A Review on Deep Learning based Image Steganography Techniques

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Abstract:

Image steganography plays a significant role in secure communication by concealing secret information within images while preserving the visual quality of the cover images. With advancements in deep learning, image steganography has evolved from manually designed embedding strategies to automatically learned embedding and extraction frameworks. This paper provides a systematic review of deep learning-based image steganography techniques, with primary focus on embedding capacity, invisibility and security performance. The reviewed fully deep learning-based image steganographic techniques are analyzed and classified into encoder-decoder-based models and generative adversarial network (GAN)-based models, highlighting their key characteristics. Additionally, hybrid techniques such as cover generation, distortion learning, and adversarial image embedding are also analyzed in this paper. These techniques are evaluated using key metrics such as peak signal-to-noise ratio (PSNR), structural similarity index (SSIM), hiding capacity, secret recovery accuracy, and steganalysis detection performance. A comparative analysis has also been conducted using commonly employed benchmark datasets such as CelebA, ImageNet, DIV2K and BOSSBase. The key features, advantages, and limitations of these approaches are also discussed in this study. This review also identifies major limitations of each technique, such as low capacity, high computational complexity, limited generalization, and vulnerability to advanced steganalysis. Although deep learning-based steganography has demonstrated promising progress in terms of embedding capacity, visual imperceptibility, and secret recovery, achieving an optimal balance among these factors remains a challenge. This review provides a comprehensive overview of the current state of deep learning-based image steganography and suggests future research directions for developing more secure, robust, computationally efficient, and adaptive steganographic systems.

Keywords:

Image Steganography, Deep Learning, generative adversarial networks (GAN), encoder-decoder, steganalysis, secure communication.