Neural Networks Based Method For Automatic Classification Of GPR Data

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Abstract. In this article a neural networks based method for automatic classification of ground penetrating radar (GPR) traces is presented. It is used on new representation of GPR signals by polynomials approximation. The coefficients of polynomial (feature vector) are neural network inputs for automatic classification of anomalous of geologic structure. The analysis and results show that the classifier can effectively be used for a lot of geologic structures.

EXTENDED ABSTRACT OF THE PAPER

GPR (Ground Penetrating Radar) has been widely used for almost twenty years in archaeology, geology, civil engineering.

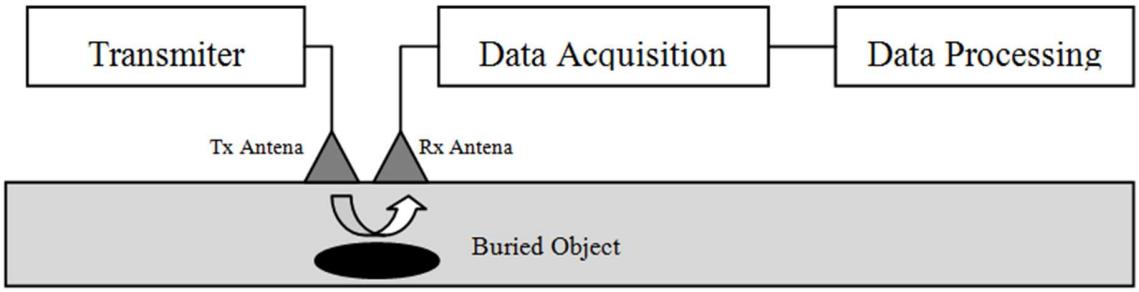

FIGURE 1. GPR system

GPR sends EM waves in the ground and then collects backscattered echoes (figure 1) and it acquires signal traces moving along survey line. These raw data are then collected to form 2D GPR profile (radargram).

GPR signal is difficult to interpret because it is disturbed and distorted. Attenuation of electromagnetic waves in a real geological medium is often large, and the power of GPR signal must be small for safety reasons. GPR method is sensitive to noises from other devices, such as mobile phones, GSM, WiFi, Bluetooth and all kinds of cables and wires for power and data transmission. GPR is also susceptible to numerous disturbances caused, for example by the presence of nearby buildings, rails, pipes, various metal objects, strong electromagnetic calls, etc.

The terrain (uneven ground, troughs, depressions, vegetation, trees, landscaping elements) impede and distort the measurement results. They are very much dependent on the degree of saturation of the soil with water so they depend on the amount of rainfall in the period immediately preceding the measurements. Geological structure is practically always composed of different materials, the interporous spaces (if any) are filled with water (with different mineral composition) or gas (usually air). The quality of recorded results is dependent on the choice of measurement parameters of GPR, which are often difficult to be optimally defined. Interpretation of radargrams is performed by a specialist, based on their experience and intuition. It is often affected by error.

There is no unambiguous automatic recognition method of GPR records. The use of neural networks to solve the described problem appears promising. Typical neural networks are not very suitable to solve this task because of the difficulty of taking into account the dynamics of the problem. Therefore, the paper attempts to apply a new type of way of representing signals.

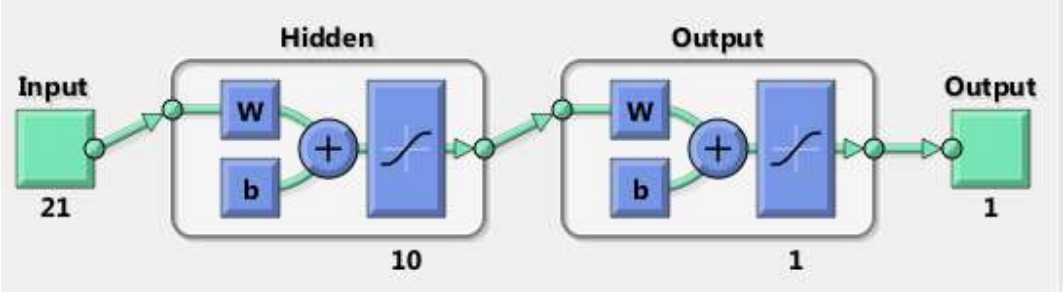

FIGURE 2. The structure of the neural network used in paper

During last years, many models of neural network have been created. An original way of representing signals at the neural network input was proposed. It lies in approximating the course of the signal with a polynomial. Then, attempts were made to use the terms of the polynomial as a signal entered at the neural network input.

The method described can be implemented in various areas. Everywhere where it is possible to make the radargram, the neural networks may be used to detect anomalies.

The method may be used in following areas:

- Archeology
- Farming
- Construction
- Geology
- Criminology

Similarly as in the example of the problem of moisture neural network (figure 2) can be teach to recognize a variety of other anomalies (deviations from the norm) registered in the GPR signal.

CONCLUSION

The paper presents an original method of classification of discrete values into an approximation polynomial and used the coefficients to teach the neural network. A variety of applications have been given, combining the method with GPR surveys. Similar effects may be possible for other applications, for example classification of biomedical signals. Such applications are now a subject of authors' research.

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