I. Strunin, M. Yarysh, Master students
D. Progonov, PhD in Comp. Sci., As. Prof., research advisor
K. Havrylenko, PhD in Ling., Senior teacher, language advisor
National Technical University of Ukraine Igor Sikorsky Kyiv Polytechnic Institute

IMPACT OF SRNet NEURAL NETWORK REGULARIZATION ON STEGANOGRAM DETECTION POWER FORMED ACCORDING TO ADAPTIVE EMBEDDING METHODS

Today special attention is devoted to counteracting the leakage of confidential data of state and private organizations by using hidden (steganographic) communication systems. For organizing hidden communicating channels are widely used methods of embedding messages in digital data, particularly digital images. Providing high detectability of the formed steganograms needs using highly complicated computations of steganalysis methods [1] that make it impossible disclosing confidential data leakage in real-time. That's why the important task is to find rapid methods of steganogram detection, particularly with using convolutional neural networks.

Modern digital image steganography methods are based on an adaptive approach of data embedding into cover images. The approach is to represent the process of message hiding as solving an optimization problem – minimizing distortion of cover image while embedding fixed number of stegodata. One of the state-of-art adaptive steganographic methods is MG embedding method [2] based on minimizing Kullback-Leibler distance D_{KL} between distribution values of cover image elements P_c and formed steganogram P_s:

$$D_{KL} = \sum_{q \in Q} P_c(q) \cdot log_2(P_c(q)/P_s(q)),$$

where Q = {0,1,..., $2^k - 1$} – range of pixel brightness of digital image;

k – number of bits used to represent pixel brightness.

Ensuring high detectability of the steganograms needs highly complicated methods of statistical analysis to detect weak alterations of the statistical and spectral characteristics of cover image caused by message hiding and at the same time preserving high accuracy of estimation statistical characteristics of the images. One of the possible solutions to reduce the duration of the digital images' analysis and calculate local digital image characteristics is to use convolutional neural networks, particularly SRNet [1]. The feature of the neural network is digital images components analysis that corresponds to residual noises of the image and potentially can be used for message hiding [1].

In this paper was conducted the analysis of steganography detector efficiency based on SRNet neural network for hidden data detection embedded according to MG adaptive method. Examined the case of using an additional regularization layer of SRNet aimed for boosting the accuracy of digital image classification while working on image datasets of different quality. As regularization method was used Dropout that for today is one of the most effective ways to avoid overfitting of the neural network by ignoring neurons that are chosen randomly during the training stage.

The payload of the steganography detector with stegodata varied in the following range: 3%, 5% 10%, 20%, 30%, 40% and 50%. The research was conducted using

pseudorandom samples of 2000 images on the standardized dataset MIRFlickr [3]. The detection accuracy of the designed steganography detector was assessed with the next standard metrics: False Acceptance Rate (FAR), False Rejection (FRR) and classification accuracy. The values of these metrics obtained by results of cross-validation procedure of tuning steganography detector are shown in Table I.

Table I. Comparing the accuracy of the original and modified neural network SRNet of steganograms detection formed according to MG algorithm.

Payload, %	Without using regularization			With using regularization		
	FAR, %	FRR, %	Accuracy, %	FAR, %	FRR, %	Accuracy, %
3	8.50	1.70	83.00	1.20	2.45	97.60
5	14.20	0.65	71.60	4.10	3.20	91.80
10	4.55	2.45	90.90	1.95	1.55	96.10
20	3.85	5.10	92.30	2.05	1.00	95.90
30	14.35	2.45	71.30	4.00	0.55	92.00
40	8.20	2.00	83.60	1.45	0.50	97.10
50	4.45	3.10	91.10	2.95	6.30	94.10

By the results of the experiment was found that the use of regularization layers in SRNet neural network allows significantly improve detection power of steganograms: in case of small payloads (less than 10%) accuracy has risen by more than 10% up to 20% in case of larger payloads.

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