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DATA BASE COMMUNICATIONS RELIABILITY BY RADIO LINK

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Executed modeling of process of exchange given when using a radio link in the automatic checking system and account of electric power. Shown that sufficiently reliable reception and recognition given with probability more 0,9 possible at the correlation a signal/noise not less 12.

Exchange by data, radio link, probability, automatic system, checking, account of electric power.

As is well known, using an automatic checking system and account of electric power (АСКОЕ) allows to get exact and reliable измерительную information, raises efficiency of energy governing, enables to create real balances of electric power and powers for the evaluation of current modes electrosupply, short- and long-term forecasting, registrations of economic and financial documents on all levels of power system of state [2].

In the system of an automatic control checking the parameters of lines supply and account of amount потребляемой electric powers is executed by electronic counters with using the microconttrollers. The Data base communications is executed in the numerical type and can be realize by two lines interface, telephone or on the optical communication link - where this possible. But laying of new cables on groups of ten of kilometers possible not around and costs much.

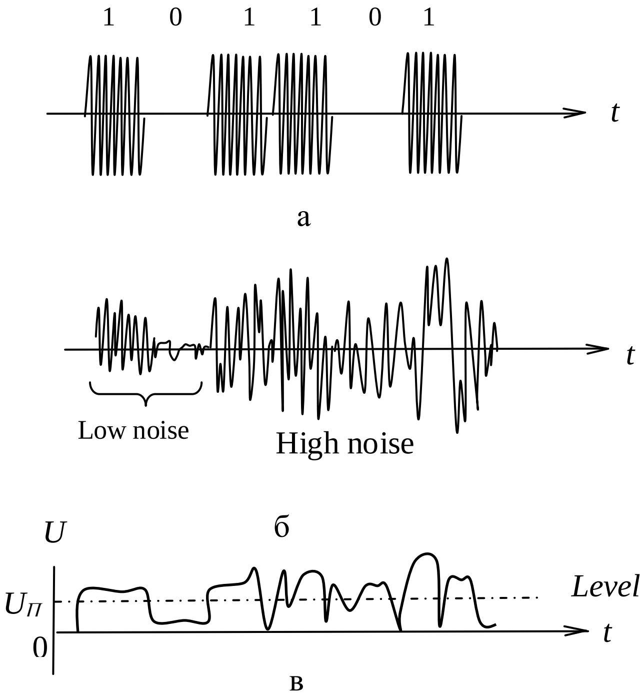
Now is perspective an using a radio link numerical GSM-standard. However at the transmission of numerical code on he affects different obstacles: atmospheric noises, electromagnetic pulse from the bit of light and others, that brings about unfaithful receiving the numerical data.

Purpose of studies - a theoretical analysis of process of data base communications by the radio link and determination probability features of exchange channel.

Material and strategy of studies. On leaving a transmitter be only useful signal (рис.1,but). At the input, receiver acts additive mixtures of useful signal s(t) and noise n(t) (Grap.1,b):

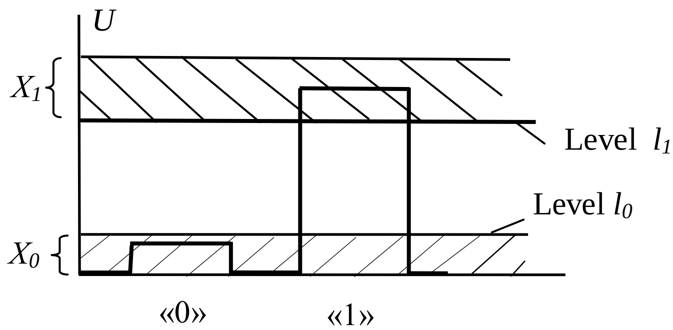
$$x(t) = s(t) + n(t). \qquad (1)$$

In accordance with pic.1, beside the decision, which accepted signal be logical "1", is taken, when amplitude of signal of above threshold U0; deciding, which accepted signal be logical "0" - when amplitude of signal below borders U_0.
As logical "0" , so and logical "1" be useful signal, in particularities, if data base communications is executed frequency inflexion, the logical "1" - signal



Grap.1

on the frequency f1, logical "0" - a signal on the frequency f2. Deciding on that, that accepted signal be logical "1" is taken, if top of signal on leaving single-line part of the receiver (to the detector) falls into the area X1 (grap.2), but logical "0" , if top of accepted pulse bases in area X0.



Grap.2

At the determination of deciding are to be two взаимоисключающего condition: H_{11} - sent by the transmitter logical "1"; H_{01} - was sent logical "0".

Receiver on the base of analysis of signal h(t) comes to a conclusion: was sent "1" or "0". Обозначим Decision: A_{11} - a signal logical "1" be, A_{01} - logical "1" is not accepted, is accepted logical "0". One of the deciding correct, second - a mistake. Then are to be such events:

$A_{00}H_{00}$ - nothing was not send, transmitter was вимкнено, and reception side was an accepted decision, which useful signal was not (correct неопределение);

$A_{11}H_{11}$ - sent logical "1" and are accepted deciding, which accepted logical "1" - a correct determination logical "1";

$A_{11}H_{00}$ - a signal will not be send, but was an accepted decision, which accepted logical "1" (wrong determination logical "1");

$A_{01}H_{00}$ - a signal will not be send, but was an accepted decision, which accepted logical "0" (wrong determination logical "0");

$A_{01}H_{11}$ - sent logical "1", but is decide that this - logical "0" - a skipping logical "1";

$A_{11}H_{01}$ - is sent logical "0" , but are accepted deciding, that this - logical "1" - a wrong determination logical "1";

$A_{01}H_{01}$ - is sent logical "0" and are accepted deciding, that this - logical "0", the correct determination logical "0".

Degree of unwillingness of these mistakes different, but all of these bring about perverting data, that is necessary take account into data processing. Execute this by means of factors, which name a mistake cost.

System of exchange given possible characterize a value of average charge per inaccuracy, which is number by the rules population mean:

$$\bar{r} = r_{1000} \cdot ð(A_{10}H_{00}) + r_{0100} \cdot p(A_{01}H_{00}) + r_{0111} \cdot p(A_{01}H_{11}) + r_{1101}p(A_{11}H_{01}) \ , \qquad (2)$$

where r_{1000} - a cost of wrong determination of presence of logical signal "1", when transmitter was expelled; r_{1101} - a cost per the wrong decision of acceptance "1", when is sent 0; r_{0111} - a cost per wrong acceptance 0 when is sent by 1; r_{0100} - a decision making cost, which is accepted signal "0" when transmitter was exclude; $p(A_{XX}H_{XX})$ - corresponding probability of mistakes.

Obviously, that $r_{1000} = r_{0100} = r_{01}$; $p(A_{10}H_{00}) = p(A_{01} \quad H_{00}) = p(A_sH_0)$, where A_s - decision makings on presence of useful signal of at the input detector; H_0 - an absence of transmissions.

Besides, as far as charge per the wrong decision of presence "1" or "0" alike, $r_{1101} = r_{0111} = r_{10}$; $p(A_{10}H_{11}) = p(A_{11}H_{01}) = p(A_{ps}H_1)$.

Then equations (2) takes a type:

$$\bar{r} = 2r_{01} \cdot p(A_{ïð}H_1) + 2r_{10} \cdot (p(A_{Ñ}H_{00}) \ , \qquad (3)$$

where $p(A_{ps}\ H_1)$ - probability of wrong deciding (is accepted "1" or "0") at presence of signal of transmitter; $p(A_sH_0)$ - probability of wrong deciding, that signal be (for want of the transmission).

Use a rule of multiplying імов:рностей:

$$p(A_n H_1) = p(H_1)\cdot p(A_{np}|H_1) = p(H_1)F_{wd}; \quad (4)$$

$$p(A_c H_0) = p(H_0)\cdot p(A_C|H_0) = p(H_0)D_{ss}\ , \quad (5)$$

where $F_{wd} = p(As|H_1)$ - probability of wrong determination logical "0" or "1"; $D_{ss} = p(AsH_0)$ - probability of wrong deciding on the absence of transmissions (skipping of signal).
Charge per the skipping sent given D_{ss} less, than for wrong decision F_{wd} ("1" instead of "0" or on the contrary), as far as information possible to retransmit.

If probability of correct acceptance given D_{cp}, then $D_{cp} + D_{ss} = 1$, and $D_{ss} = 1 - D_{cp}$.

Then after conversions an expression (3) takes a type:

$$\bar{r} = 2r_{10}p(H_1)\left[1-(D_{cp} - l_0 F_{wd})\right], \quad (6)$$

where coefficient $l_0 = \dfrac{r_{10}p(H_0)}{r_{01}p(H_1)}$ = const is kept only a priori probability and does not depend on deciding, that is accepted after information handling.

Optimum be such processing, which gives a minimum of average risk. Such condition of minimum of total probability of inaccuracy be a known criterion of ideal watcher. Minimum $\bar{r}$ will be at the maximum, if :

$$(D_{cp} - l_0\ F_{wd}) = max. \quad (7)$$

Noises of atmosphere for want of the useful signal (refer to pic.1,a) be a stationary casual process Y, which density of distribution answers Relay law [1]:

$$w(Y) = \frac{Y}{\sigma_n{}^2} e^{-\frac{Y^2}{2\sigma_ш{}^2}}, \quad (8)$$

where : $\sigma_n = k_0^2 E_S N_n / 2$ a dispersion of noise; k_0 - proportional factor ; E_S – a full energy of signal; N_n – spectral density of noise.

For presence of useful signal density of mixture of signal and noise [1]:

$$w_{SN}(Y) = \frac{Y}{\sigma_N^2} exp\left(-\frac{Y^2 + k_0^2 E_C^2}{2\sigma_n^2}\right)\cdot I_0\left(\frac{k_0 E_s Y}{\sigma_n^2}\right)\ , \quad (9)$$

where I_0 - a modified Bessel function zero order, $I(x) \cong \dfrac{e^x}{2\pi x}/$

Then probability of correct receiving data can be consider as conditional probability of excess borders l1 accepted by the signal logical "1" (refer to рис.2) [3]:

$$D_{ПП} = \frac{1}{\sqrt{2\pi}}\int_{v_0}^{\infty} e^{-v^2/2}dv = \frac{1}{2}\left[1 - F(v_0)\right]\ , \quad (10)$$

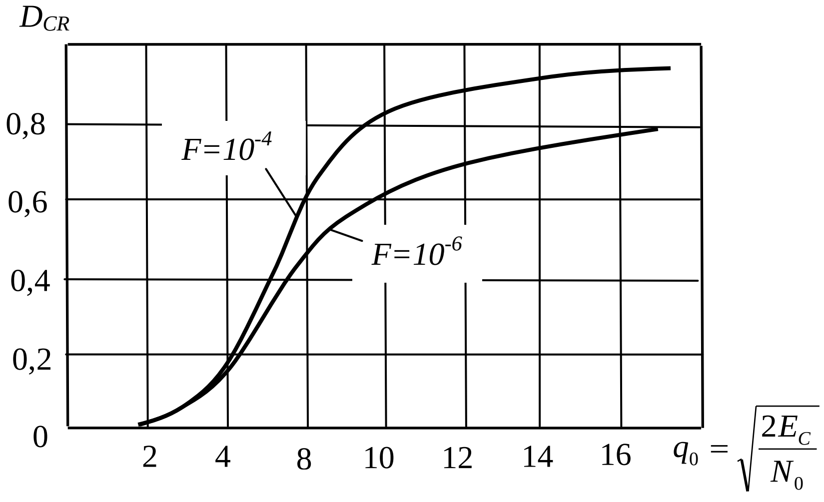
where $F(v)=\frac{2}{\sqrt{2\pi}}\int_0^v e^{-v^2/2}dv$ - an integral of probability [1]; $v_0=u_0-q_0$;

u_0 - a relative border of operating; $q_0=\sqrt{\frac{2E_C}{N_0}}$ - relations a signal/noise of at the input detector of receiver.

So probability of correct receiving a numerical signal

$$D_{CR}=\frac{1}{2}\left[1-F(u_0-q_0)\right]$$

and answers graphs a revealing a signal under additive mixtures of useful signal and noise without the accumulation, for want of retransmissions.



Grap.3. Characteristics of revealing a numeral signal for a canal with noise

Findings

When using a radio link for the data base communications електровим:р:в in the system АСКОЕ probability of correct acceptance and recognition of numerical datas can be consider as conditional probability of excess borders accepted by the signal logical "1" or "0" and is perfect when increasing a relations of energy of signal to energy of noise of at the input detector of receiver, at probability of wrong discovery given decreases.

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