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DEEP LEARNING APPROACH TO SIGNAL PROCESSING IN INFOCOMMUNICATIONS

Digital communications techniques based on random, chaotic, or noisy carriers are well known and successfully used in a number of applications. Simple on-off or amplitude shift noise keying modulation schemes are among the most popular. In this paper, we propose to use a classification model based on an artificial dense neural network and a deep learning approach for software-defined demodulation of spread spectrum signals.

Keywords: *spread spectrum; communication system; amplitude noise shift keying; digital communications; demodulation; software defined radio; machine learning; deep learning; artificial neural network; deep neural network; interference immunity; bit error rate; symbol error rate.*

Digital communications based on spread spectrum technology is very popular area in the communication field. Spread spectrum signals have time-bandwidth product greater than one. Nowadays there are some classical approaches to generating and processing of such signals: spreading bandwidth of sinusoidal signals, using of non-sinusoidal waveforms, dynamic chaos-based methods, using of noise carrier, etc. All approaches except the last utilize pseudo-random techniques and noise-like signals. This limits the benefits of complex signals using. This paper investigates the performance of communication system where the amplitude of the band-limited Gaussian noise represents binary information symbols and deep artificial neural network is responsible for demodulation and detection.

The amplitude noise shift keying modulation scheme is very simple. If the transmitted binary information symbol is “mark” then the transmitter radiates a band-limited white Gaussian noise signal. Inactive state of the noise generator represents the transmission of the symbol “space”. The processing of received signal is performed at the receiver side. The received signal is a sum of the convolution of the transmitted signal waveform with the channel impulse response and the channel interference. Demodulation is performed using artificial dense neural network over a symbol duration interval. The output of the last neuron layer (in this case it is a single neuron) represents the demodulator output at the end of the each symbol interval.

The interference immunity of amplitude noise shift keying demodulation based on dense neural network was obtained for the first time as a result of this research. It has been proved that the proposed method is competitive with other well-knows methods. The noise immunity is greater than immunity of “power reception” method for at least 3.5 dB. The method can be used as core physical technology for the data exchange in wide area of applications. It has very low probability of interception by design. The time complexity was evaluated and real-time processing capability was proven. The reinforcement learning ideology can be used to implement the cognitive radio concept.

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