# G.723.1 語音編碼器之殘值預估 MP-MLQ 快速搜尋演算法 和 實驗

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# Outline

- **Instruction**
- **Residual signal for Fast MP-MLQ Search**
- **An experiment for Fast MP-MLQ Search**
- **Conclusion**

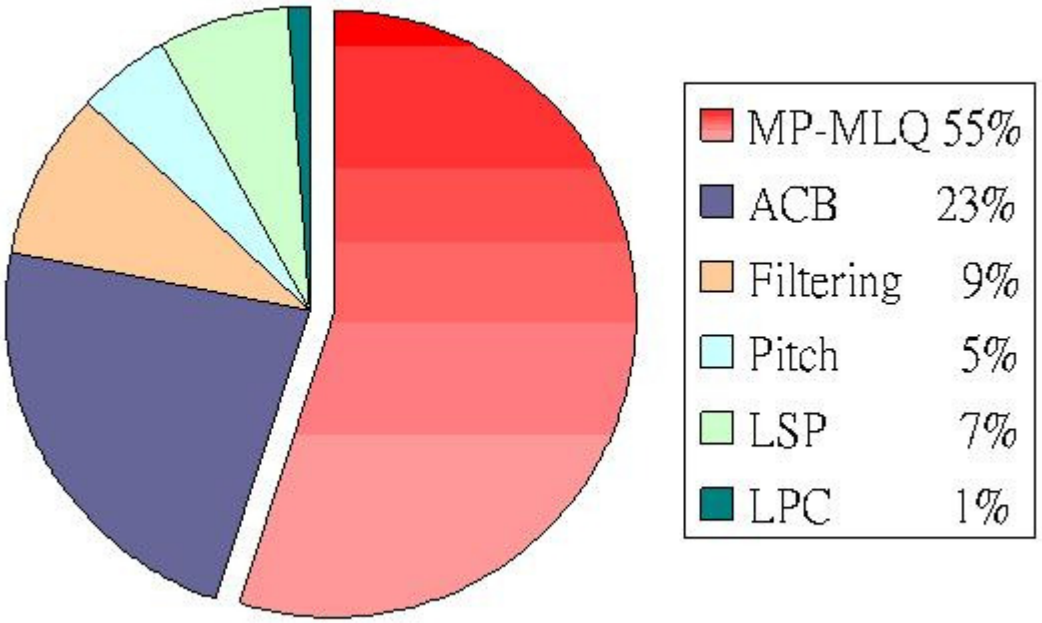
# Instruction

- G.723.1 採用 analysis-by-synthesis 技術做編碼。

  - **Advantage –Low-bit rate and high voice quality 。**
  - **Defect – High computational complexity。**

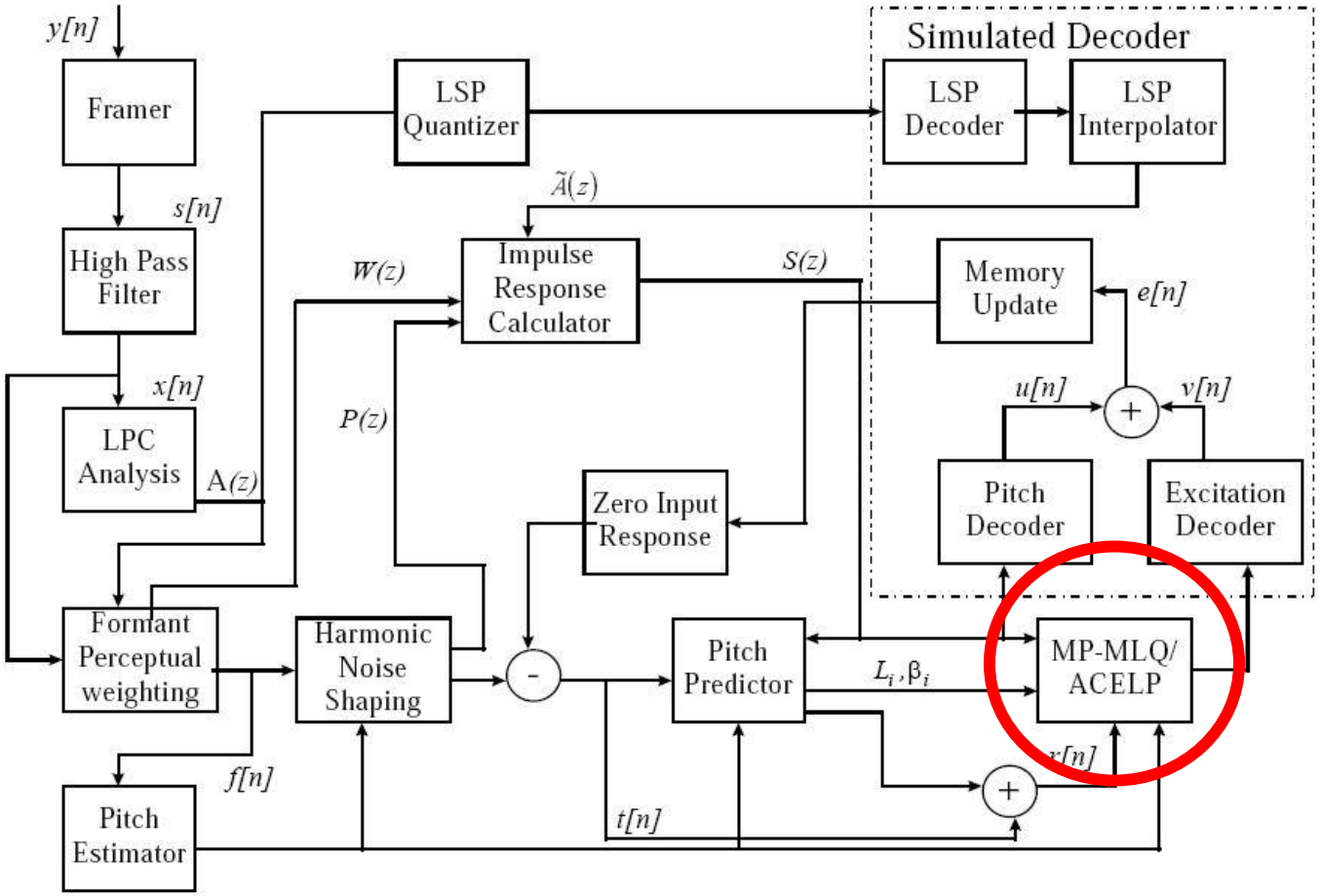
    1. **The stochastic Codebook.**
    2. **The estimated coding gain calculation.**

# Instruction




**The distribution of computational load in the encoding process for high-rate G.723.1**

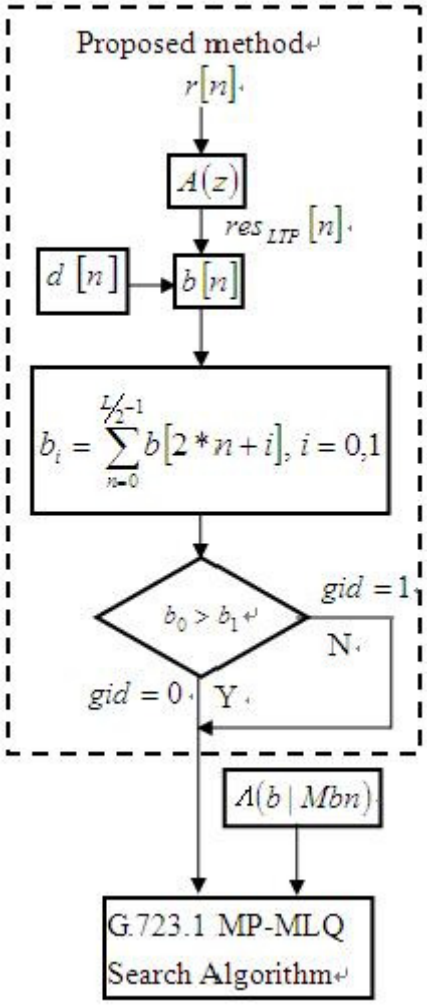
# Instruction




Block diagram of the ITU-T G.723.1 speech coder

# Residual signal for Fast MP-MLQ Search

快速隨機碼簿搜尋之流程方塊圖




1. $res_{LTP}[n]$ 非週期性激發訊號.
2. $d[n]$ 可能脈衝預估向量.
3. $b[n]$ 非週期性激發訊號能量.
4. $b_i$ .

# Residual signal for Fast MP-MLQ Search

Step 1 :

$$r[n] \longrightarrow A(z) = 1 - \sum_{i=1}^{10} a[i] z^{-i} \longrightarrow res_{LTP}[n]$$

Step 2 :

$$b[n] = \frac{res_{LTP}[n]}{\sqrt{\sum_{i=0}^{L-1} res_{LTP}[i] \cdot res_{LTP}[i]}} + \frac{d[n]}{\sqrt{\sum_{i=0}^{L-1} d[i] \cdot d[i]}}$$

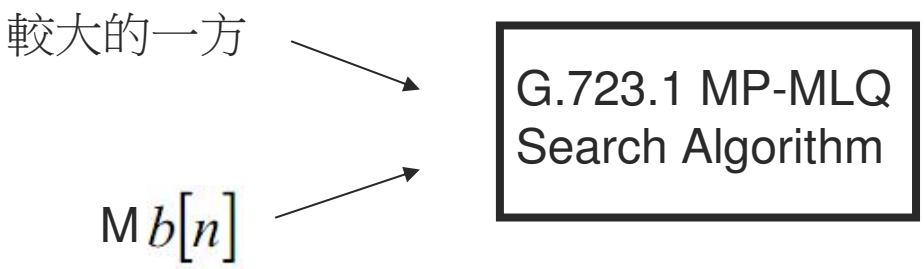
$$,0 \le n \le L-1$$

# Residual signal for Fast MP-MLQ Search

Step 3 :

分別將ODD 和 EVEN 的$b[n]$ 值作加總，並且判斷大小 。

Step 4 :



# Residual signal for Fast MP-MLQ Search

搜尋激發脈衝位置組合數之比較

($Mbn$=20)

| method | search load | |
|---|---|---|
| STD (G.723.1) | $P_0[n] = 2 * C_6^{30}$<br>$P_1[n] = 2 * C_5^{30}$ | $P_0[n] = 1187550$<br>$P_1[n] = 285012$ |
| Proposed | $P_0[n] = C_6^{Mbn}$<br>$P_1[n] = C_5^{Mbn}$ | $P_0[n] = 38760$<br>$P_1[n] = 15504$ |

# Residual signal for Fast MP-MLQ Search

快速搜尋演算法所需之計算量

| Procedure | Computational load | Total |
|---|---|---|
| $res_{LTP}[n] = s_w[n] - \sum_{i=0}^{9} a[i] * s_w[n-i]$ | $(L-10)*10+55$(mul)<br>$(L-10)*10+55$(add) | 797(mul)<br>791(add) |
| $b[n] = \frac{res_{LTP}[n]}{\sqrt{\sum_{i=0}^{L-1} res_{LTP}[n] * res_{LTP}[n]}} + \frac{d[n]}{\sqrt{\sum_{i=0}^{L-1} d[n] * d[n]}}$ | $4*L+2$ (mul)<br>$3*L-2$ (add) | |
| $b_i = \sum_{n=0}^{L/2-1} b[2*n+i], i = 0,1$ | $L-2$ (add) | |

ODD : $\frac{1187550-38760-1588}{1187550} * 100\% = 96.6024\%$

EVEN : $\frac{285012-15504-1588}{285012} * 100\% = 94.0031\%$

SNR

SNR數據

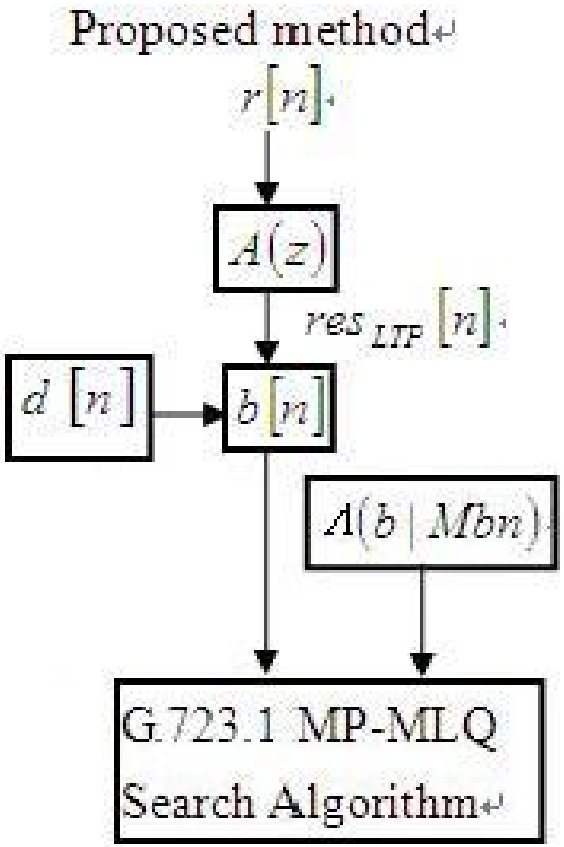
| | A | B | C | D |
|---|---|---|---|---|
| 1 | 音檔 | 標準 G.723.1 SNR(dB) | 限制20-預估奇偶 SNR(dB) | |
| 2 | | | | |
| 3 | 4david | 16.973 | 16.554 | -2.469% |
| 4 | 5david | 16.766 | 16.493 | -1.628% |
| 5 | 6david | 17.224 | 16.413 | -4.709% |
| 6 | SPBOY | 19.546 | 18.735 | -4.149% |
| 7 | CHEN2 | 20.528 | 20.371 | -0.765% |
| 8 | DAVID | 14.642 | 14.152 | -3.347% |
| 9 | female12 | 18.28 | 17.911 | -2.019% |
| 10 | female22 | 15.67 | 15.349 | -2.049% |
| 11 | GIRL1 | 16.331 | 16.145 | -1.139% |
| 12 | HUNG | 18.548 | 17.963 | -3.154% |
| 13 | HUNG3 | 17.565 | 17.492 | -0.416% |
| 14 | KUO | 18.078 | 17.514 | -3.120% |
| 15 | KUOAM | 17.942 | 17.545 | -2.213% |
| 16 | male4 | 15.211 | 14.757 | -2.985% |
| 17 | nsan | 14.693 | 14.275 | -2.845% |
| 18 | rdavid | 16.654 | 16.009 | -3.873% |
| 19 | SAN | 17.038 | 16.576 | -2.712% |
| 20 | SERIC2 | 13.612 | 13.307 | -2.241% |
| 21 | SPGIRL | 14.179 | 13.802 | -2.659% |
| 22 | WANG2 | 14.927 | 14.379 | -3.671% |
| 23 | SUM | 334.407 | 325.742 | |
| 24 | Average | 16.72035 | 16.2871 | |
| 25 | Avg ERR(%) | | -2.608% | |

PESQ

PESQ數據

| | A | B | C | D |
|---|---|---|---|---|
| 1 | 音檔 | 標準 G.723.1 PESQ | 限制20-預估奇偶 PESQ | |
| 2 | | | | |
| 3 | 4david | 3.735 | 3.629 | -2.838% |
| 4 | 5david | 3.655 | 3.563 | -2.517% |
| 5 | 6david | 3.656 | 3.596 | -1.641% |
| 6 | SPBOY | 3.572 | 3.433 | -3.891% |
| 7 | CHEN2 | 3.153 | 3.073 | -2.537% |
| 8 | DAVID | 3.581 | 3.501 | -2.234% |
| 9 | female12 | 3.582 | 3.491 | -2.540% |
| 10 | female22 | 3.23 | 3.194 | -1.115% |
| 11 | GIRL1 | 3.429 | 3.412 | -0.496% |
| 12 | HUNG | 3.798 | 3.726 | -1.896% |
| 13 | HUNG3 | 3.654 | 3.572 | -2.244% |
| 14 | KUO | 3.504 | 3.456 | -1.370% |
| 15 | KUOAM | 3.538 | 3.491 | -1.328% |
| 16 | male4 | 3.693 | 3.652 | -1.110% |
| 17 | nsan | 3.698 | 3.581 | -3.164% |
| 18 | rdavid | 3.703 | 3.627 | -2.052% |
| 19 | SAN | 3.872 | 3.845 | -0.697% |
| 20 | SERIC2 | 3.716 | 3.724 | 0.215% |
| 21 | SPGIRL | 3.627 | 3.646 | 0.524% |
| 22 | WANG2 | 3.855 | 3.682 | -4.488% |
| 23 | SUM | 72.251 | 70.894 | |
| 24 | Average | 3.61255 | 3.5447 | |
| 25 | Avg ERR(%) | | -1.871% | |

# An experiment for Fast MP-MLQ Search



# An experiment for Fast MP-MLQ Search

- 利用非週期性激發訊號能量 $b[n]$，去將odd subframe、even subframe 分別遞減排序。

- 針對已排序的 odd 、 even 分別取出前25、20、15、10大的限制。

# An experiment for Fast MP-MLQ Search

- 限制前 **25** 大 激發訊號能量 (可省下計算量) 66.113%

$$P_0[n] = 2 * C_6^{25} = 177100 * 2 = 354200$$

$$P_1[n] = 2 * C_5^{25} = 53130 * 2 = 106260$$

even subframe ((1187550-354200-1530)/ 1187550)*100%= 70.045 %
odd subframe ((285012-106260-1530)/ 285012)*100%= 62.181 %

- 限制前 **20** 大 激發訊號能量 (可省下計算量) 90.963%

$$P_0[n] = 2 * C_6^{20} = 38760 * 2 = 77520$$

$$P_1[n] = 2 * C_5^{20} = 15504 * 2 = 31008$$

even subframe ((1187550-77520-1530)/ 1187550)*100%= 93.343 %
odd subframe ((285012-31008-1530)/ 285012)*100%= 88.583 %

# An experiment for Fast MP-MLQ Search

- 限制前 **15** 大 激發訊號能量 (可省下計算量) 98.192%

$$P_0[n] = 2 * C_6^{15} = 5005 * 2 = 10010$$

$$P_1[n] = 2 * C_5^{15} = 3003 * 2 = 6006$$

even subframe ((1187550-10010-1530)/ 1187550)*100%= 99.028 %
odd subframe ((285012-6006-1530)/ 285012)*100%= 97.355 %

- 限制前 **10** 大 激發訊號能量 (可省下計算量) 99.561%

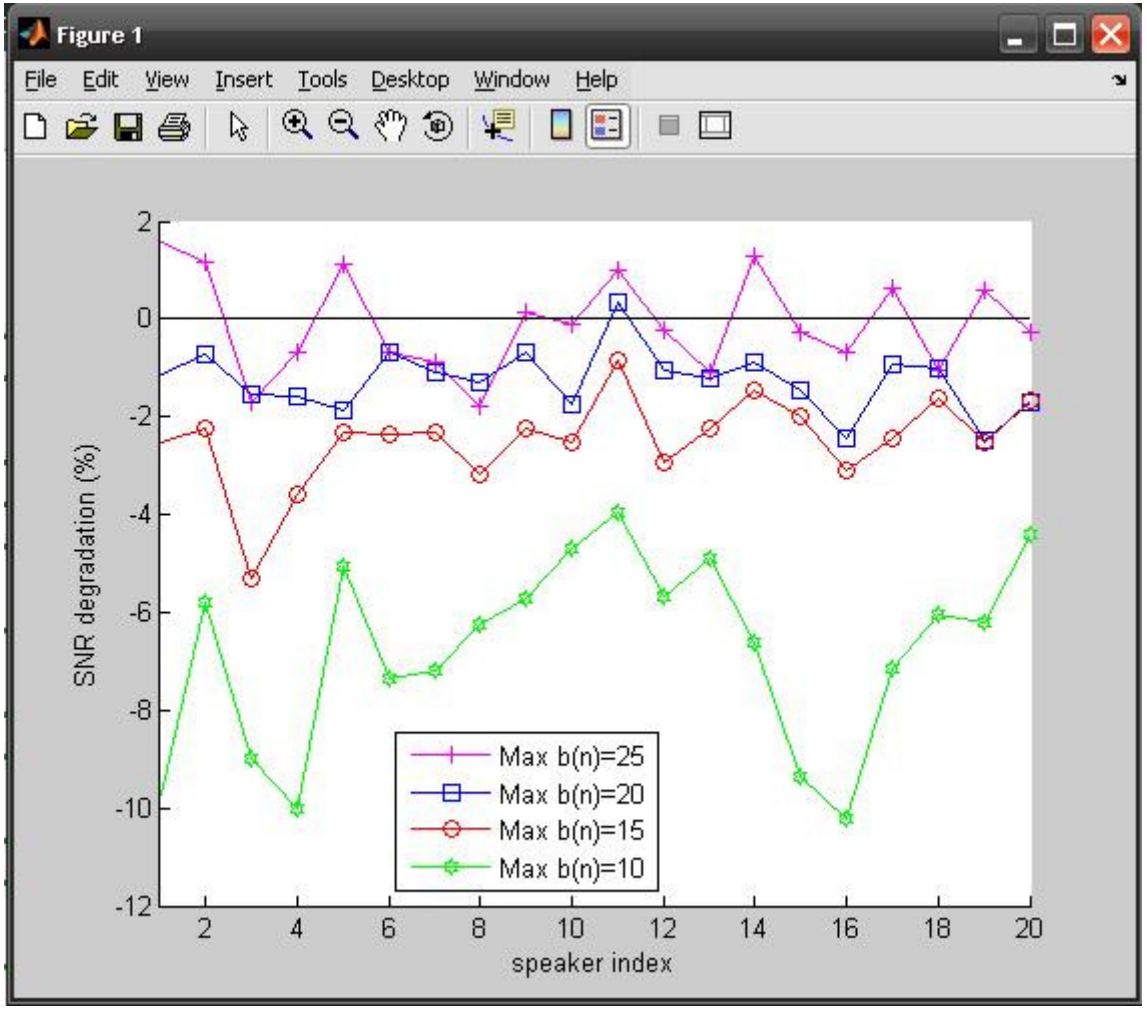
$$P_0[n] = 2 * C_6^{10} = 210 * 2 = 420$$

$$P_1[n] = 2 * C_5^{10} = 252 * 2 = 504$$

even subframe ((1187550-420-1530)/ 1187550)*100%= 99.835 %
odd subframe ((285012-504-1530)/ 285012)*100%= 99.286 %

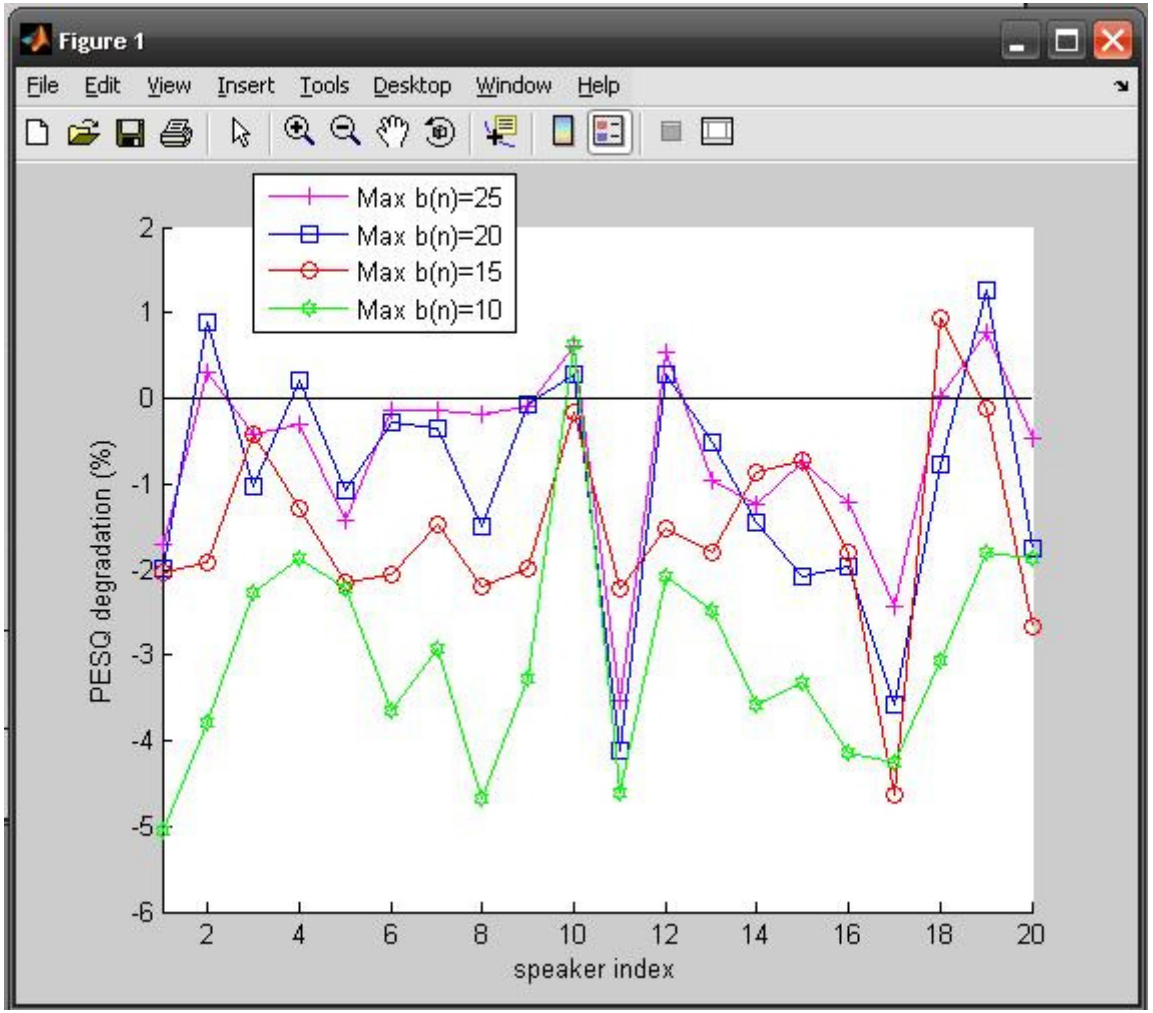
# An experiment for Fast MP-MLQ Search

SNR

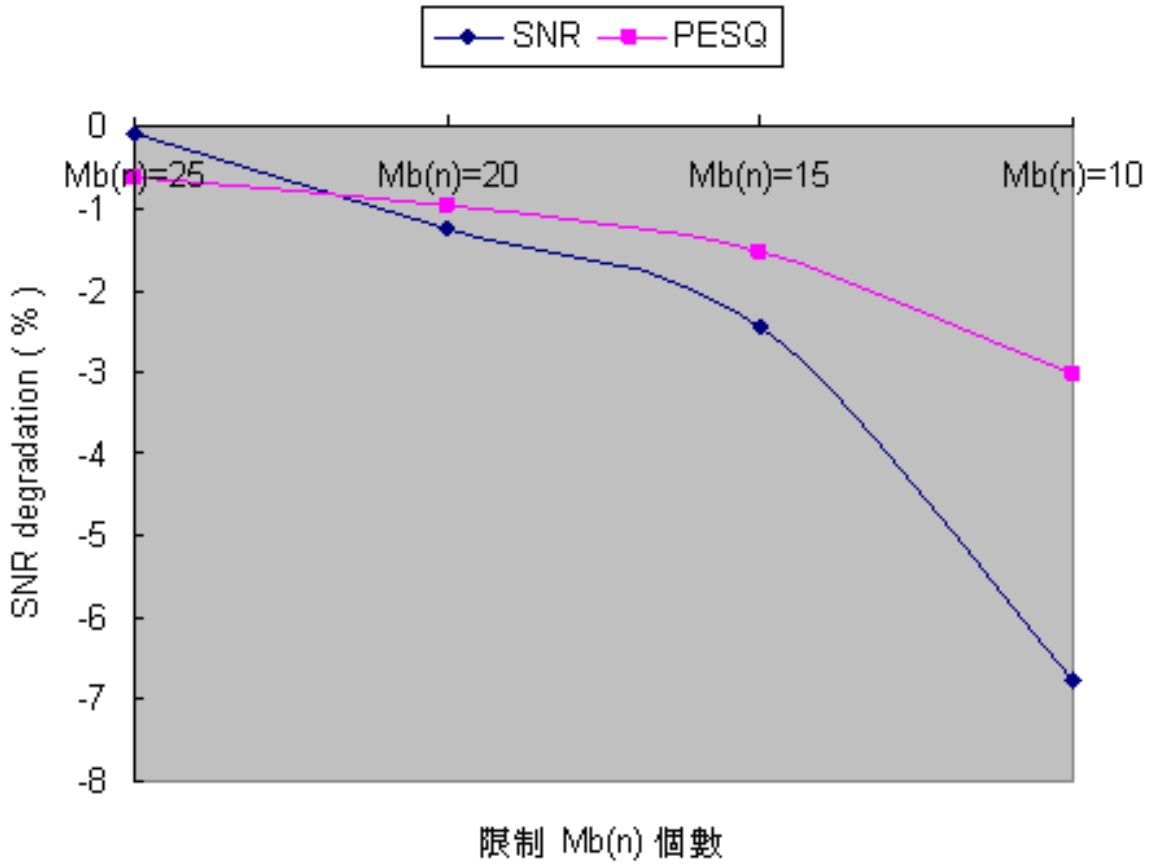


# An experiment for Fast MP-MLQ Search

PESQ



# An experiment for Fast MP-MLQ Search



# Conclusion

- 不設限 odd 或 even 皆搜尋之下，在同樣只取 $M_b[n]$= 20 SNR 和 PESQ 只降低 1.254% 、0.973%，但是在計算量卻只省下 90.963% 。

- 然而在 $M_b[n]$ =15 時， SNR 和 PESQ 稍稍分別降低了 2.470%、1.555% ，然而計算量大幅省下 98.192%