RFID SIGNAL DENOISING - EXPERIMENTS WITH NEURAL NETWORK

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Abstract. *Radio Frequency Identification signal denoising can be a perspective method for the future intelligent Radio Frequency Identification readers with high reading distances capability. This paper deals with the Group Method of Data Handling neural network denoising filter experiments. Capability of the probability learning of the Group Method of Data Handling filters is an effective instrument in more exacting applications in comparison with classical Finite Impulse Response filters. Results show that the realized experiment can be a perspective method for Radio Frequency Identification signal processing.*

Keywords

Denoising, neural network, RFID.

1. Introduction

One of the main limits for using of the RFID (Radio Frequency Identification) is a maximum reading distance between transmitter and the reader. The maximum distance is a function of the signal quality and an electromagnetic compatibility regulations limits. Using of the signal processing methods could be an interesting way for increasing of the reading distances. The methods like classical FIR (Finite Impulse Response) Adaptive filters are available only for normal signals. The structure of classical FIR Adaptive filters is still constant. The searching of the filter's coefficients is not a trivial problem in more exacting applications. The structure and the coefficients of GMDH (Group Method of Data Handling – Ivachněnko 1966) neural network filter are designed during the network training [1].

2. RFID and Signal Quality

There are two main limits of a radiofrequency communications between the transceiver and the transponder.

The first one is SNR (Signal to Noise Ratio) of a communication channel (1).

$$SNR = 10\log \frac{P_{signal}}{P_{noise}} [dB/mW]. \quad (1)$$

The second limit depends on EMC (Electromagnetic Compatibility) of whole RFID system - impulse and continual interference.

The filtration on the transceiver side could be effective only for the noise and some continual interference.

3. GMDH Neural Network

GMDH is an algorithm of the neural network family for digital signal processing. The structure is similar to serial connection of a simple FIR filters. GMDH is a non typical neural network. Basically (like neuron network) the system works only during the training - finding the structure and the coefficients of a new filter [2]. Used type of training method is called "with teacher". It means the original (clean) signal and the received mixture signal with noise from the transceiver is needed.

3.1 GMDH Neural Network Filter Architecture

The structure of GMDH filter is acquired during training process, when some parts of the common structure are used or not. The example of the structure is depicted in Fig. 1.

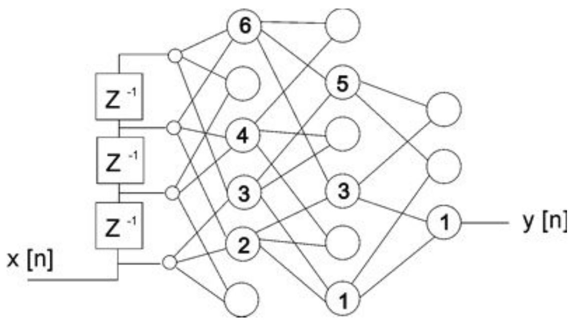
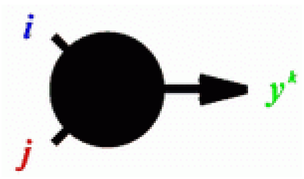


Fig. 1: GMDH neural filter architecture.

Each active neuron, which is used in structure in Fig. 1, has its own number and represents one quadratic polynomial function. Active neuron and his function are depicted in Fig. 2.



$$y^k = a^k (i^{k-1})^2 + b^k (i^{k-1})(j^{k-1}) + c^k (j^{k-1})^2 + d^k i^{k-1} + e^k j^{k-1} + f^k$$

Fig. 2: Active neuron and its function.

The training process objective is the finding of functions coefficients a-f. Theory of the coefficients finding process is described in [3].

4. RFID Signal Structure

Answers from the transponders are realized by an amplitude modulating signals with double side bands (AM-DSB). The carrier frequency in the system ISO 15693 is 13,56 MHz, Fig. 3. The side bands frequency is 210 kHz. RFID communication theory is described in [4].

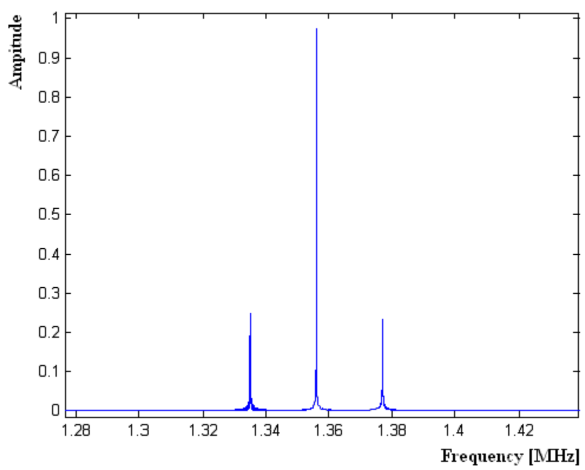


Fig. 3: ISO 15693 RFID signal spectrum.

4.1 RFID Signal Representation

The classical AM-DSB RFID signal is compound of logical 1 and 0.

The clean signal with noise and the data (length 8 bits) has 203200 samples, Fig. 4. The quantity of samples could be really problem for real simulation and processing with neural network.

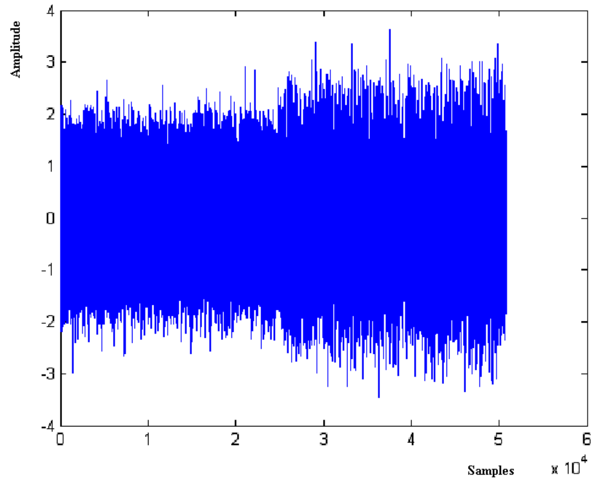


Fig. 4: Noised RFID signal sample.

5. Simulation

The input is testing RFID signals – clear and mixture with noise. There were some problems with number of samples during the testing in MATLAB software. Polynomial coefficients were calculated by MATLAB during the difference minimization (difference between the original signal and the mixture). The MATLAB calculated 45 coefficients and had problems with counting of the coefficients. This number of the polynomial coefficients is probably the main problem for PC with low power.

5.1 Sinus Signal Denoising

Figure 5 depicts sinus signal processing results from the signal processing with GMDH neural network. It shows reference signal, interfered signal and the final product from the signal filtration [2].

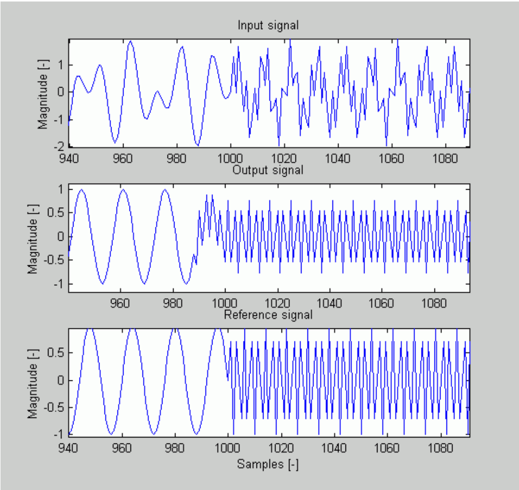


Fig. 5: GMDH neural filter - sinus signal denoising.

6. Future Work

The described simulation problem has two main solutions - stronger PC or signal adjustments. The work on RFID signal processing with neural network will be continue as a Bachelor work announced on the department of Telecommunication engineering CTU in Prague.

7. Conclusion

The system described in this paper is perspective for realization of the more exacting RFID signal filtering. There is a possibility of increasing reading distance, in the case of having a better signal quality. Practical application of the GMDH neural network filtering can be an implementation in the programmable logical arrays or DSP. Algorithm implementation using VHDL can be really effective and strong.

References

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About Authors

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