一、波形计算分析

1、信噪比 SNR 计算公式如下：

$$\mathrm{SNR}=10\lg\frac{\sum_{i=1}^{N}[\mathrm{x}_{\mathrm{o}}(\mathrm{i})]^{2}}{\sum_{i=1}^{N}[x_{o}(i)-x_{d}(i)]^{2}} \tag{1}$$

2、波形拉伸不会影响 SNR 结果：结果与式（1）相同

$$\mathrm{SNR}=10\lg\frac{\sum_{i=1}^{N}\left[{\mathrm{x}_{\mathrm{o}}(\mathrm{i})}/{L}\right]^{2}}{\sum_{i=1}^{N}\left[{x_{o}(i)}/{L}-{x_{d}(i)}/{L}\right]^{2}} \tag{2}$$

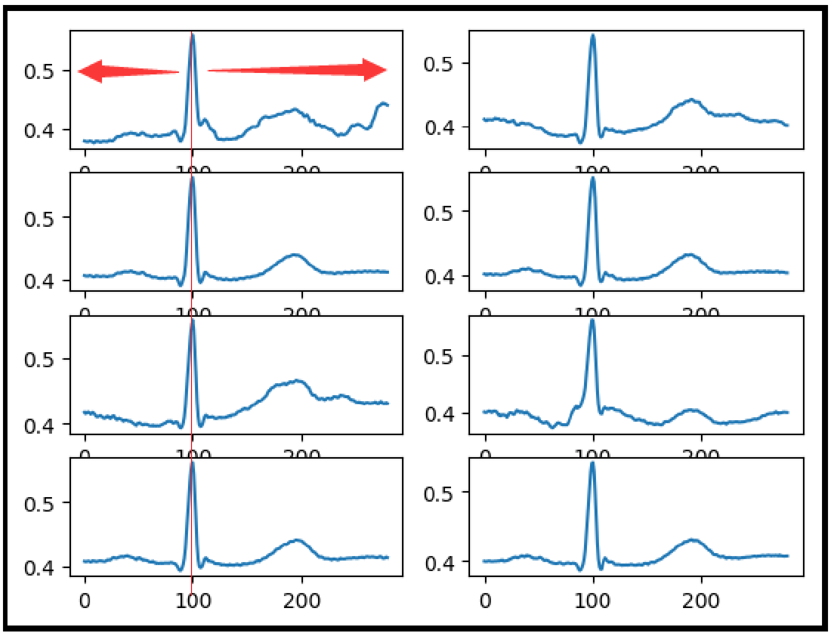
3、上下平移波形，会影响 SNR 值：

$$\mathrm{SNR}=10\lg\frac{\sum_{i=1}^{N}\left[{\mathrm{x}_{\mathrm{o}}(\mathrm{i})}/{L}+\lambda\right]^{2}}{\sum_{i=1}^{N}\left[\left({x_{o}(i)}/{L}+\lambda\right)-\left({x_{d}(i)}/{L}+\lambda\right)\right]^{2}}=10\lg\frac{\sum_{i=1}^{N}\left[{\mathrm{x}_{\mathrm{o}}(\mathrm{i})}/{L}+\lambda\right]^{2}}{\sum_{i=1}^{N}\left[\left({x_{o}(i)}/{L}\right)-\left({x_{d}(i)}/{L}\right)\right]^{2}}$$

问题：波形上下平移并不会改变波形峰值变化，会不会影响医生鉴别患者病情？

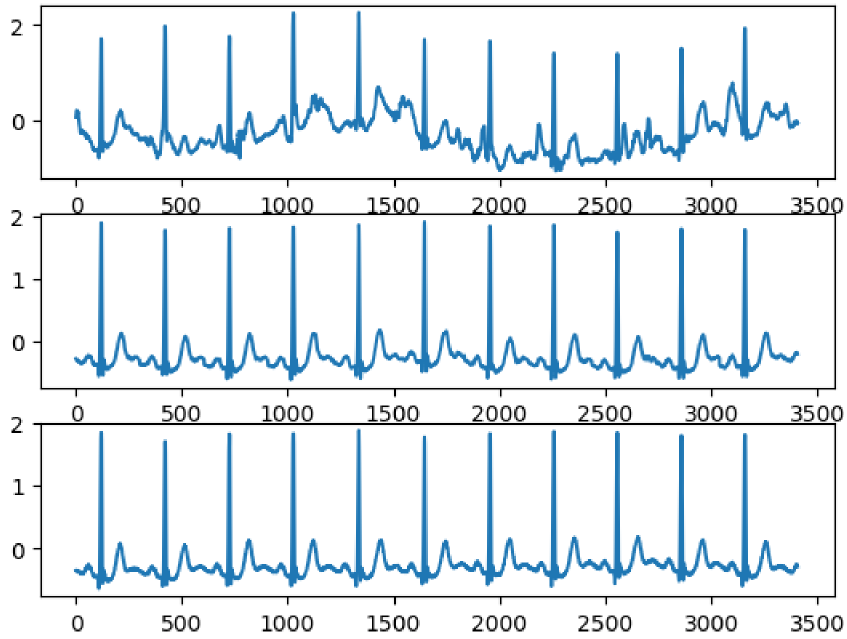
二、实验结果改进

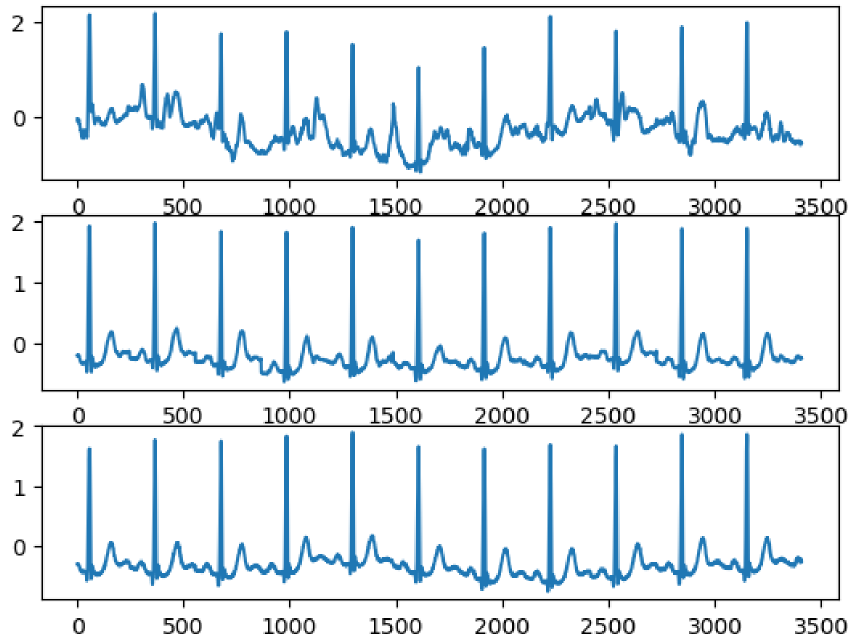
1、将实验数据改成以 QRS 波为中心，向两边取一定长度作为一个训练样本。形式如 $x_{QRS}\in\left\lfloor x_{QRS}-\delta_{left},x_{QRS}+\delta_{right}\right\rfloor$ ；

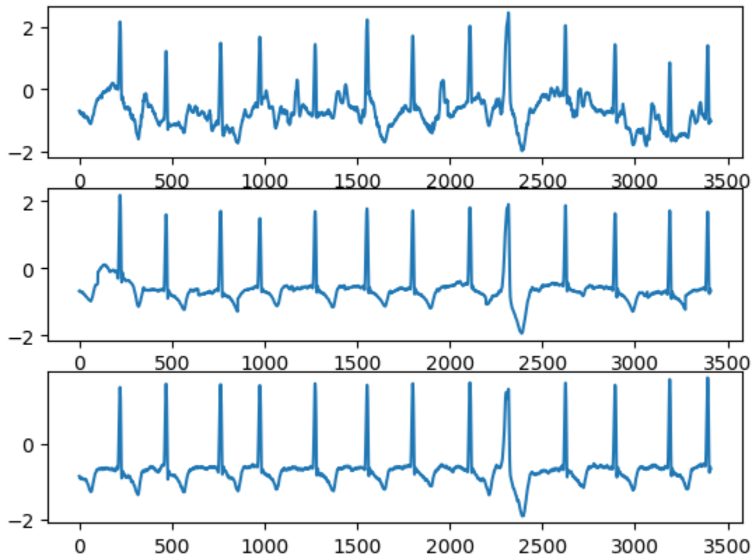


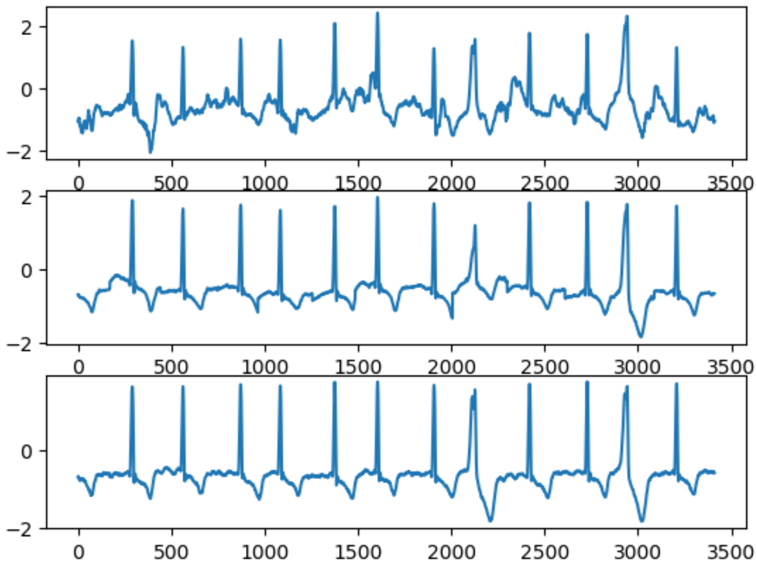
2、使用以上形式数据集实验，波形结果有所优化。

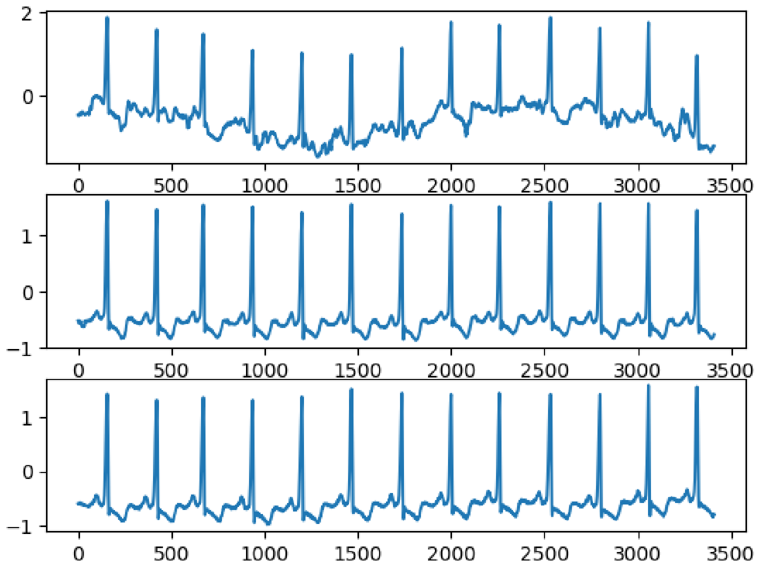
（1）工频干扰 EM 噪声，第一行为噪声数据，第二行为去噪后数据，第三行为原始数据，对比结果如下：



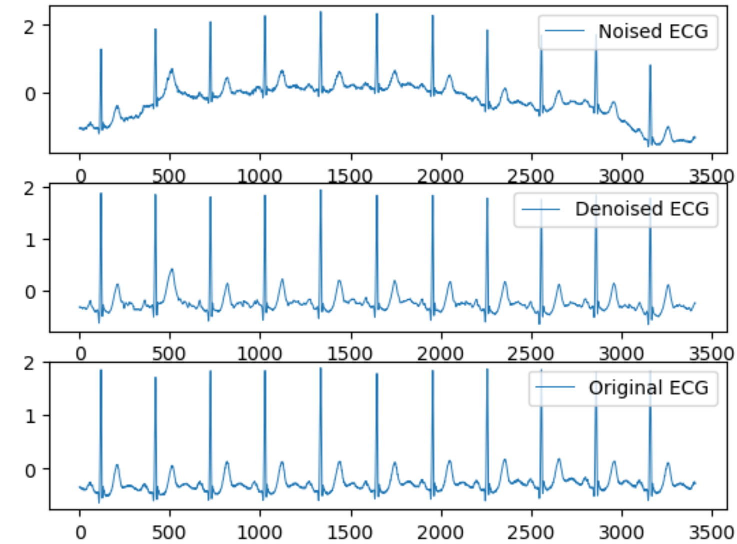


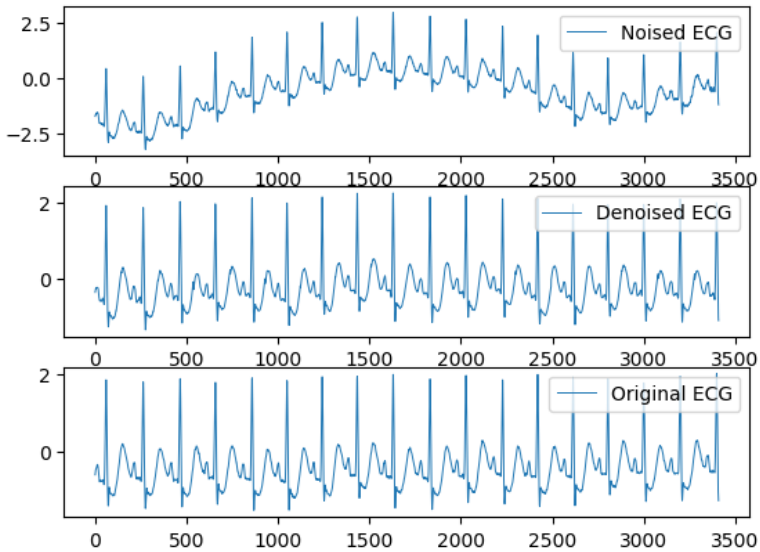

2
0
−2
0
500
1000
1500
2000
2500
3000
3500

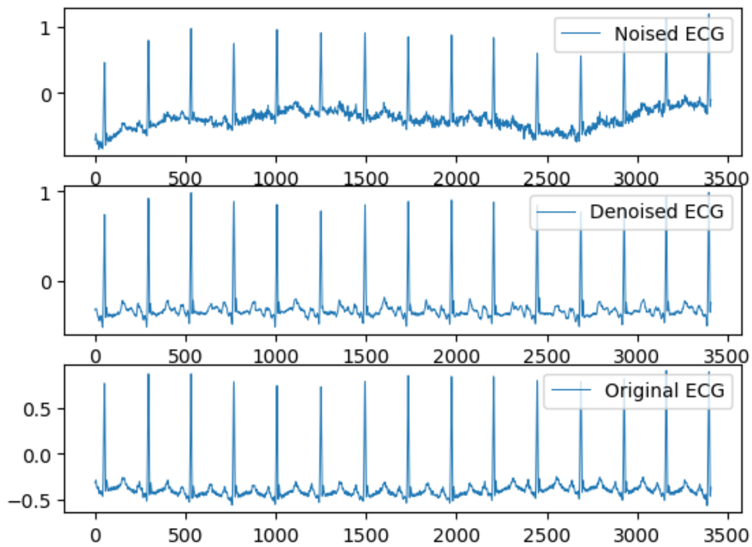

2
0
−2
0
500
1000
1500
2000
2500
3000
3500


2
1
0
−1
0
500
1000
1500
2000
2500
3000
3500

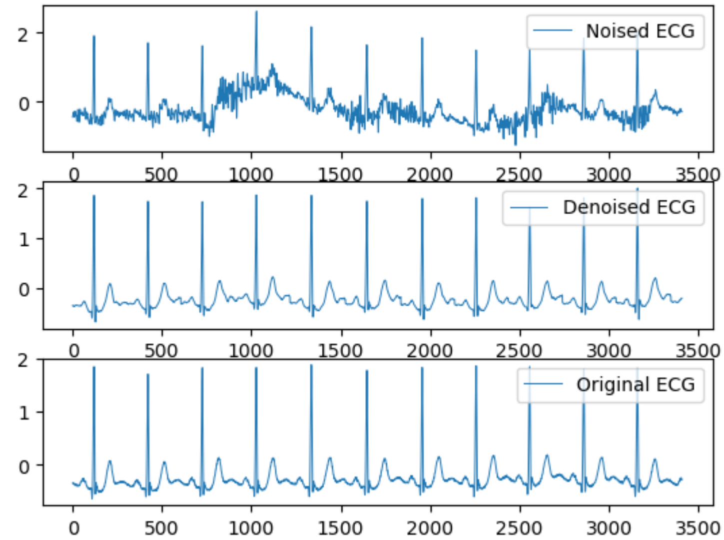
（2）基线漂移噪声 BW

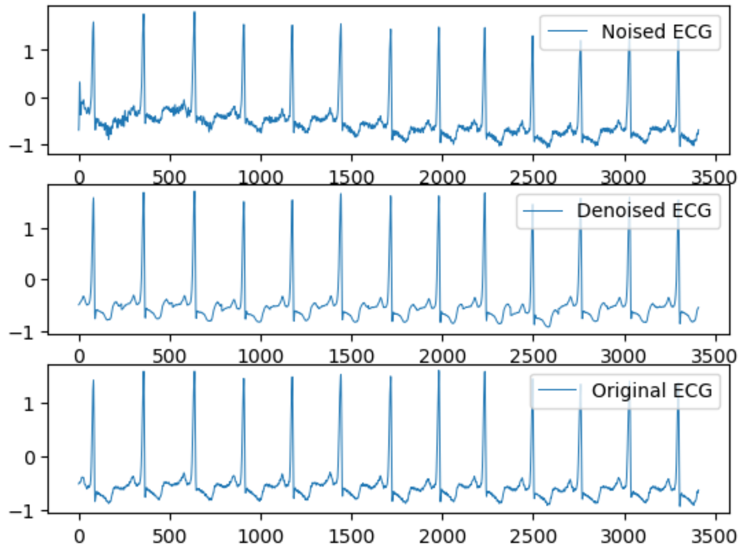

Noised ECG
Denoised ECG
Original ECG

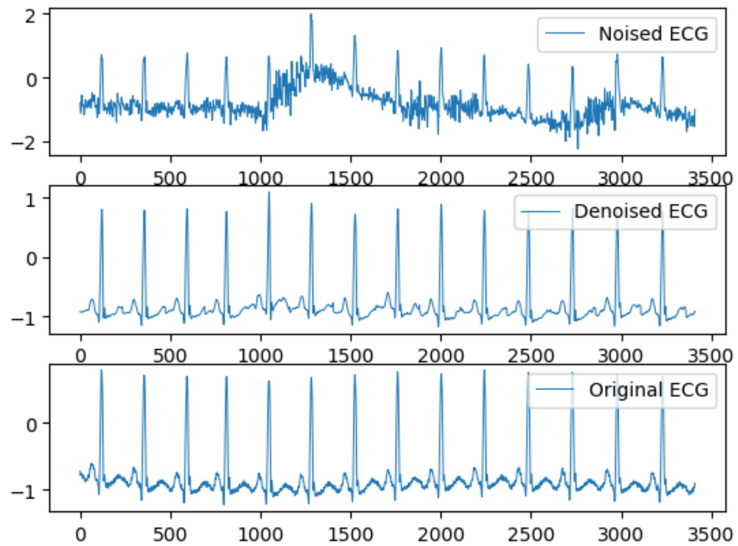

Noised ECG
Denoised ECG
Original ECG


Noised ECG
Denoised ECG
Original ECG

（3）肌电干扰噪声 MA

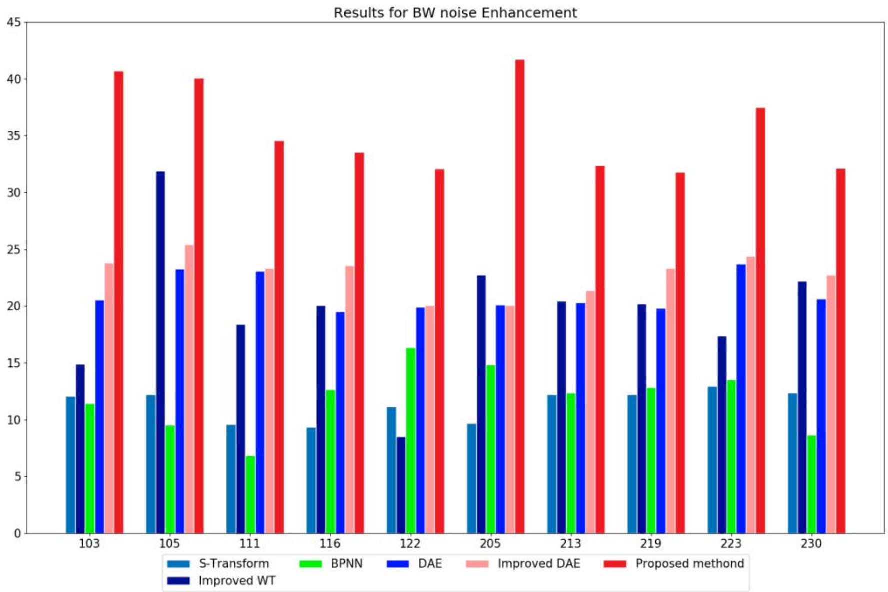

Noised ECG
Denoised ECG
Original ECG


Noised ECG
Denoised ECG
Original ECG

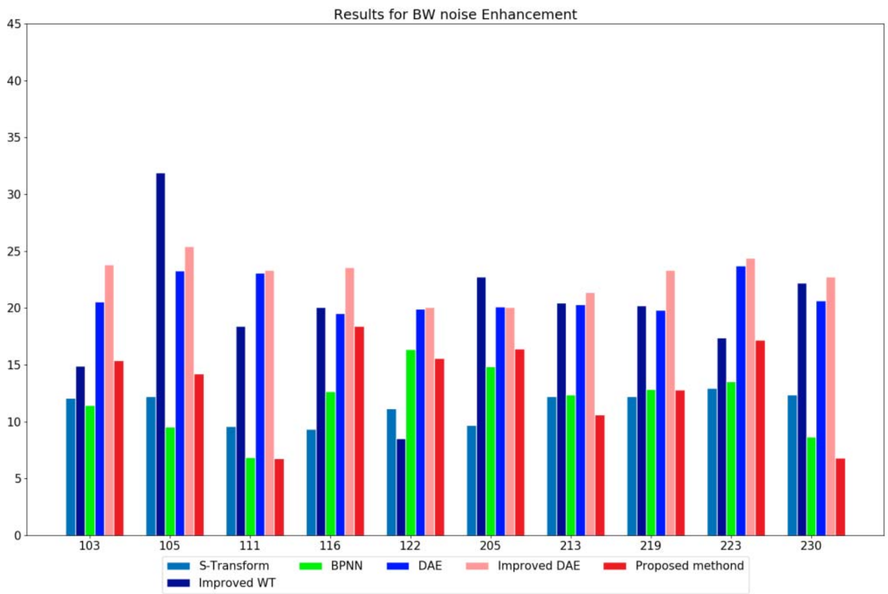

Noised ECG
Denoised ECG
Original ECG

（4）信噪比结果对比

归一化结果如下：



反归一化之后结果如下：



- 小论文进展

题目暂定 ： 基于生成对抗网络的 ECG 信号去噪

基本结构已经完成，正在修改中。

三、论文进展

题目 ： 基于生成对抗网络的 **ECG** 信号去噪

结构 ：

Abstract

1. Introduction

2. Proposed approach and ECG database

    2.1 GAN

    2.2 ECG database

    2.3 Details in proposed method

        2.3.1 Data preprocessing

        2.3.2 Training Details

3. Experiment results

    3.1 Performance evaluation

    3.2 Results in removing noise

        3.2.1 Removal of em noise

        3.2.1 Removal of em noise

        3.2.1 Removal of em noise

    3.3 Comparison and discussion

4. Conclusion

References