RHFCN: FULLY CNN-BASED STEGANALYSIS OF MP3 WITH RICH HIGH-PASS FILTERING

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Github: https://github.com/Charleswyt/tf_audio_steganalysis

Introduction

1. **MP3** is the most commonly-seeing compressed audio format on the Internet.
2. Various MP3 **steganographic algorithms** with large capacity and good imperceptivity have been proposed.
3. The performance of existing MP3 **steganalytic algorithms** are needed further improving.

Rich High-Pass Filtering Module

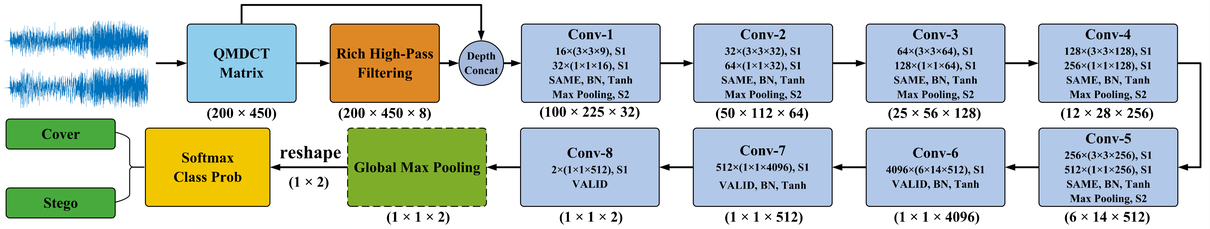
$$M_Q = \begin{bmatrix} Q_{1,1} & \cdots & Q_{1,j} & \cdots & Q_{1,450} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ Q_{i,1} & \cdots & Q_{i,j} & \cdots & Q_{i,450} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ Q_{200,1} & \cdots & Q_{200,j} & \cdots & Q_{200,450} \end{bmatrix}$$

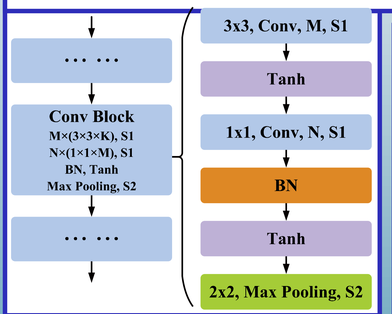
$$M^{\rightarrow}_{m,n} = Q_{i,j} - Q_{i,j+1}$$
$$M^{\downarrow}_{m,n} = Q_{i,j} - Q_{i+1,j}$$
$$A^{\rightarrow}_{m,n} = |Q_{i,j}| - |Q_{i,j+1}|$$
$$A^{\downarrow}_{m,n} = |Q_{i,j}| - |Q_{i+1,j}|$$
$$M^{\rightrightarrows}_{m,n} = Q_{i,j} - 2 \times Q_{i,j+1} + Q_{i,j+2}$$
$$M^{\downdownarrows}_{m,n} = Q_{i,j} - 2 \times Q_{i+1,j} + Q_{i+2,j}$$
$$A^{\rightrightarrows}_{m,n} = |Q_{i,j}| - 2 \times |Q_{i,j+1}| + |Q_{i,j+2}|$$
$$A^{\downdownarrows}_{m,n} = |Q_{i,j}| - 2 \times |Q_{i+1,j}| + |Q_{i+2,j}|$$

Table 1 Percentages of **modified QMDCT coefficients** via each HPF (128 kbps, $W = 4$)

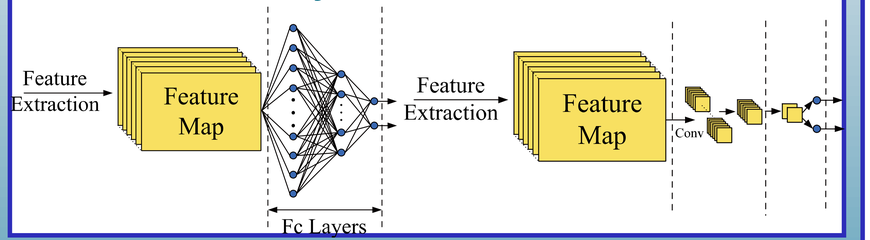
M_Q	$M^{\rightarrow}$	$M^{\downarrow}$	$M^{\rightrightarrows}$	$M^{\downdownarrows}$	$A^{\rightarrow}$	$A^{\downarrow}$	$A^{\rightrightarrows}$	$A^{\downdownarrows}$
1.45	2.00	2.82	2.87	4.14	2.17	2.81	2.88	4.14

Network Structure





Removal of Fc Layers



Network Variants

Table 2 Description and detection accuracy of each network variant (128 kbps, $W = 4$)

ID	Description of the network	Accuracy (%)
a	**RHFCN**	**80.44**
b	Remove rich HPF module	78.13
c	Quit Removing Fc layers	79.09
d	Remove rich HPF module and quit removing Fc layers	77.36

Conclusion

1. The **rich HPF module** "enlarges" the traces of the signal introduced by secret messages, so that the network is more sensitive to the existence of stego signal.
2. The design of **fully CNN structure** does not only improve the performance of the network due to the utilization of spatial and structural correlation of feature maps, but also contributes to the steganalysis of MP3 with **size mismatch**.

Steganalysis with Size Mismatch

Table 3 Detection accuracy (%) of MP3 steganalysis with size mismatch (128 kbps, $W = 4$)

Size	**200×450**	230×450	200×480	230×480
Accuracy	**80.44**	78.22	77.07	75.53

Experimental Results

Table 4 Detection accuracy (%) of **HCM** algorithm

Bitrate	*RER*	**RHFCN**	WASDN	MDI2	ADOTP
128	0.1	**87.18**	83.71	58.48	56.84
	0.3	**92.77**	88.05	68.11	65.13
	0.5	**95.18**	93.34	80.35	74.95
320	0.1	**98.84**	93.26	82.45	68.21
	0.3	**99.23**	94.99	88.44	80.44
	0.5	**99.51**	98.27	93.55	88.34

Table 5 Detection accuracy (%) of **EECS** algorithm

Bitrate	*W*	**RHFCN**	WASDN	MDI2	ADOTP
128	2	**93.26**	90.08	68.79	68.30
	3	**87.96**	82.17	60.79	60.30
	4	**80.44**	74.37	57.71	56.74
	5	**74.76**	64.55	54.72	54.34
	6	**68.50**	55.97	52.02	51.54
320	2	**98.46**	95.57	76.59	73.41
	3	**95.57**	90.17	66.86	61.66
	4	**88.63**	80.15	61.75	57.03
	5	**83.23**	72.54	58.86	54.82
	6	**78.71**	66.67	54.24	53.28