AN APPROACH TO SELECTION OF ANTINOISE CODING TECHNIQUE

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Abstract— In the field of data communications the requirements to protection against noise is still growing. There are many methods of antinoise coding. Each method has the advantages and disadvantages, that is why the selection of antinoise coding technique is very important in the development of the devices, which can data communicate. An approach to selection of antinoise coding technique was developed, which consists of three stages. Firstly, it is use theoretical estimations for characteristics of various codes, and also results of previous researches. Further, algorithms are estimated by number of operations and memory cost. In the upshot the mathematical simulation is realized.

Keywords: antinoise coding, coder, decoder, modulation, demodulation

1. INTRODUCTION

Selection of antinoise coding technique can be considered as polyvalent problem. Quality characteristic of system of information transfer can be presented as:

H=F(C,K,T,A), where:

- C - indexes of information transfer channel;
- K - characteristics of coding system;
- T – time characteristics;
- A - characteristics of realization;

As quality characteristics some single characteristics can be used, for example, frame error probability (FER), probability of loss of information and others or their generalized characteristic. For each of these characteristics there exists dependence on P (probability of bit error of decoded data) therefore H is considered to be $P_{bd.}$

For research of system of antinoise coding it is possible to use the simplified model of system of information transfer - the modulator, the channel with additive white noise and the demodulator form the discrete channel - we exclude blocks of signal modulation and demodulation and take these processes into consideration in model of the channel of information transfer. Generally under the characteristic of channel C it is possible to consider the attitude signal/ noise by bit (h_0^2), in the given work we use value P_{bc} - bit error probability in the channel which is eguivalent to h_0^2. For specific type of modulation there is the dependence $P_{bc\ c} = f(h_0^2)$. For example, when using binary PM (phase modulation) and coherent receiving [1] error probability is:

$$P_{bc} = Q(\sqrt{\frac{2E_c}{N_0}}) = Q(\sqrt{2\gamma_b R_c})\ ;$$

at binary frequency modulation and coherent detecting:

$$P_{bc} = Q(\sqrt{\gamma_b R_c});$$

at binary frequency modulation and incoherent detecting:

$$P_{bc} = \frac{1}{2}\exp(-\frac{1}{2}\gamma_b R_c)$$

Parameters of K system coding are code type, code parameters (for example, for convolution code these are code speed, code limitation and code seed).

Time parameters of T system are information rate, frame processing time of specified length.

Characteristics of realization A are regarded as algorithm of decoding, method of realization (software or hardware) and resources requirement.

Parameters C,K,T,A have an influence not only on H, but also on each other, in limitation, therefore it is insufficient to carry out analysis on the level of getting dependances under realisation of system of information transfer:

$H=f_1(C)$, $H=f_2(K)$, $H=f_3(T)$, $H=f_4(A)$.

2. AN APPROACH TO SELECTION OF ANTINOISE CODING TECHNIQUE

2.1 Approach description

Process of chosing of antinoise coding technique is proposed to be performed in following steps:

1. Choosing methods of coding, as a result of theoretic research.
2. Choosing algorithm of decoding, estimation of possibility of decoder practical realization.
3. Mathematical simulation of coding system for getting characteristics of system quality.

On a first step it is possible to use theoretical estimations for characteristics of various codes, and also results of previous researches.

On the second step it is necessary to estimate algorithms by number of operations and memory cost. Criteria of a choice of algorithm is the opportunity of realization at given limitations, for example, limitations of the chosen element base, and time of algorithm execution (time of decoding one bit or one block of information). The result of the second step is reducing of number of possible methods of coding.

Third step is mandatory, because only mathematical simulation allows to get real estimate of system characteristics.

2.2 Example of application of the offered approach

The offered technique is shown on an example of a choice of antinoise code providing minimal FER value when transferring the 16 bit block and when values of a channel bit error are 0,05 - 0,07 and hardware realization is limited.

In figure 1 the model of system of information transfer is presented.

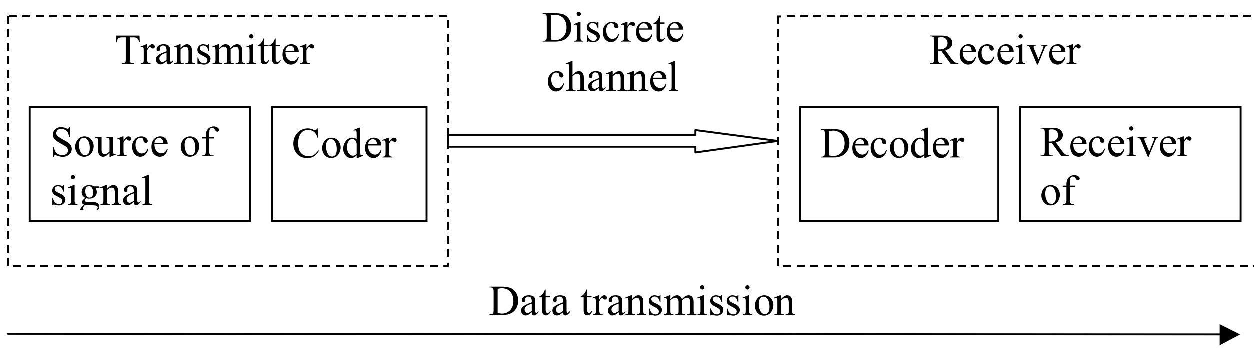

Fig. 1 Model of the data transmission, protected by antinoise coding on discrete channels.

For modelling it is possible to use various CAD systems, for example, ADS ("Agilent Technologies") [2], System View ("Elanix"), MatLab software ("MathWork"). The environment of mathematical modelling MathSoft MatLab 7.0 gives wide opportunities for simulation of various algorithms of coding/decoding by means of built-in functions. Functions of algorithms of antinoise coding are located in Communication Toolbox module.

Algorithm of realization of communication system using convolution codes:

- Bit sequence coding by means of convolution code

convenc (sourceData, trellis ;)

- Formation of error vector

errors = randerr (1, length (codedData), bitIndex);

- Entering errors into the coded sequence

noisedData = bitxor (codedData, errors ;)

- Sequence decoding by means of algorithm Viterbi

decodedData = vitdec (noisedData, trellis, tblen, ' term ', ' hard ');

- Comparison of decoding sequence with the initial one

numErrors = biterr (decodedData, sourceData);

- Calculation of frame error probability

Programme data-in are bit sequence which is loaded from a file. Results of modelling are represented in tables or diagrams.

For modelling codes BCH(Bose-Chaudhuri-Hocquenguem) of function *convenc* and *vitdec* are replaced by *bchenc* and *bchdec,* entrance bit sequences are represented as form Galua fields by means of function *gf.*

The program has been developed for modelling block and convolution codes with various parameters.

2.3 Result of application of the offered approach

For the represented problem satisfactory results when using block codes can be received only using long codes whose decoding complexity is considerably higher, than that of convolution codes with the same characteristics, therefore convolution codes have been chosen. The results of modelling convolution codes with various parameters are presented in figure 2.

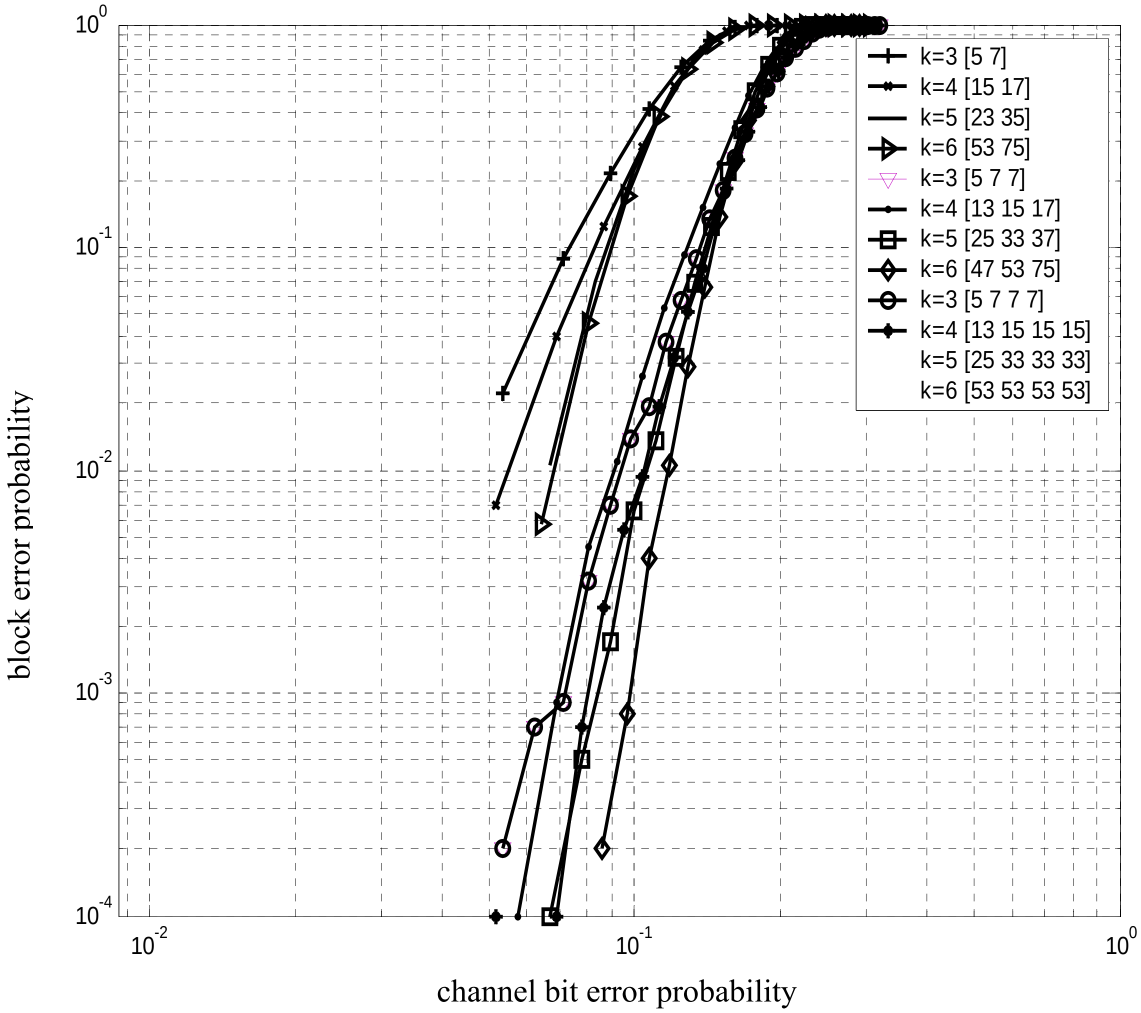

Fig. 2 Characteristics of convolution codes

For convolution codes decoding by means of algorithm Viterbi [3] algorithmic complexity has been estimated. In table 1 values of the basic operations of decoding are resulted, the quantity of operations depends on parameters of a code and a decoder:

A_k, Γ_k - metrics of state and transitions;

LLR_k - the logarithmic attitude of plausibility of a way;

MLP - length of the most plausible way;

δ - depth of the ways` history.

In the bottom line of the table algorithmic complexity of convolution code decoding with parameters (R=1/3, K=6, a code seed 45 53 75) is calculated.

Table 1. Algorithmic complexity of convolution codes decoding by means of algorithm Viterbi.

	N	ADD	MAX.	MUL(-1)	MUL(C)	MIN.
A_k	$(L-1)\cdot 2^{K-1}$	2	1			
MLP	$L-\delta$		$2^{K-1}-1$			
Γ_k	$L\cdot 2^K$	3		3	2	
LLR_k	L					δ=5*k
K=6	72	5	32	3	2	30

The code should be choosen according to limitation of hardware realization. The basic limitations are expenses of operative memory which can be calculated by the formula

V = $2^k * \delta$.

Memory cost for realization of algorithm with K=6 at δ=5*k are equal 1920 byte, that meets hardware requirements. Application of a code with K=7 will improve characteristics, but it demands a memory size more than 10 Kb, that is unacceptable for realization.

3. Conclusion

An approach to selection antinoise coding technique was developed. The convolution code has been chosen by means of the offered approach as a antinoise code providing minimal FER value when transferring the 16 bit block and when values of a channel bit error are 0,05 - 0,07 and hardware realization is limited

4. References

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