_{r>1}\frac{\varphi(x,y)}{r}dxdy$$

Equation (12) is summarized regular function of $\frac{1}{r}$, which is not locally integrable in the vicinity of the beginning of the coordinate system.

V. Summarized function of IVth type for probing signal describing.

Let the summarized function has the following expression[6]:

$$w\left(\frac{1}{x^2+y^2}\right)$$

The function of IInd type can be put in summarized function $w_f\left(\frac{1}{x^2}\right)$, which is pseudofunction $\frac{1}{x^2}$ and could be described with expression of the following type:

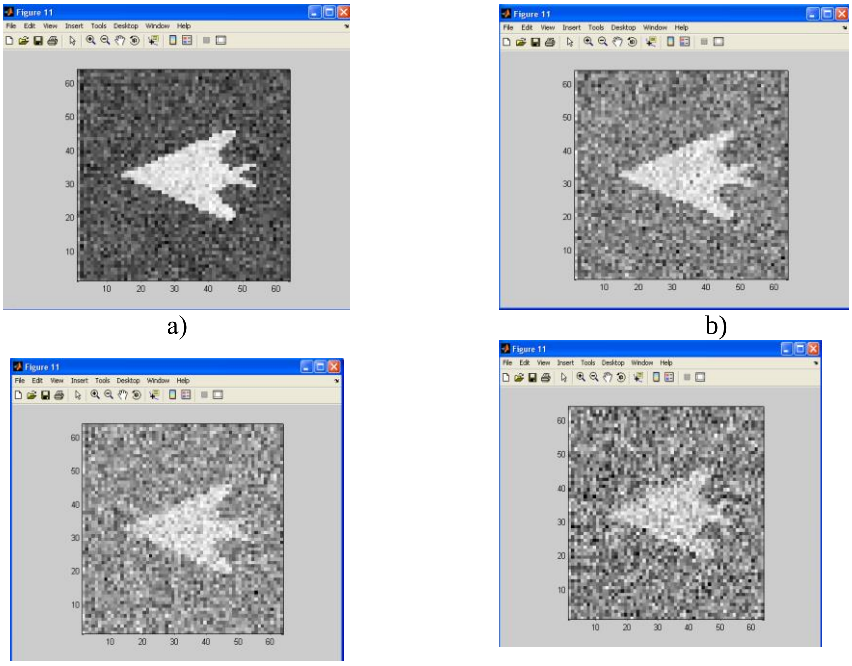
$$(13)\ \left(w_f\frac{1}{x^2},\varphi(x)\right)=\lim_{\varepsilon\to+0}\left[\int_{-\infty}^{-\varepsilon}\frac{\varphi(x)}{x^2}dx+\int_{\varepsilon}^{\infty}\frac{\varphi(x)}{x^2}dx-2\frac{\varphi(0)}{\varepsilon}\right]$$

For received pseudofunctions can be written summarized equation of the type [5]:

$$(14)\ \left(w_f\frac{\theta(x)}{x},\varphi(x)\right)=\lim_{\varepsilon\to+0}\left[\int_{-\varepsilon}^{\infty}\frac{\varphi(x)}{x}dx+\varphi(0)\ln\varepsilon\right]$$

$$(15)\ \left(w_f\frac{\theta(-x)}{x},\varphi(x)\right)=\lim_{\varepsilon\to+0}\left[\int_{-\infty}^{-\varepsilon}\frac{\varphi(x)}{x}dx-\varphi(0)\ln\varepsilon\right]$$

The shift ε around the beginning for probing signal in xth range is determined experimentally [4]. When using probing frequent linear modulated signal in xth range we use the theory of inverse aperture synthesis for radiolocational image recreating of aircraft ε ≈ 10 MHz. [7] The results at Gaussian dispersion of Gaussian noise corresponding a)- 0,1; b) -0,3, c) -0,5, d) -0,7 are shown on Fig. 2 [4]. The root mean square error at the corresponding dispersion of Gaussian noise is shown in tabular (Table1) and graphical (Fig.3)



a) b) c) d)

Fig. 2. Recreated radiolocational images using probing signal under Cauchy’s law

Table. 1. Error in Radiolocation Image recovery via Line-frequency modulation signal and carrying frequency retribution under Cauchy’s law ($K_K = 10^6$)

Dispersion	0,1	0,3	0,5	0,7	0,9
$\overline{\delta}\%$	29	26	37	48	41

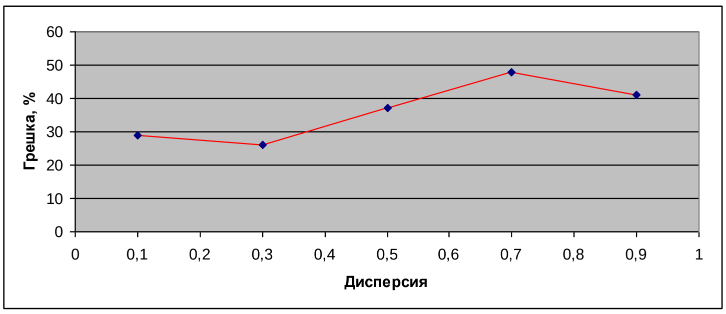


Fig. 3. Graphical representation of root mean square error at different Gaussian noise dispersion

Conclusions:

1. Summarized functions of every type can well be applied for describing the type of synthesis for extracting information from air.
2. The mathematical model of the probing signal under Cauchy's law is difficult for analysis.
3. Broadcasting of sequence of probing impulses under law, described using summarized function of IInd and IIIrd type could bring to divergence of the processes for their analyzing.

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