ANALYSIS ON INFLUENCE OF THE RANDOM INTERFERENCE STRUCTURE ON THE QUALITY OF UNAUTHORIZED DIGITAL SIGNALS RECEPTION

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ABSTRACT – Currently, a number of digital information transmission systems have been developed. It is noted that there may be existed information leakage channels. It means that the radio interception is worked on the leak channel. In this paper, it was considered when two active interferences (impulse noise and harmonic interference) acted on the input of the radio intercept receiver. In addition, at the input of receivers an additive noise such as "white noise" is acted. It was produced due to its own noise. The condition for the safe transmission of information over digital radio channels (Pulse-Code Modulation) was considered.One of the main problems in the field of wireless communication systems is a significant increase in the speed of data transmission and improving the quality of user service (reducing the probability of transmission error).

Keywords – *Signal Strength, Probability of Error, White Noise, Impulse Noise, Harmonic Interference.*

I. INTRODUCTION

a) System of Transmission of Digital Information

The systems by which discrete information is transmitted are often referred to as digital, since the information transmitted by these systems can be viewed as a sequence numbers expressed in a form convenient for practical use. Digital information transmission systems are often also called code systems or systems with Pulse Code Modulation.

The most significant advantages of digital information transmission systems are:

1) The ability to automate the processing of information;

2) The universal form of presentation of messages of a different physical nature and, as a result, the flexibility of the systems, allowing, by replacing the program, to use the same equipment for different purposes;

3) High-quality performance of systems;

4) The possibility of combining individual systems into larger systems and complexes.

Digital information transmission systems are currently developing rapidly and are finding increasing application in various fields. Figure 1. Show structural diagram of a digital information transmission system.

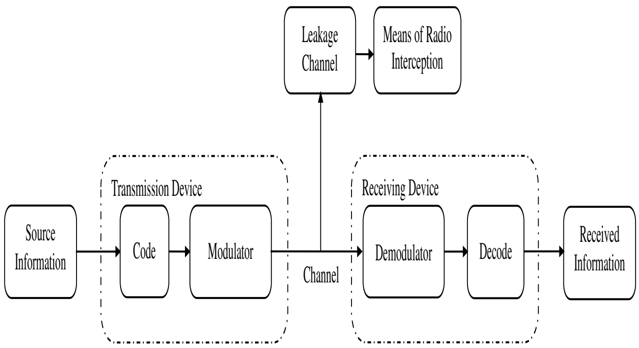

Figure 1. Structural diagram of a transmission of digital information system.

b) Channel Noise

In any communication system, the received signal will consist of a transmitted signal reduced as it multiplied along the transmission media and suffers from some distortion due to the characteristics of the system. In addition, unwanted signals (or noise) can be occurred between the transmitter and the receiver, which are added to the transmitted signal. Noise is the main factor that limits the performance of communication systems as shown in figure 2.

In figure 2, the first line is binary digital information soure and second line is represented squared wave form from binary data. The third line is noise which effected to the transmission data at receiving end. Finally receiver regenrated original data and it included error bits that limit the performance of data transmission system.

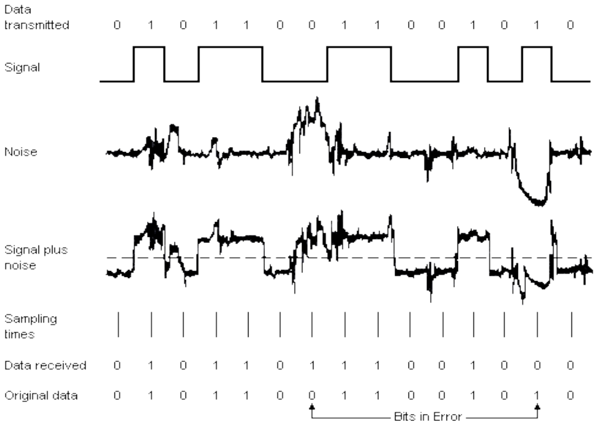

Figure 2. The effect of noise on the digital signal

II. TRANSMISSION CHANNEL EFFECTED BY WHITE NOISE

White noise (Gaussian Noise) is a random signal (or process) with a flat power spectral density. In other words, the signal contains equal power within a fixed bandwidth at any central frequency.

A random signal is considered as "white noise" if it is observed near a flat spectrum of a wider medium capacity. In this case, it has autocorrelations that can be represented by delta functions over the corresponding dimensions of space.

Even binary signals that can only take 1 or -1 values will be white if the sequence is statistically uncorrelated. Noise having a continuous distribution, such as a normal distribution was represented in figure 3.

The probability of symbol error due to white noise can be calculated by –

$$P_E = 0.5 - \Phi_0(\sqrt{\left(\frac{1}{2} \times \frac{P_S}{G_N}\right) \times T_S}) \quad , \quad (1)$$

where P_E= Probability of symbol error due to white noise effects

Φ_0= Gaussian integral of error

P_S = Signal strength

G_N= Spectral noise density

T_S= Symbol time

In this equation, $\frac{P_S}{G_N} = 2 \times 10^3$Hz and $T_S = 10^{-3}$sec, and it was inserted or driven by simulation tools and drawn out as a figure. Figure 3 shows probability of symbol error due to white noise.

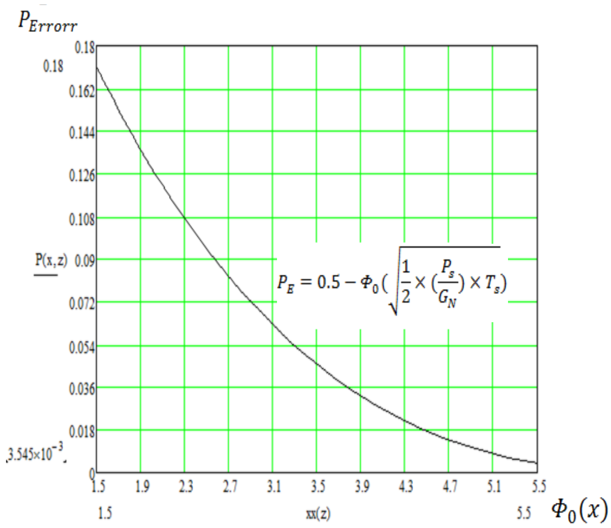

Figure 3. Probabilities of symbol error due to white noise effect.

III. TRANSMISSION CHANNEL EFFECTED BY IMPULSE NOISE

Impulse noise is a relatively short and powerful burst of interfering voltage in the channel. Although the time action of impulse noise is short, the effect of high-frequency interference is high. The impulse noise is usually irregular, and the position of the stray flashes on the screen is not constant in time.

Impulse noise can be represented as a process, formed by a sequence of individual short-term pulses of random form that occur at random moments.

Amplitudes of impulse noise in communication channels can reach values that exceed the level of the useful signal. Such interference is very likely to cause errors in the received sequence of single elements.

The probability of symbol error of impulse noise can be calculated by –

$$P_{EI} = (P_{ER} \times 0.5) + (1 - P_{ER}) \times P_E, \quad (2)$$

where P_{EI} = Probability of symbol error of impulse noise

P_{ER} = Probability of symbol error of random noise.

In this equation, probability of symbol error of random noise is equal to 0.033 and it was driven by software tool and the result was shown in figure 4.

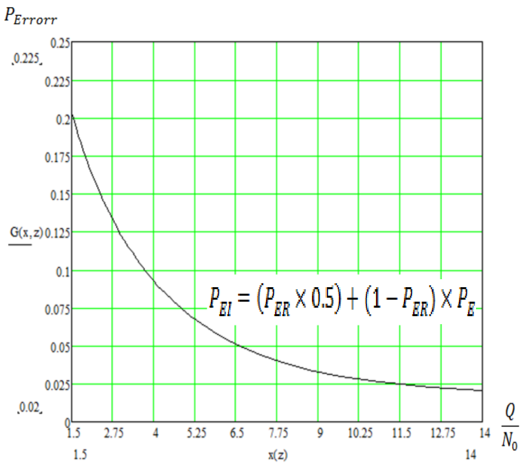

Figure 4. Probabilities of error of impulse noise symbols with white noise

IV. TRANSMISSION CHANNEL EFFECTED BY HARMONIC INTEFERENCE

It is known that the greatest influence on the efficiency of digital data transmission is the accuracy of fixing the timing position of the synchronizing signal, which in turn depends on the degree of limitation of the spectrum of the emitted signal, the clock synchronization mismatch, the presence of harmonic interference and interference due to multipath signal propagation.

The probability of symbols error of harmonic interference can be calculated by-

$$P_{EH} = 0.5 - \Phi_0\left(\sqrt{\frac{1}{2} \times \frac{P_S}{(G_N+G_H)}}\right) \times T_S), \qquad (3)$$

where P_{EH} is probability of symbols error of harmonic interference, P_S is signal strength and it is equal 4.35×10^{-17} Watts, G_N is Spectral noise density and it is equal 1.38×10^{-23} kWatts/Hz and G_H is spectral density of harmonic interference and it is equal 0.48×10^{-20} Watts/Hz. This equation was drawn out as a output figure as shown in figure 5.

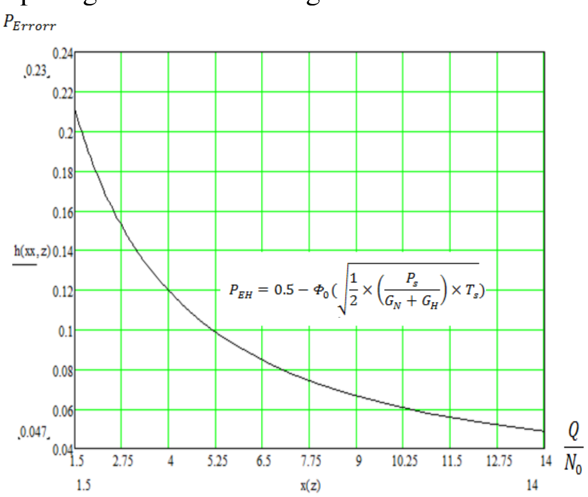

Figure 5. Probabilities of symbols error of harmonic interference with white noise.

Finally probability of symbols error can be combined with various errors sources; white noise, impulse noise and harmonic interference, and drawn out in one figure shown as figure 6.

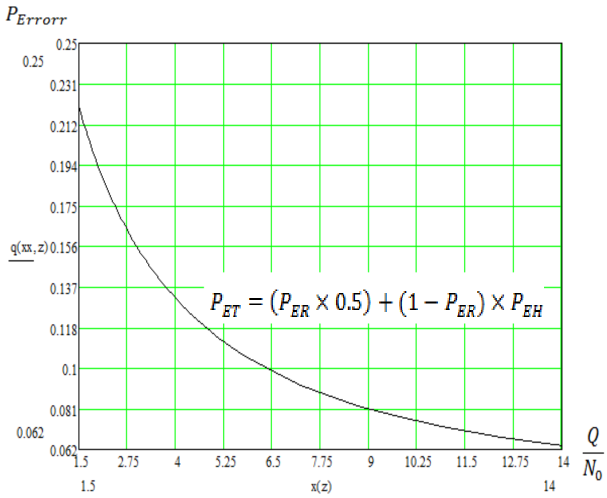

Figure 6. Probabilities of symbols error with white noise, impulse noise and harmonic interference.

Then, probability symbols error can be compared per each effected noise as shown in figure 7. In figure, various probabilities of symbols errors were shown in each graph line. The first line (left to right) was probability of symbols error with white noise only and the second line was probability of symbols error with impulse noise, the third line was represented as probability of symbols error with harmonic interference and the fourth line was probability of symbols error with combination of three errors sources. From this result, probability of three errors combination was occurred largest errors than other error sources.

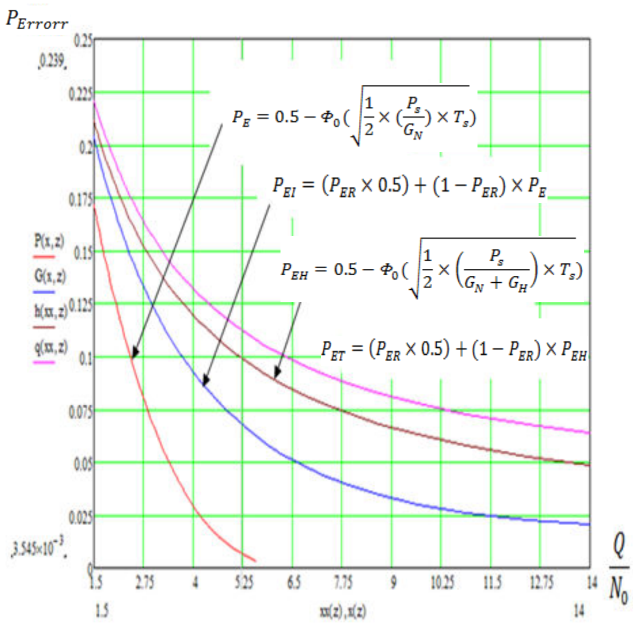

Figure 7. Comparison of probabilities of symbols error sources

All probability of symbols error can be calculated by using graph user interface (GUI) that was driven by related equations such as equation (1) to (3). Figure 8 shows example calculation of probability of symbols error using GUI application.

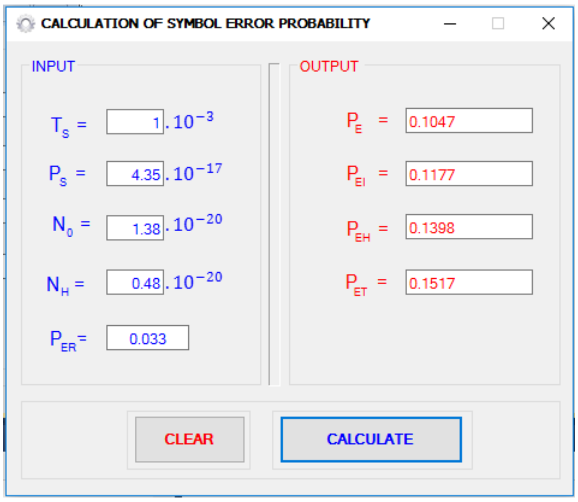

Figure 8. Calculating the various probabilities of symbols error using GUI application.

In this application, all required parameter can be inserted as an input parameter, and then the output will be shown as all probability of symbols error. It is very useful to calculate the equations that related in this process.

V. CONCLUSION

The paper was considered the problem and solved the problems associated with increasing the survivability of connected systems in the information conflict. The influence of the masking interference structure on the quality of radio interception of digital information was considered. The value of the probability of an erroneous reception of a symbol was determined for a different structure of the masking process. The received data were intended for development and research of methods of active radio masking of signals of data transmission systems.

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