INTL JOURNAL OF ELECTRONICS AND TELECOMMUNICATIONS, 2023, VOL. 0, NO. 0, PP. 0
Manuscript received February 14, 2023; revised February, 2023. DOI: 10.24425/ijet.2022.139xxx

Testing a modulator with keying the autocorrelation of the noise carrier.

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***Abstract*—This article describe solution of the signal transmittion using white noise and the evolution of that conception which use autocorrelacion. There will be also modifications of the transmitter and receiver to add to them coherent receiving and study the possibilities of signal synchronisation and spectrum shaping. This paper also shows very basic interface with intention for future use during works on that idea.**

***Keywords*—carrier noise, modulator, orthogonal matched filters, reception incoherent, white noise**

I. Introduction

THIS article aims to present the general concept of a modulator with carrier noise keying, as well as the developed interface in the Matlab environment to study its properties and further work on its development.

First projects and ideas to use noise as a carrier to hide signals was developed a long ago. They find usage in military. With technological progress more and more frequencies were used and the scope of free frequencies started to going down really slow, here appear the idea to use noise as a carrier not only for hidding the transmission, but also to use that part of the propagation environement to save some frequency band.

This article and the whole idea are based on the idea of white noise masking the telegraph signal presented in the article [1].

II. Theory

Concept of the transmitter and receiver is based on a modulator and a demodulator which contains a pair of complementary non-recursive comb filters where the information carrier is the white Gaussian noise.

The advantage of such a solution is not only that it can hide to a information transmitted in the noise to some extent, but also the the low complexity of the transmitter and receiver, which has lower numerical cost.

A diagram of the solution is shown in figure 1.

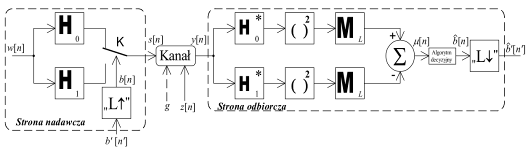

Fig. 1. Diagram of the algorytm of coding and encoding telegraphic signal

A. Transmittion part

The wait noise is taken as an input w[n]. Later it is processed with through a pair of orthogonal filters H1 and H2, whose output is keyed before entering the channel.

B. Kanał

Additive interference are added to the channel.

C. Receiving part

On the receive side, the signal goes to a pair of orthogonal filters, matched to that ones on transmit side, then the signal goes to the to the averaging filters, from where the sum of the signals extracted by the filters goes to the decision algorithm.

The receiver is using asynchronous method, which means that the decision-making algorithm does not use any information from the transmitting side during encoding process.

D. Filters

Transmission and reception processes use a pair of non-recursive comb filters. These filters are omniband and have impulse responses mutually orthogonal to each other, as well as dual complementarity.

Using that filtration we can send two type of signals, one from the harmonic cutout filter and the other one from the output of the harmonics extractor filter. That two types of signals are switched with binary signals.

The result of the operations on the trasnmit side is a masked sequence that has an identical mean value and variance, regardless of the position of the key.

E. Unmasking algorithm

Signal processed in the receiver is the same as the signal transmitted, because it was used matched symmetrical filters.

The decision made is not directly influenced by the attenuation or gain of the channel attenuation or additive interference, but rather from estimates of the instantaneous variance of the signals.

III. Problem to solve

Problem on this project was to make an observations of the autocorrelation of the signals in a modulator with noise carrier. To work out this problem there was an Matlab interface created, which allows to generate different signals and check their properties.

IV. Matlab environnement interface

During the research, Matlab interface was created to enable generating and studying the corresponding graphs and signal properties at various points of the diagram during the digital processing path.

The main interface is illustrated in Figure 2. That interface allows to generate graphs, zoom them to choose only single binary symbols and slide through them.

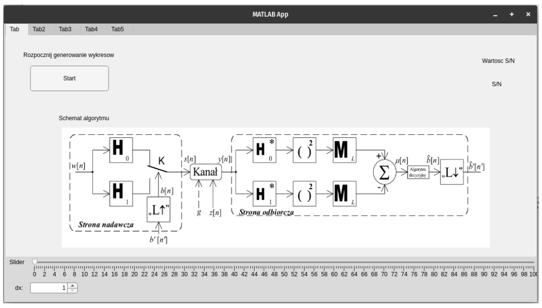

Fig. 2. Matlab environment (main view)

Figure 3 represents the signal in the time domain and periodogram of the input signal.

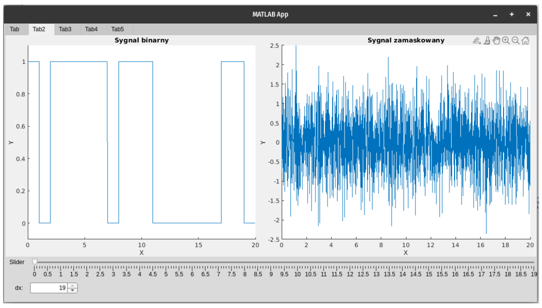

Fig. 3. Matlab environment (input signal)

Figure 4 shows the noise correlations used for transmitting.

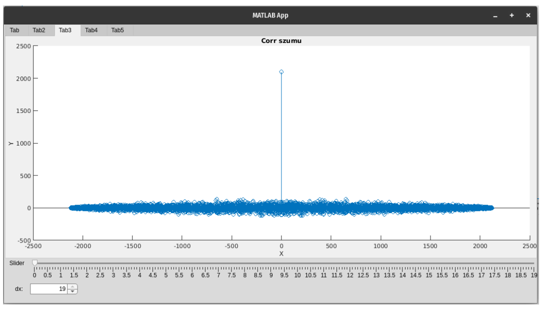

Fig. 4. Matlab environment (testing the noise correlation)

Figure 5 represents the periodogram of the noise that we are using for broadcasting.

V. Conclusion

Using created interface, there can be done further experiments and studies to test the if that solution can be implemented or if it is impossible.

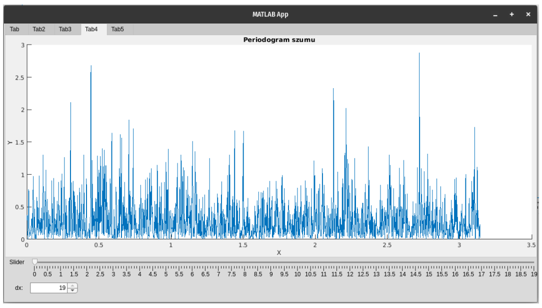

Fig. 5. Matlab environment (noise periodogram)

Work to carry out:

- Investigating the autocorrelation of different signals in proposed solution,
- Analysis of noise spectrum formation and its autocorrelation,
- Study cross-correlation of the signal subcarriers,
- Investigating the possibility of implementation a modulator and demodulator using autocorrelation of the noise carrier to encode transmitted symbols,
- Investigating the impact of coherent and non-coherent reception on the properties of the algorithm,
- Analysis of the impact of symbol and carrier synchronisation to the owerall performance of the algorithm,
- Prepare simulations of the solution in a matlab environment,
- Possible implementation of the modulator and demodulator in a real-world environment with implementation in the GnuRadio environment.

References

[1] M. Blok and M. Rojewski, “Maskowanie szumem białym sygnału (radio) telegraficznego vi międzynarodowa konferencja i wystawa.” *Wojskowa Konferencja Telekomunikacji i Informatyki. WKTiI-97*, pp. 197–206, 1997.