Application of neural networks in object recognition tasks for ADAS systems

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Abstract. Modern driver assistance systems (ADAS) require an environmental recognition function to inform the driver and for making management decisions. Neural networks are used to select and recognize objects in such systems. The paper presents the results of comparative analysis of various neural networks in object recognition problems. Experimental data showed that convolutional neural networks show the best results in recognition problems.

1. Introduction
Currently, the development of various driver assistance systems (ADAS systems) that improve the quality and safety of vehicle management is relevant. The standards define 6 levels of ADAS automation: from 0 (no automation) to 5 (full automation). Any of these levels involves the use of recognition systems of surrounding objects.

Various artificial neural networks are used in pattern recognition problems [1-5]. Most often, classical neural networks (network of radial basis functions, multilayer perceptron, etc.) are used. However, the analysis of experimental data obtained using such networks shows that the use of classical neural network architectures in recognition problems has little efficiency for the following reasons:
- recognized images are often large, which leads to an increase in the structure of the neural network;
- a large variety of parameters increases the size of the system, which results in an increased need for a larger training set and, therefore, an increase in the complexity of calculations and the time required for training the system;
- multiple neural networks are required to ensure efficient operation of the recognition system. This leads to an increase in the complexity of the task and the time of its execution;
- high sensitivity to various changes in the geometry of the input images, such as changes in the image angle, image scale, and other distortions [6].

In this regard, in addition to the multilayer perceptron, convolutional neural networks were used in the work. Such networks provide some resistance to small changes in scale, change of perspective, swerve, displacement and other distortions [7].

2. Comparative analysis
For comparative analysis we used the multilayer perceptron with elastic-propagation (RProp, 3 and 4 layers), multilayer perceptron with back-propagation (BackProp, 3 and 4 layers) and a convolutional neural network (CNN).

In the problem of image recognition (on the example of the base of handwritten numbers MNIST and the base of road signs GTCRB), the model YOLOv2 was used, which was designed to work with convolutional neural networks. It allows you to detect objects in real time, work with images of different sizes, offering a compromise between speed and accuracy.

the results of using convolutional neural network for recognition of handwritten digits: the ordinate axis indicates the number of correct recognition of 10,000 samples provided by the network, the axis of abscissa indicates iteration of training.

When using MNIST database, the highest accuracy for convolutional neural network was achieved at 1900 iterations with the number of correct recognitions at 9345. Accordingly, the recognition accuracy at this step is 93.5%. When using the road signs GTSRV recognition accuracy amounted to 98.6%.

The averaged test results of correctly recognized objects for various machine learning algorithms in the aggregate for two tests (the MNIST and GTSRB bases) are shown in Figure 2.

For the case of a multilayer perceptron, the most accurate was an architecture with 4 layers (2 hidden layers) with back propagation of error (MLP BackProp). However, the accuracy of this algorithm is extremely low (21.7%), which is insufficient for practical use in recognition systems.

For a convolutional neural network (CNN), the averaged result was 96%, which is the maximum in this study.

Figure 1 - The number of correct recognitions depending on the iteration of training of the convolutional neural network
3. Conclusions

From the combination of two tests for the classical neural network, the most accurate was an architecture with 4 layers with back propagation of error. However, its accuracy was not sufficient for practical use. For a convolutional neural network, the average result was approximately 96%. Thus, for the practical implementation of the object recognition system in ADAS systems, convolutional neural networks are more applicable.

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