UDC 004.021

WILDFIRE SMOKE DETECTION USING CONVOLUTIONAL NEURAL NETWORKS

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This article describes the algorithm for detecting smoke from a fire, implemented in the Java programming language. Examples of the work of the developed application are given and conclusions are drawn about the expediency of using convolutional neural networks to solve the task.

Introduction. In connection with the intensive development of computer technology, computer vision systems have become available to a wide class of users and can effectively solve many problems in human practical activities [1-2]. One of the actual applied problems, solved recently with the help of computer vision systems, is the detection of forest fires. To solve this problem, an algorithm for processing dynamic images with the use of deep learning, in particular, convolutional neural networks (CNN), was developed.

The developed algorithm includes the following three stages of program execution: color segmentation, detection of moving regions, and classification of the selected assumed smoky areas.

Localization of objects in the scene occurs in two main stages. First, in the video sequence, moving objects are searched, after which they are classified according to the color characteristics.

As a method of detecting motion, the method of subtraction of the background, based on a mixture of Gaussian distributions, was chosen. This method allows you to detect slow moving objects in the scene.

It was decided to carry out the classification of moving objects in the HSV color space, since the classification in this color space gives fewer false smoke detections than the YUV color space.

The classifier of localized regions is the trained convolutional neural network. As a neural network architecture, the AlexNet model [3] was chosen, which is simple, but does not require large computing resources and allows for training.

The general scheme of the developed algorithm is shown in Figure 1.

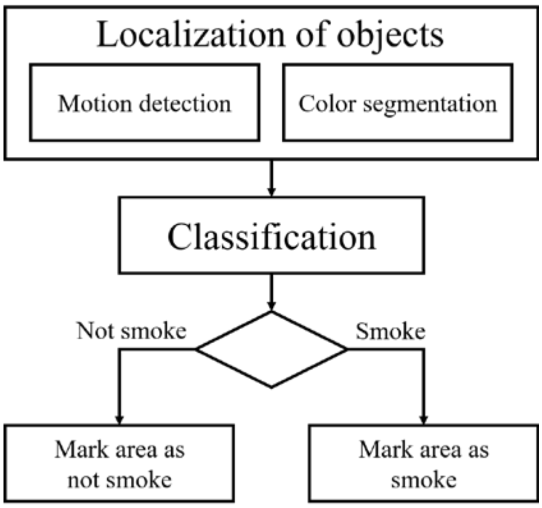

Fig. 1. Scheme of the developed algorithm

Implementation. To carry out the experiments and evaluate the results of the research, the algorithm developed was implemented in the Java language using the integrated software development environment Intellij IDEA, the computer vision library OpenCV 3.0 and the DL4J deep learning library. When designing the graphic interface, it was decided to use the platform to create JavaFX applications.

The development, testing and analysis of the algorithm's results were carried out using a Samsung 300E5Z laptop with the following main characteristics: CPU - Intel Core i3-2350M with a clock frequency of 2.3GHz, RAM - 4.0GB, graphics accelerator - Intel HD Graphics 3000.

To capture a video stream (from a video surveillance camera or from a permanent computer memory) and extract frames from the video sequence, an OpenCV library is used. OpenCV (Open Source Computer Vision Library) is a library of algorithms for computer vision, image processing with open source code [4]. OpenCV is designed to provide a common standard machine vision interface for applications in the field of dynamic image processing and to increase the use of computer vision systems in commercial products.

Construction, training and use of the CNN was carried out using DL4J library. DL4J (Deep Learning for Java) is a deep learning library written for Java and the Java virtual machine (JVM) and a computing environment with broad support for deep learning algorithms [5].

To demonstrate the capabilities of the algorithm, it was decided to implement an application designed for early detection of forest fires. The interface of the implemented application is shown in Figure 2. The application interface consists of a main window, a text information output window and a video output window.

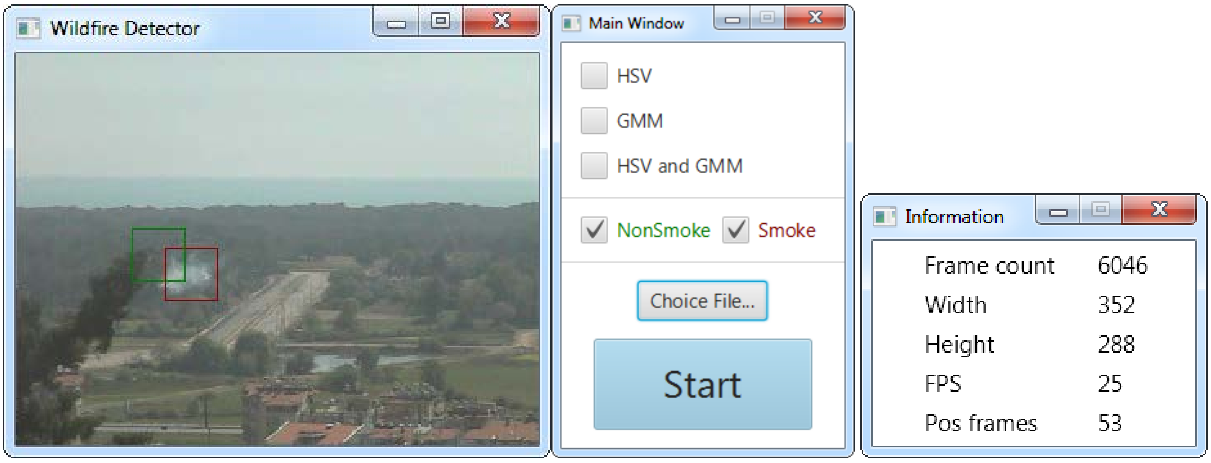

Fig. 2. The interface of the software product

For the analysis of the developed algorithm, video sequences obtained in real light conditions for shooting outdoors with a different angle of inclination, including an unstable background, were used. The work of the developed application is shown in Figure 3.

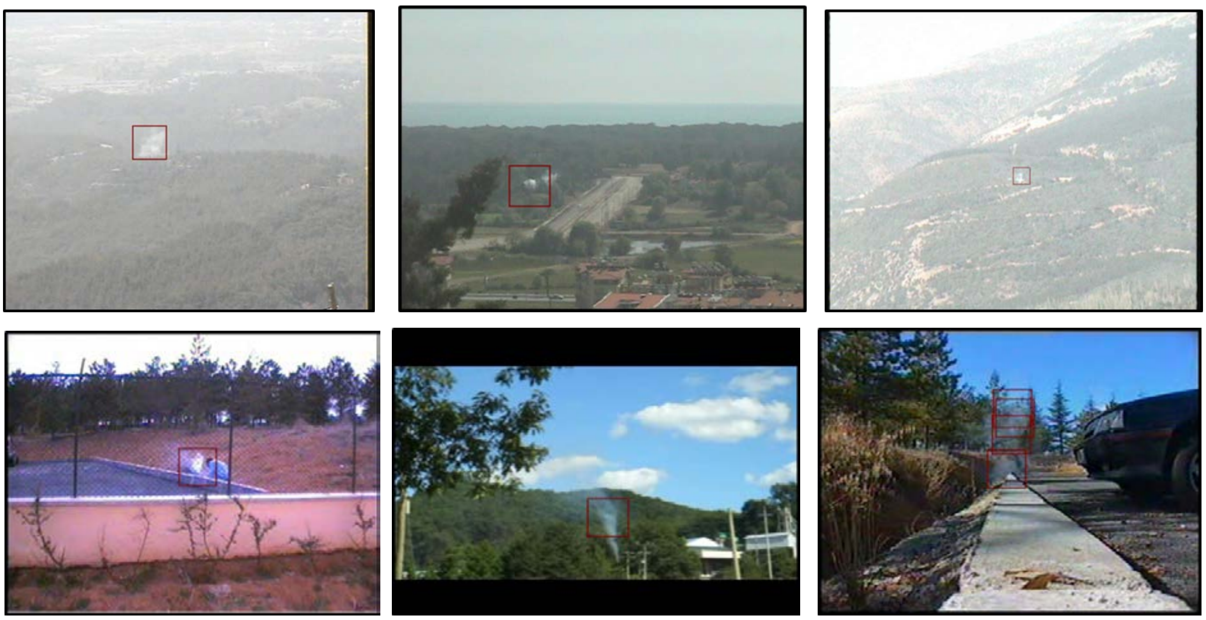

Fig. 3. Frames of used video sequences

Conclusion. The results of testing the developed algorithm have shown that convolutional neural networks can serve as a fire classifier. In view of the fact that a simple network model was chosen as a classifier, and a relatively small sample of samples was used in training, testing showed poor results. The coefficient of false positive classification of the developed algorithm was 7%, which is not permissible. However, it can be assumed that when using complex architectures of neural networks and a large training sample, the results of fire detection can be improved many times.

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