Transmission of hidden information based on the generalized chaotic synchronization mode

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Abstract

A method for transmitting information based on generalized chaotic synchronization is proposed, which is characterized by a sufficiently high degree of reliability achieved by changing the characteristics of a signal containing useful information using a noise generator with specified characteristics. It is shown that in the considered method, based on generalized synchronization, the noise has a constructive roller shutter that increases the confidentiality of data transmission. The main ideas of the method are illustrated by the example of unidirectional coupled Rossler systems used as generators of transmitting and receiving devices. The effectiveness of the proposed communication system has been demonstrated by numerical modeling and radio physical experiment

Introduction

One of the most important practical applications of the phenomenon of chaotic synchronization is its use for covert transmission of information. Over the last decade, this area of research has been in demand by a wide range of theorists and experimenters. However, the technical implementation of most known circuits and devices is quite a challenge. The requirement of identity of generators on different sides of communication channels, low resistance to noise, privacy problems - this is a list of major problems that are identified only by theoretical analysis of known communication systems based on chaotic synchronization. Overcoming these problems is quite a difficult task. Increasing the degree of confidentiality of information transfer in some cases entails an exacerbation of other shortcomings. For example, the scheme proposed in the work requires two and three identical generators and remains operational only when transmitting information over silent communication channels. The identity of the generators on different sides of the communication channel and the relatively low resistance to noise are characteristic of almost all known communication systems based on chaotic synchronization.

This paper proposes a new method of covert transmission of information, which is a modification of our previously proposed method, which provides concealment of traces of modulation of control parameters and ensures a high degree of reliability in its transmission. The method is based on the mode of generalized chaotic synchronization, but in the presence of an additional noise source, the presence of which, as will be shown below, plays a constructive role in this case.

Mode of generalized synchronization of chaotic data transmission

The use of generalized synchronization mode for covert transmission of information opens up a number of new features that are not typical of other types of synchronous behavior, such as full and phase synchronization.
First, in contrast to full synchronization, generalized synchronization can be observed in the implementation of various interacting dynamic systems, which suggests the possibility of simplifying the technical implementation of methods of latent data transmission based on this type of synchronous behavior.
Secondly, the type of functional dependence, which is established between the states of interacting systems, can be very complex, including fractal, which greatly complicates the possibility of obtaining information about the characteristics of the generator on the receiving side of the communication channel by a third party implementation of the transmitted signal, increases confidentiality.
Third, the behavior of the generalized synchronization boundary when changing the detuning of the generators differs significantly from the behavior of the boundaries of other known types of synchronous behavior, demonstrating abnormal behavior. In particular, for a number of systems at small change of frequency fast change of a threshold of emergence of the mode of the generalized synchronization in the field of small disorders of frequency is observed.
Fourth, as will be shown below, the noise has little effect on the threshold of the generalized synchronization mode, the synchronous mode occurs in unidirectional connected dynamical systems in the absence and presence of noise at close values of the communication force between the systems.
The first three advantages of the generalized synchronization mode were fully taken into account when developing the method of covert transmission of information on the basis of generalized synchronization, which was mentioned in the introduction. At the same time, the fourth feature is not fully used. Indeed, the method has a high resistance to noise, but the noise is not used in it for design purposes. This work is aimed at solving this problem. Before discussing the method of covert transmission of information based on the mode of generalized synchronization in the presence of noise, let's briefly discuss the reasons for the resistance of the mode of generalized synchronization to noise.

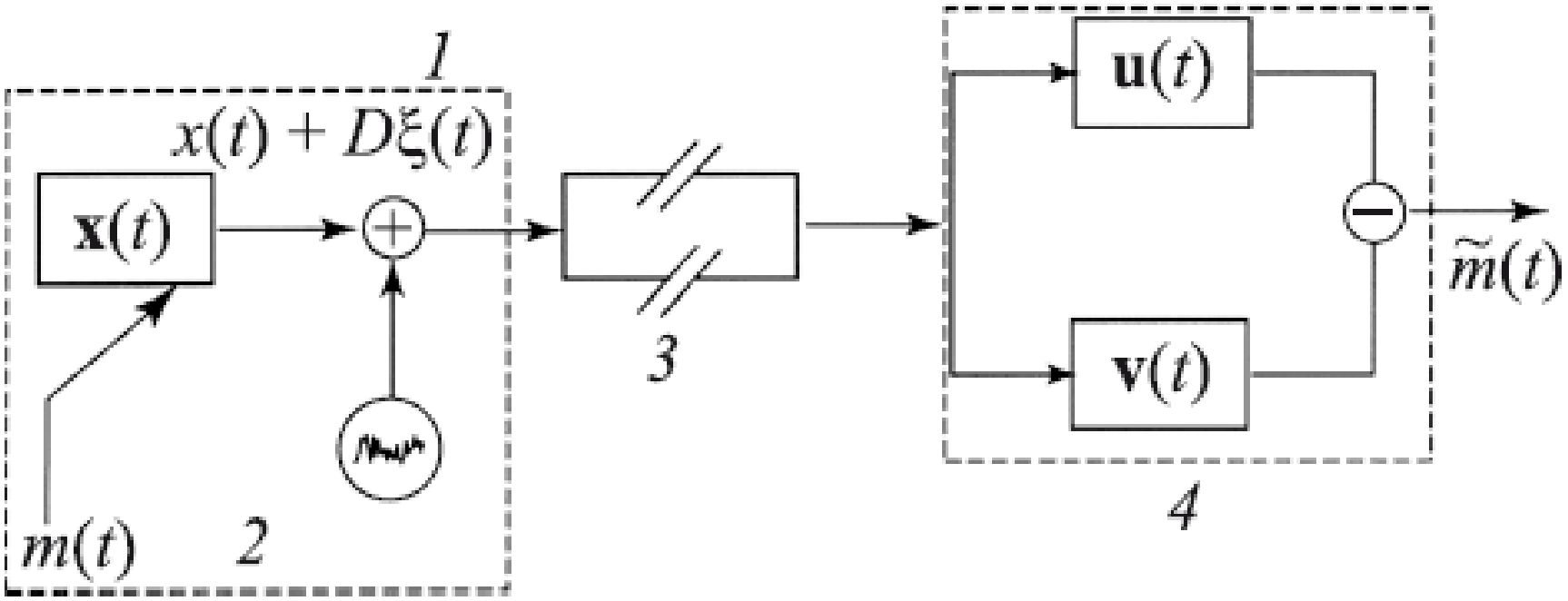

Figure 1. Scheme for implementing a method of covert transmission of information based on the mode of generalized chaotic synchronization in the presence of noise (1 - transmitting device, 2 - noise generator, 3 - communication channel, 4 - receiving device).

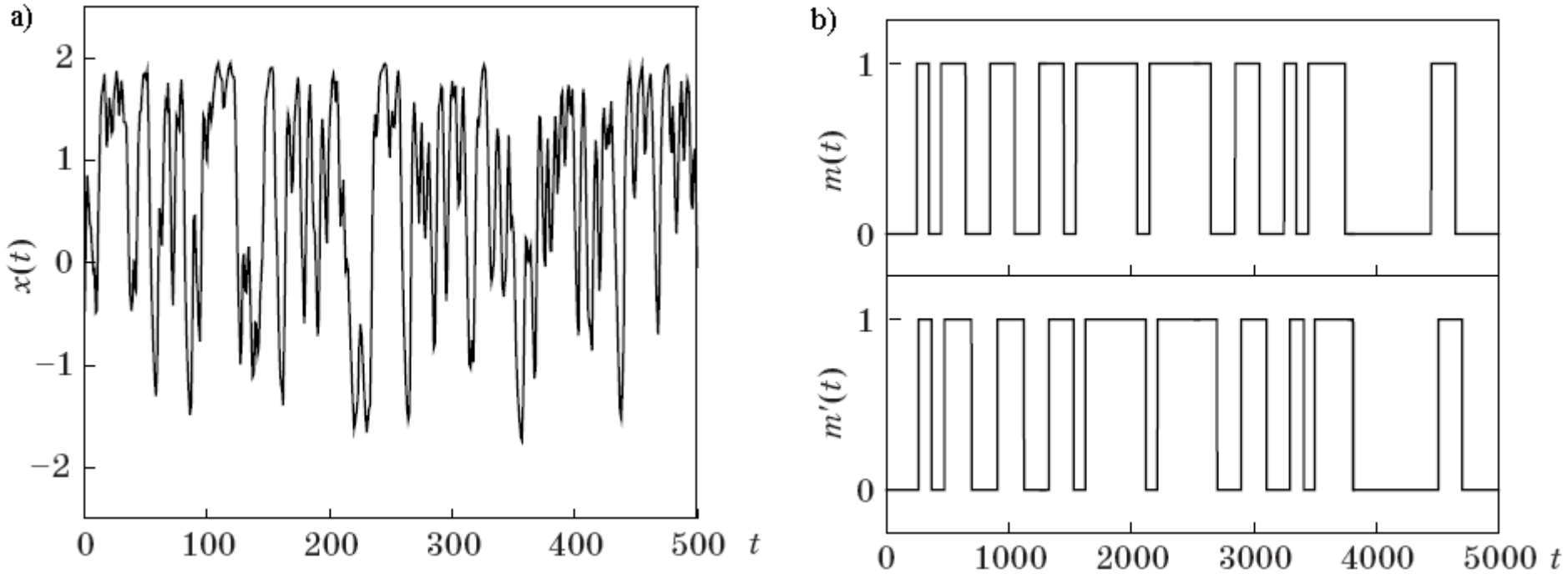

Figure 2. Fragments of temporary implementations of the chaotic signal x (t) (a) and information signals m (t) and m (t) (b).

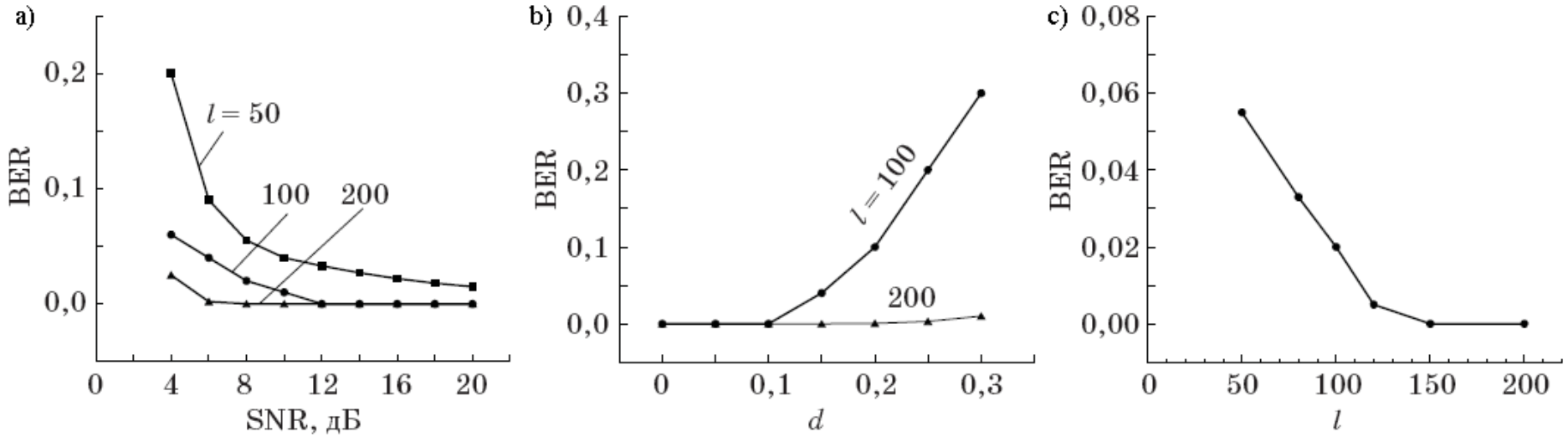

Figure 3. Dependences of error probability on a bit: a - on a signal / noise ratio; b - from the attenuation of the signal in the communication channel; c - from the length of the time interval during which one bit is transmitted.

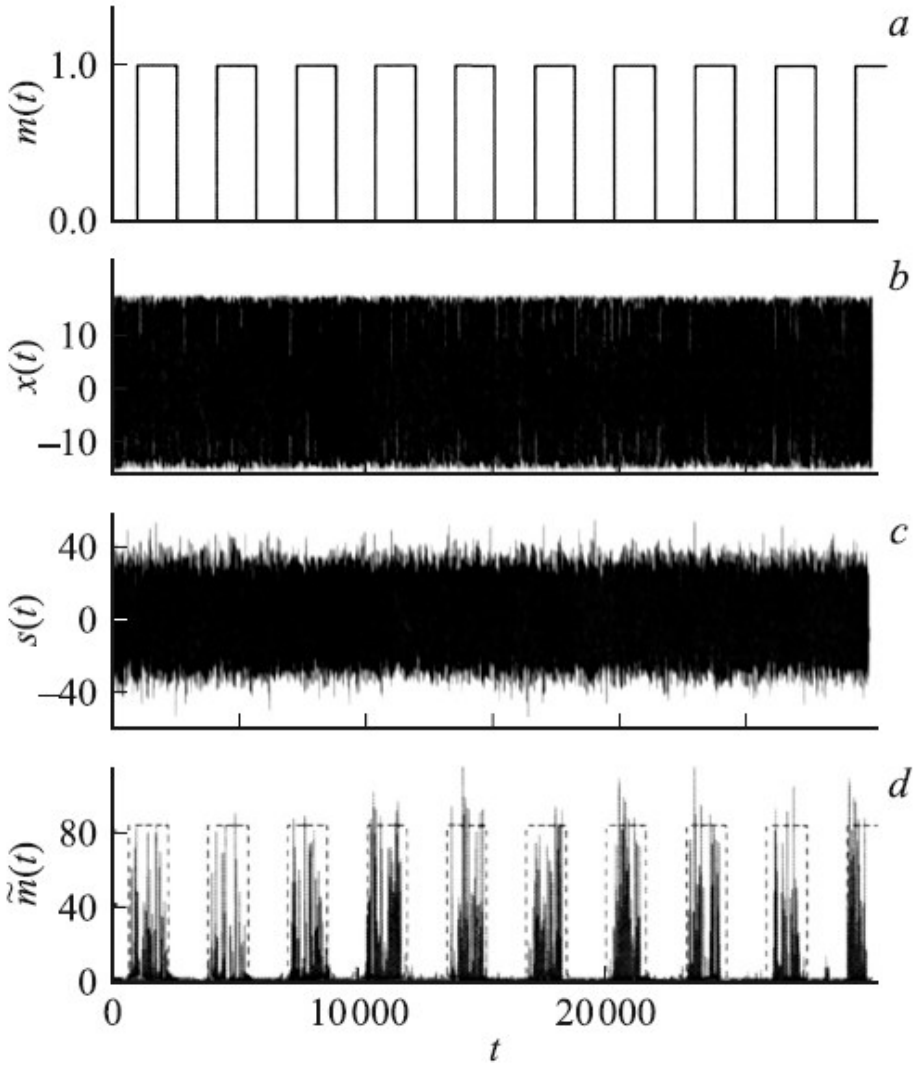

Figure 4. Illustration of numerical implementation of the method of latent transmission of information based on generalized chaotic synchronization in the presence of noise (D = 10): information signal m (t), represented by a simple sequence of binary bits 0/1 (a), signal x (t) generated by the transmitting chaotic system (b), the signal s (t) transmitted over the communication channel (c), the restored signal m ~ (t) (d), a solid line. The figure also shows the deterministic information signal (dotted line) after passing through the low pass filter.

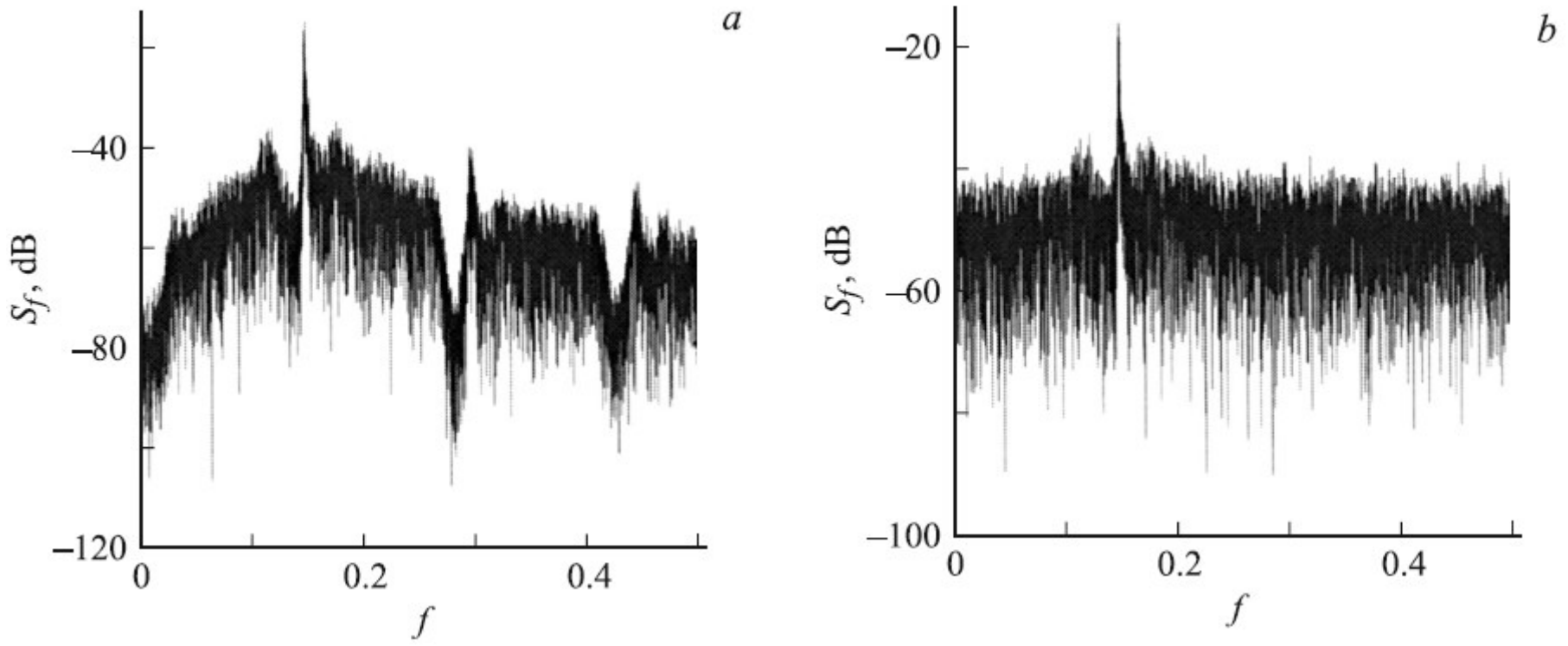

Figure 5. The power spectra of the signal x (t) generated by the transmitting chaotic system (a) and the signal s (t) transmitted via the communication channel (b).

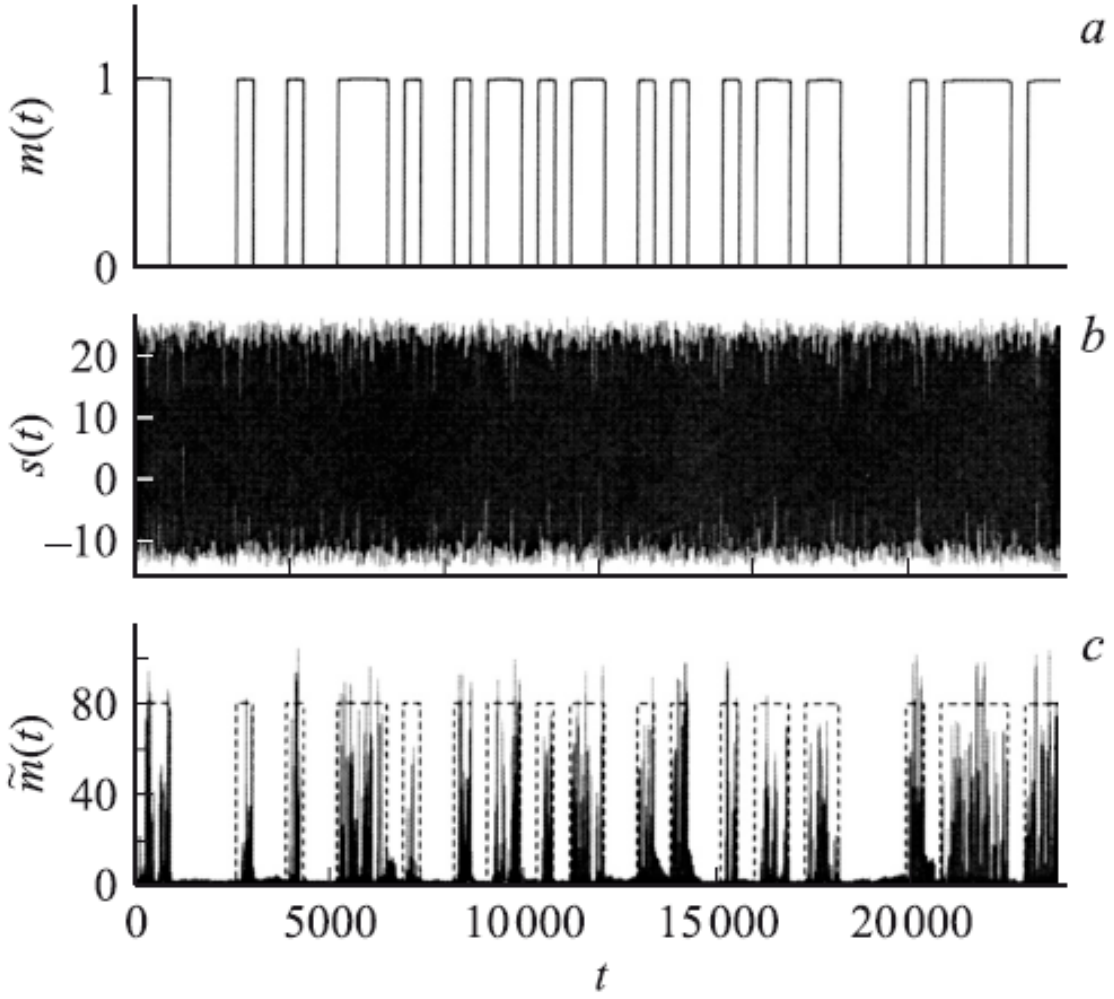

Figure 6. Illustration of the operation of the method of covert transmission of information based on the mode of generalized synchronization in the presence of noise if the noise generator produces a stochastic signal characterized by a uniform probability density distribution, the intensity of the stochastic signal D = 10: information signal m (t) represented by sequence 0 bi / 1 (a), the signal s (t) transmitted on the communication channel (b), the restored signal m ~ (t) (c), a solid line. The figure also shows the detect information signal (dotted line).

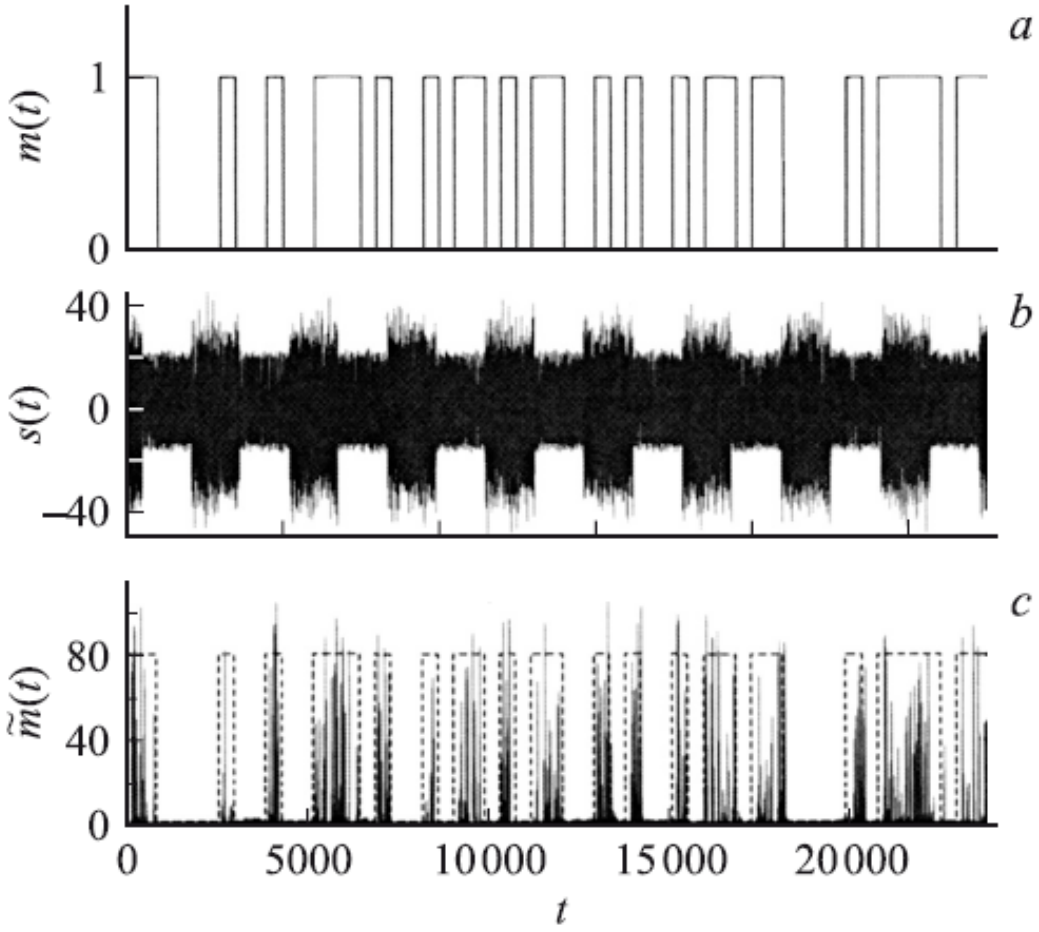

Figure 7. Illustration of the operation of the method of covert transmission of information based on the mode of generalized synchronization in the presence of noise if the characteristics of the noise generator are modulated by a sequence of binary bits: information signal m (t), represented by a sequence of binary bits 0/1 (a), signal s (t), transmitted on the communication channel (b), the restored signal m ~ (t) (c), a solid line. The figure also shows the detect information signal (dotted line).

Conclusion

While the original information message will still remain inaccessible to her. At the same time, on the receiving side of the communication channel, the change in the nature of the noise will remain invisible, and the quality of information transmission will be as high as when changing the signal characteristics of the noise generator with constant characteristics or in the absence of such at all. Thus, it is possible to improve the method of covert transmission of information based on generalized synchronization in the presence of noise by changing the characteristics of the noise generator by knowingly false information message, which increases the confidentiality of information transmission by the proposed method.

The paper proposes a method of covert transmission of information based on the mode of generalized synchronization in the presence of noise, which overcomes three disadvantages inherent in the known schemes and devices for similar purposes. This method allows you to hide traces of modulation of the control parameters of the information signal, has a high resistance to noise and eliminates the requirement of identity of the generators on different sides of the communication channel. The efficiency of the method is illustrated by the example of using Ressler systems as sending generators and devices, but at the same time the method remains operational in the case of using other generators in transmitting and receiving devices capable of demonstrating the mode of generalized synchronization.

Thank You!

Questions please!

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