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# RHFCN: FULLY CNN-BASED STEGANALYSIS OF MP3

## WITH RICH HIGH-PASS FILTERING

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Github: [https://github.com/Charleswyt/tf\\_audio\\_steganalysis](https://github.com/Charleswyt/tf_audio_steganalysis)



### Introduction

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

### Rich High-Pass Filtering Module

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

$$M_{m,n}^{\vec{}} = Q_{i,j} - Q_{i,j+1}$$

$$M_{m,n}^{\downarrow} = Q_{i,j} - Q_{i+1,j}$$

$$A_{m,n}^{\vec{}} = |Q_{i,j}| - |Q_{i,j+1}|$$

$$A_{m,n}^{\downarrow} = |Q_{i,j}| - |Q_{i+1,j}|$$

$$M_{m,n}^{\vec{}} = Q_{i,j} - 2 \times Q_{i,j+1} + Q_{i,j+2}$$

$$M_{m,n}^{\downarrow} = Q_{i,j} - 2 \times Q_{i+1,j} + Q_{i+2,j}$$

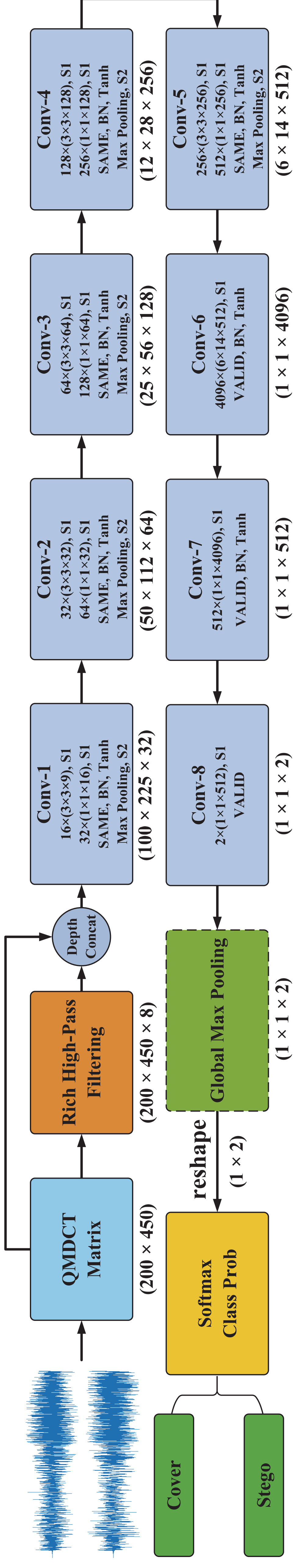
$$A_{m,n}^{\vec{}} = |Q_{i,j}| - 2 \times |Q_{i,j+1}| + |Q_{i,j+2}|$$

$$A_{m,n}^{\downarrow} = |Q_{i,j}| - 2 \times |Q_{i+1,j}| + |Q_{i+2,j}|$$

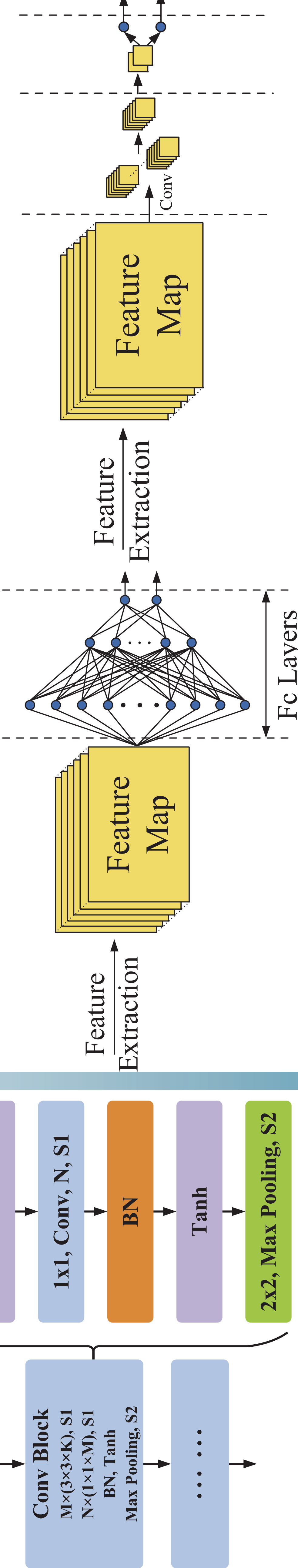
Table 1 Percentages of modified QMDCT coefficients

$M_Q$	$M^{\rightarrow}$	$M^{\downarrow}$	$M^{\vec{}}$	$M^{\downarrow\downarrow}$	$A^{\rightarrow}$	$A^{\downarrow}$	$A^{\vec{}}$	$A^{\downarrow\downarrow}$
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	<b>RHFCN</b>	<b>80.44</b>
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

### Steganalysis with Size Mismatch

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

Size	<b>200×450</b>	230×450	200×480	230×480
Accuracy	<b>80.44</b>	78.22	77.07	75.53

### Experimental Results

Table 4 Detection accuracy (%) of HCM algorithm

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

Table 5 Detection accuracy (%) of EECS algorithm

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

### 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.