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

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

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### 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.

### Experimental Results

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

<table>
<thead>
<tr>
<th>Size</th>
<th>200 × 450</th>
<th>230 × 450</th>
<th>200 × 480</th>
<th>230 × 480</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>80.44</td>
<td>78.22</td>
<td>77.07</td>
<td>75.53</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Bitrate</th>
<th>W</th>
<th>RHFCN</th>
<th>WASDN</th>
<th>MDI2</th>
<th>ADOTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>2</td>
<td>98.47</td>
<td>93.26</td>
<td>82.45</td>
<td>68.21</td>
</tr>
<tr>
<td>0.3</td>
<td>3</td>
<td>93.26</td>
<td>90.08</td>
<td>68.79</td>
<td>63.91</td>
</tr>
<tr>
<td>0.5</td>
<td>4</td>
<td>95.18</td>
<td>90.34</td>
<td>60.35</td>
<td>74.95</td>
</tr>
<tr>
<td>320</td>
<td>5</td>
<td>99.27</td>
<td>98.27</td>
<td>93.55</td>
<td>88.34</td>
</tr>
</tbody>
</table>

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### Network Structure

- **Rich High-Pass Filtering Module**
  \[
  M_g = \begin{bmatrix}
  Q_{1,1} & Q_{1,1} & Q_{1,450} \\
  Q_{1,1} & Q_{1,1} & Q_{1,450} \\
  Q_{200,1} & Q_{200,1} & Q_{200,450}
  \end{bmatrix}
  \]
  \[
  A_{m,n} = |Q_{i,j} - Q_{i,j+1}|
  \]
  \[
  A_{m,n} = |Q_{i,j} - Q_{i,j+1}|
  \]
  \[
  M_r = Q_{i,j} - 2 \times Q_{i,j+1} + Q_{i,j+2}
  \]
  \[
  M_r = Q_{i,j} - 2 \times Q_{i,j+1} + Q_{i,j+2}
  \]

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

<table>
<thead>
<tr>
<th>Network Variant</th>
<th>Description of the network</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a RHFCN</td>
<td></td>
<td>80.44</td>
</tr>
<tr>
<td>b Remove rich HPF module</td>
<td></td>
<td>78.13</td>
</tr>
<tr>
<td>c Quit Removing Fc layers</td>
<td></td>
<td>79.09</td>
</tr>
<tr>
<td>d Remove rich HPF module and quit removing Fc layers</td>
<td></td>
<td>77.36</td>
</tr>
</tbody>
</table>

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### Removal of Fc Layers

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

<table>
<thead>
<tr>
<th>$M_g^k$</th>
<th>$M_g^{k+1}$</th>
<th>$M_g^{k+2}$</th>
<th>$M_g^{k+3}$</th>
<th>$M_g^{k+4}$</th>
<th>$M_g^{k+5}$</th>
<th>$M_g^{k+6}$</th>
<th>$M_g^{k+7}$</th>
<th>$M_g^{k+8}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.43</td>
<td>2.00</td>
<td>2.82</td>
<td>2.87</td>
<td>4.14</td>
<td>2.17</td>
<td>2.81</td>
<td>2.88</td>
<td>4.14</td>
</tr>
</tbody>
</table>

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### 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.