

# **Code Excited Linear Prediction Coder for Electrocardiogram**

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**IEEE EMBS** : Proceedings of the 26th Annual International Conference  
**Location** : San Francisco, CA, USA  
**Date** : September 1-5, 2004  
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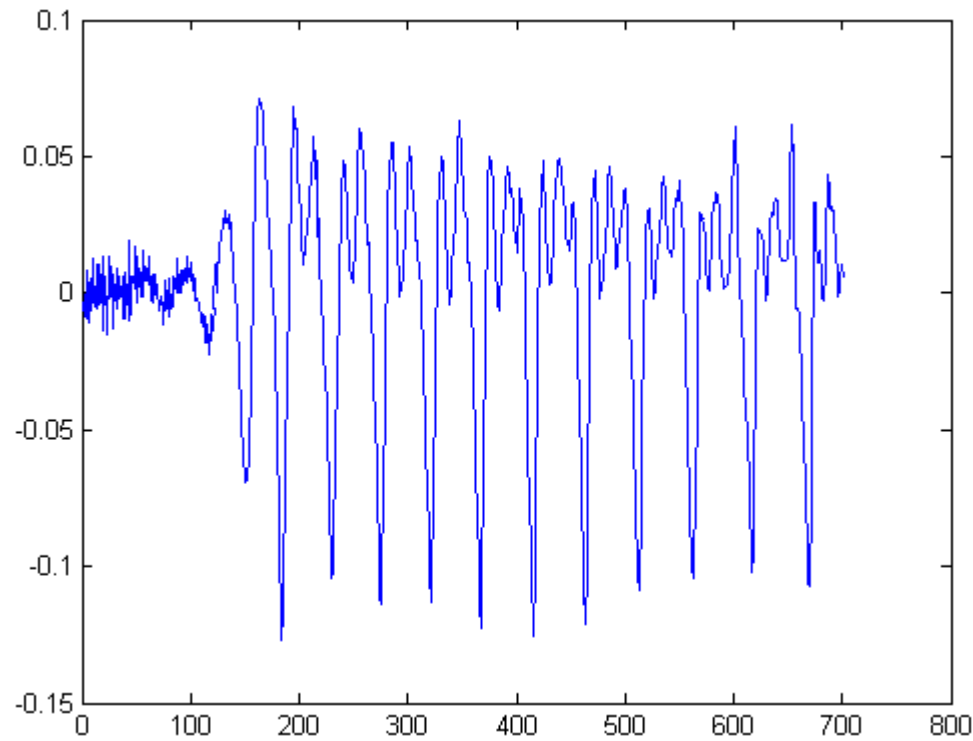
- 1) QRS detection
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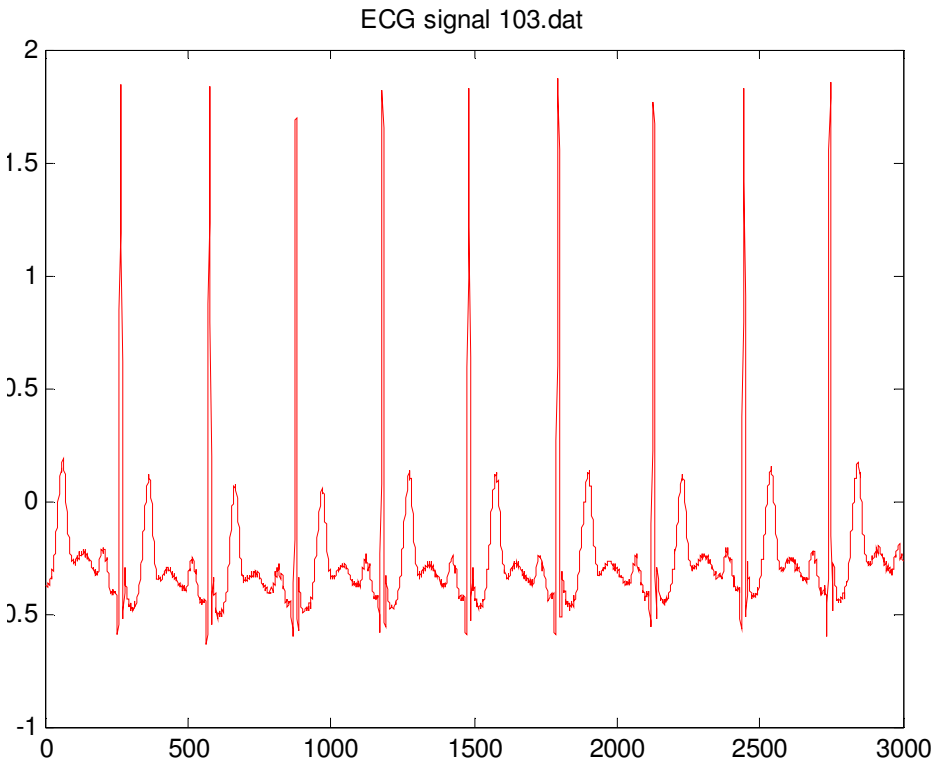
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# 1. Introduction



Speech



ECG signal



# 1. Introduction

## 1) CELP: Code Excited Linear Prediction

- 是一種以『合成做分析』的語音編碼器技術
- 是由隨機亂數組成的碼簿結構
- 利用每個字碼個別合成一段語音，然後在所有合成語音中找尋與原來最相似的。
- 將其相對應的碼字索引記錄下來



# 1. Introduction

## 2) Linear prediction

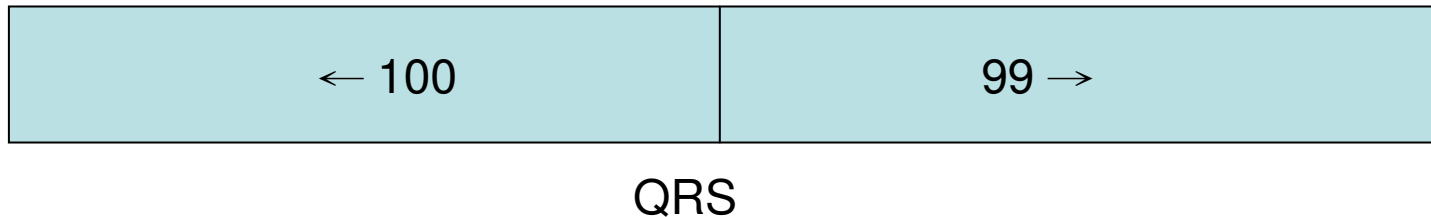
全極點濾波器

$$H(z) = \frac{1}{1 + \sum_{k=1}^p a_k z^{-k}} = \frac{1}{A(z)}$$

P是階層



## 2. Methodology



- ECG sampled at 500samples/sec
- A linear prediction model of order 2 is estimated for each of the ECG segments
- 從LP係數和部分ECG訊號去計算出殘值誤差
- 不可預測的部分使用random



## 2. Methodology

- 使用LBG演算法取得codebook
- Codebook size as 64
- Need a 6 bit index to address
- 每個係數用 14 bits 去代表



## 2. Methodology

### 1) QRS detection:

- 可以調整同時也能從每個ECG complex取得 pulse
- 從QRS的檢測可以得到確切的pulse的位置
- Pulse的寬度大約跟QRS的持續時間相同
- QRS pulse 重建出原始的位置





## 2. Methodology

2) Classified VQ to minimize search procedure:

The performance of the VQ depends :

- Dimension of the vector
- Distortion criterion used
- Code size
- Choice of the code vector



# 2. Methodology

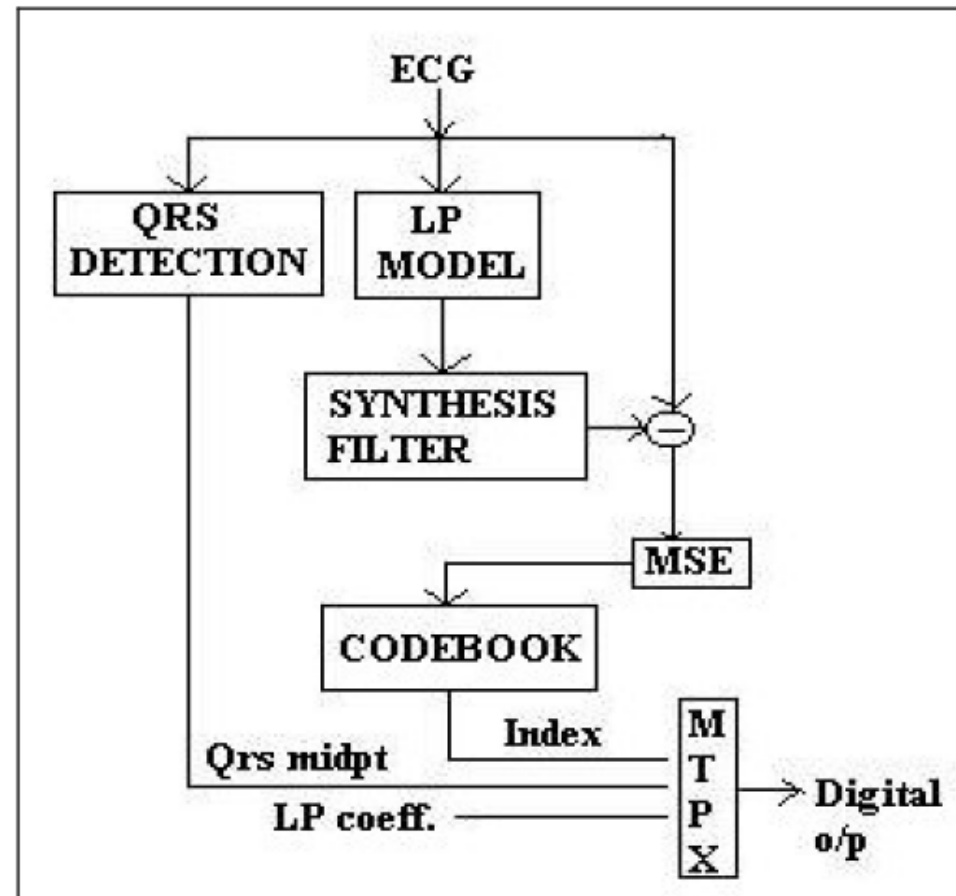


Fig (1) : Encoder Structure



# 2. Methodology

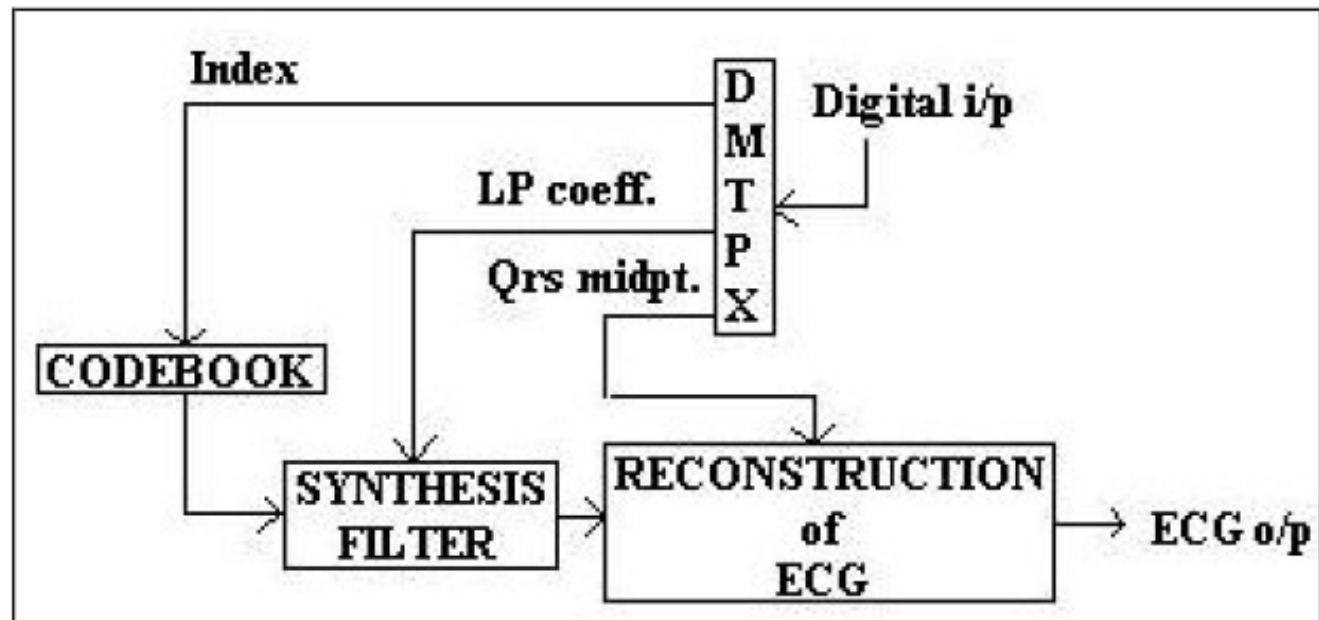
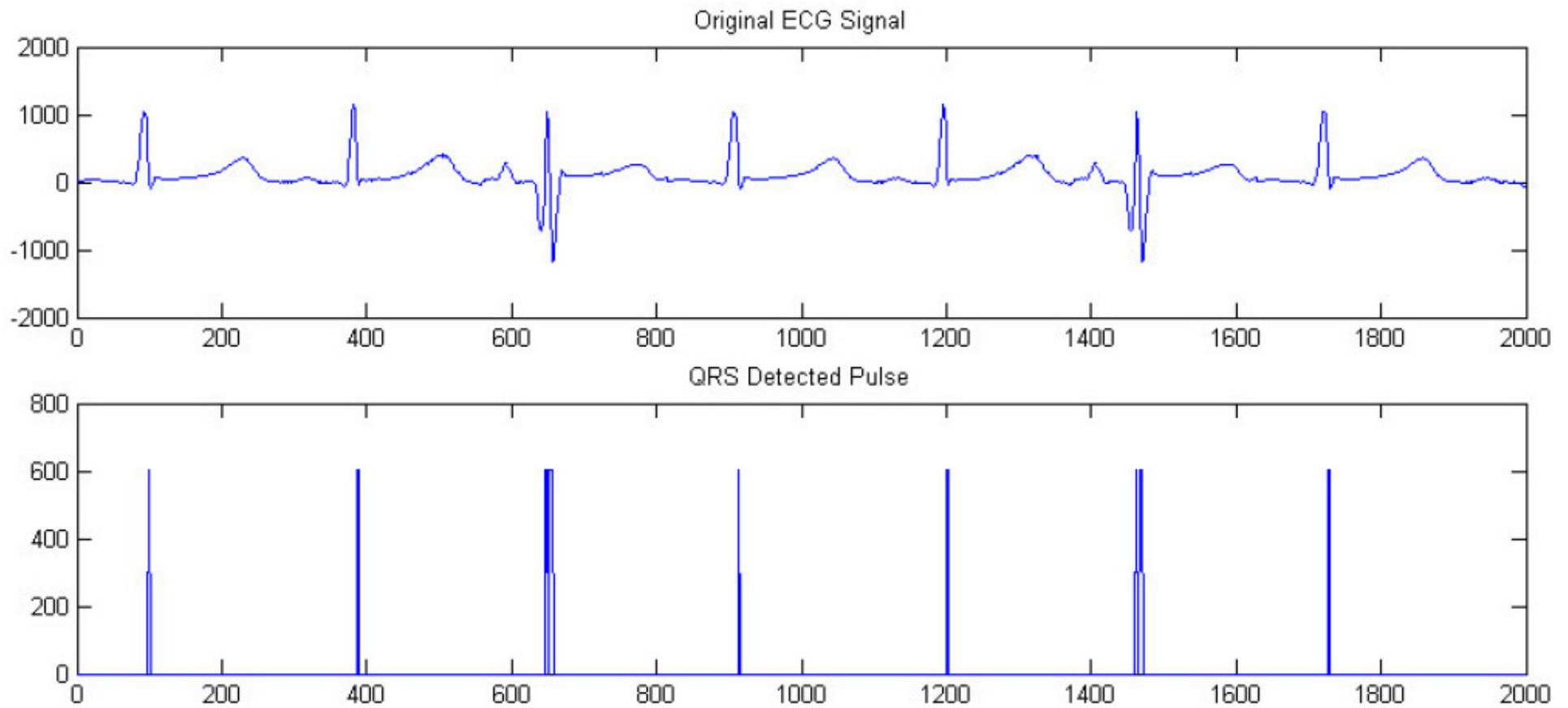


Fig (2) : Decoder Structure

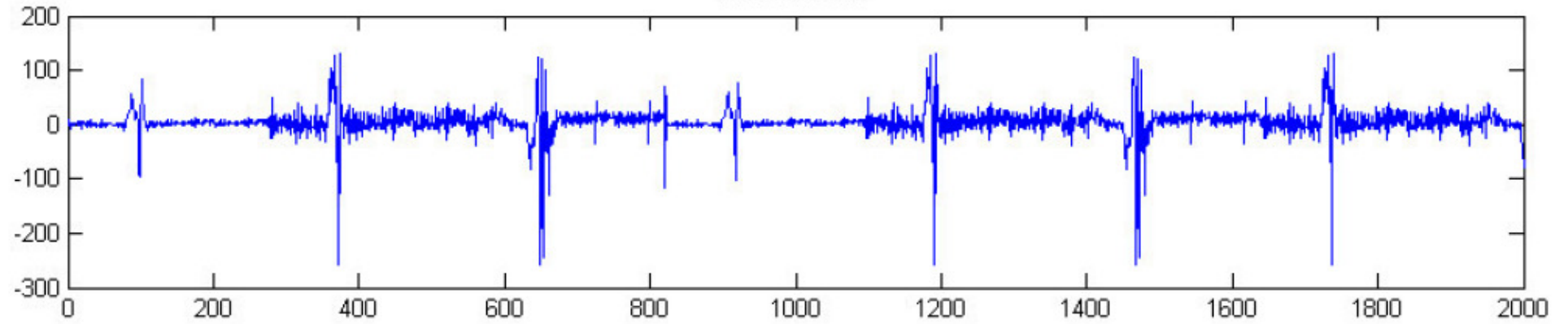


# 3. Results

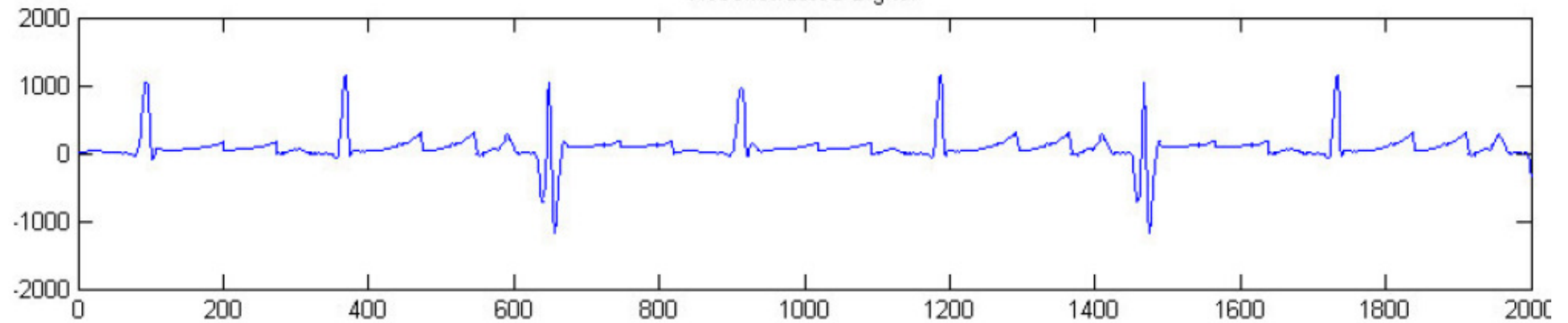


# 3. Results

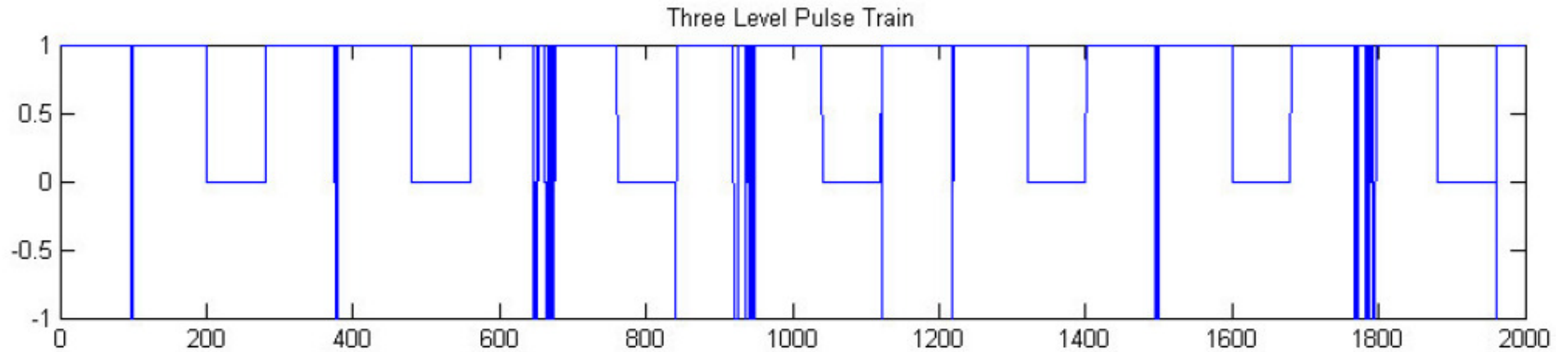
Residual Error



Reconstructed Signal



# 3. Results



$$NMSE = \sqrt{\frac{\sum_{i=1}^{2000} [ECG_{ori}(i) - ECG_{orc}(i)]^2}{\sum_{i=1}^{2000} [ECG_{ori}(i)]^2}} \times 100\%$$

$$NMSE=0.956272$$



## 4. Conclusion

- Compression ratio of 1:50
- 可以動態調整取樣大小減少bits的佔用

