Detection of Malicious Spatial-Domain Steganography over Noisy Channels Using Convolutional Neural Networks

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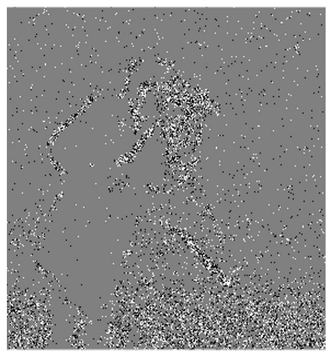
- Steganography can be used for legitimate or malicious purposes
- Detection of malicious spatial-domain steganography inserted by untrustworthy hardware
- Novelty: Transmission channel affected by noise (Gaussian, packet loss)
- Neural Network for reliable detection of steganography bits inserted by state-of-the-art algorithms
- Noise affects both: the malicious communication and the detection procedure

Steganography : Hide information in multimedia content

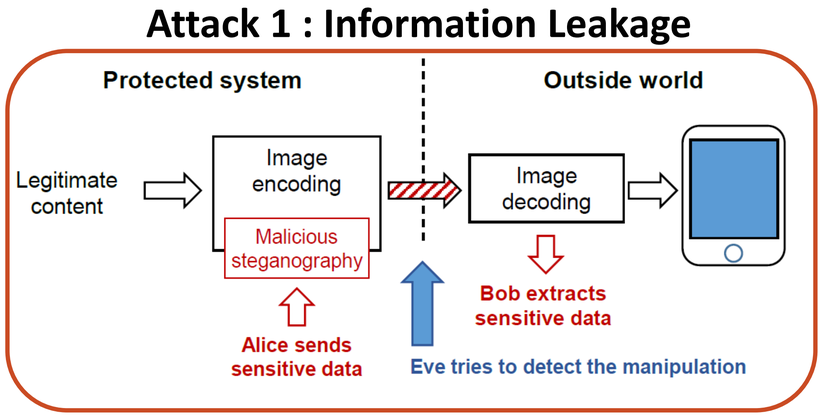
Cover Image



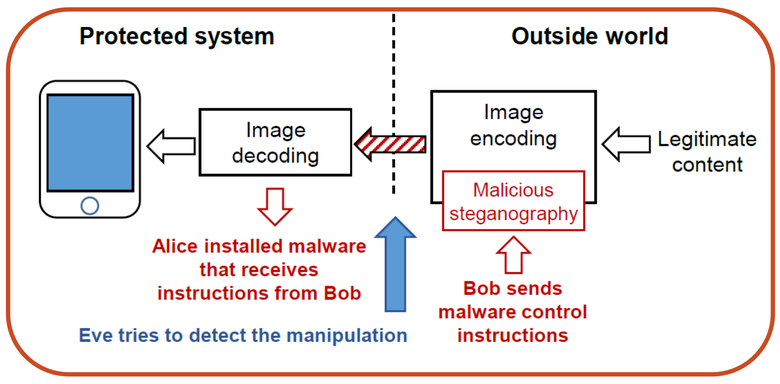
Embedded malicious steganography bits

Steganography Image

Attack 1 : Information Leakage

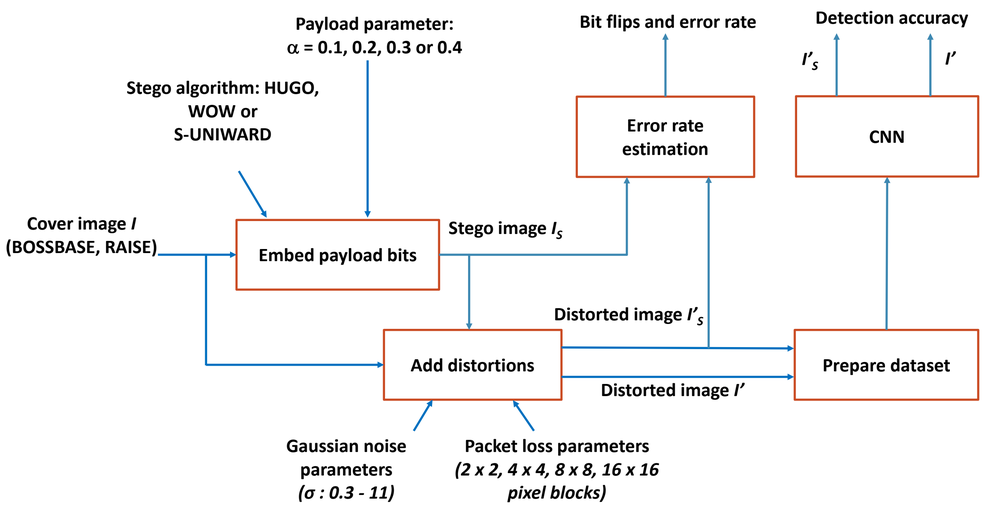


Attack 2 : Malware Control



METHODOLOGY

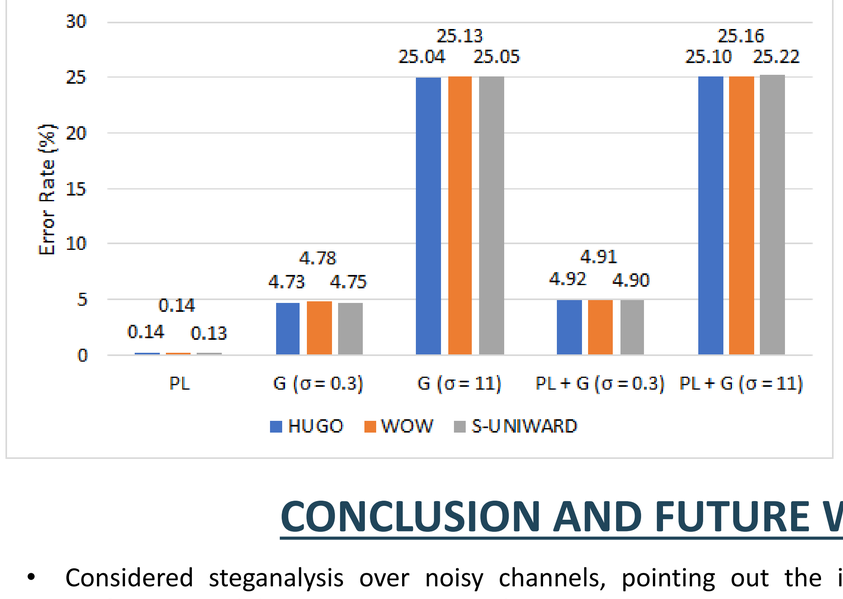
- Three state-of-the-art spatial-domain steganography algorithms HUGO [2], WOW [3], and S-UNIWARD [4] with fixed-stego key implementations considered
- Stego image transmitted over a channel affected by two kinds of noise: Gaussian noise and packet loss
- Error rate: $\frac{\text{Number of bit flips}}{\text{Total number of embedded stego bits}}$



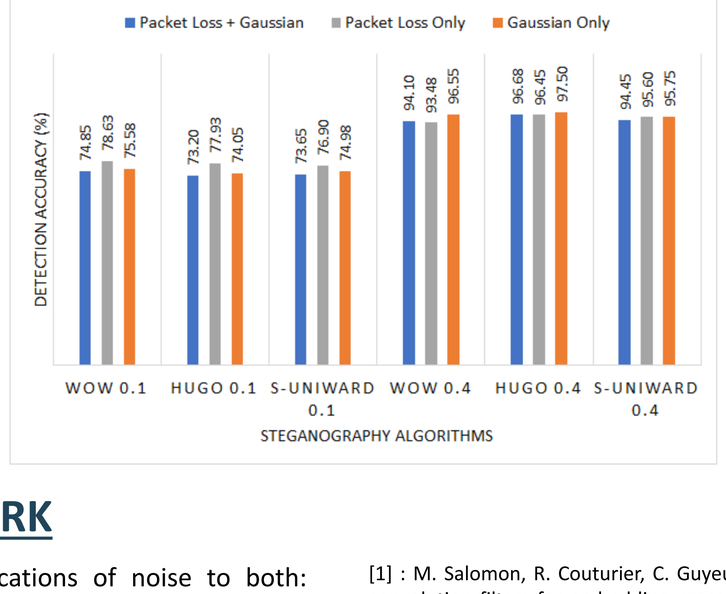
- Detection (or steganalysis) : using neural network from [1] to classify images I' or I'_s
- Early stopping with patience = 5 to overcome over-fitting and improve detection accuracy
- Datasets: BOSSBASE [5] and RAISE [6]
- 22000 training, 8000 validation and 4000 test images

EXPERIMENTAL RESULTS

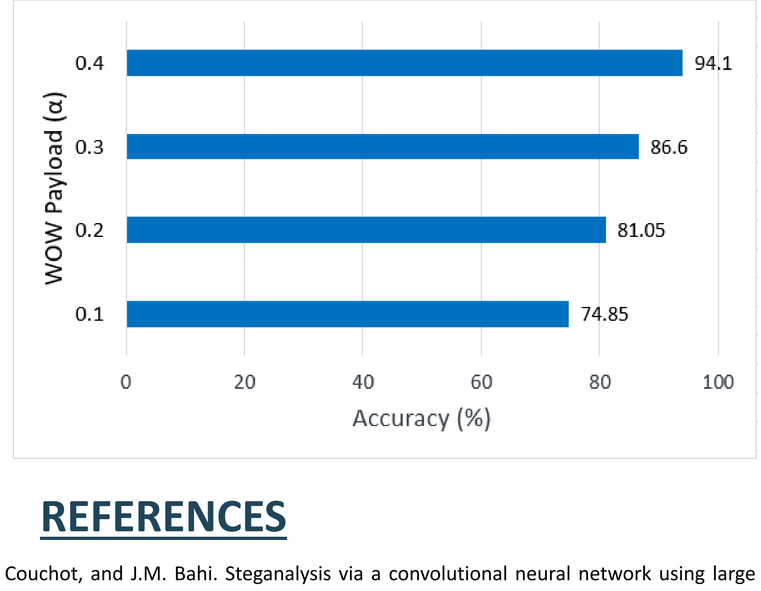
Error rate of steganographic channel when image transmitted with noise levels leading to PSNR = 30-60
(G : Gaussian, PL : packet loss)



Detection accuracy for different spatial-domain steganography algorithms and noise types/levels



Detection accuracy for different payloads (percentages of used stego bit positions) for WOW algorithm



CONCLUSION AND FUTURE WORK

- Considered steganalysis over noisy channels, pointing out the implications of noise to both: performing and detecting steganography. Good detection accuracy on realistic images
- Steganalysis is feasible as payload in an image increases. Even moderate noise have grave consequences for the steganographic channel, leading to large error rates
- While an adversary could find a fault-tolerant scheme to still transmit the information with large number of redundant bits which can be detectable by our deep learning approach
- Future work: design countermeasures against malicious steganography based on strategically inducing errors on the communication channel while avoiding too harsh consequences for the image quality

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