

Lab 3 : Coded system

NTU communication laboratory

Spring 18

2018.04.24

Outline

- 基本原理與系統架構

 - ◆ 基本原理與實驗目的

 - ◆ Modules for this lab

 - ◆ System structure

- LabVIEW模擬:

 - ◆ BER performance with/without convolutional codes

- USRP實作:

 - ◆ Image transceiver

- 注意事項

基本原理與系統架構

- 基本原理與實驗目的
- 熟悉channel coding實作
- 熟悉資料型態轉換方式(將指定圖檔轉為數位資料)
- 以USRP完成具channel coding通訊系統之傳輸

基本原理與系統架構

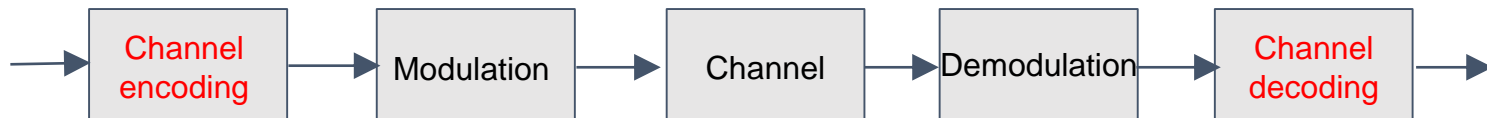
■系統架構

◆一般而言，channel coding 會在 modulation 前加入

◆Rate of channel code

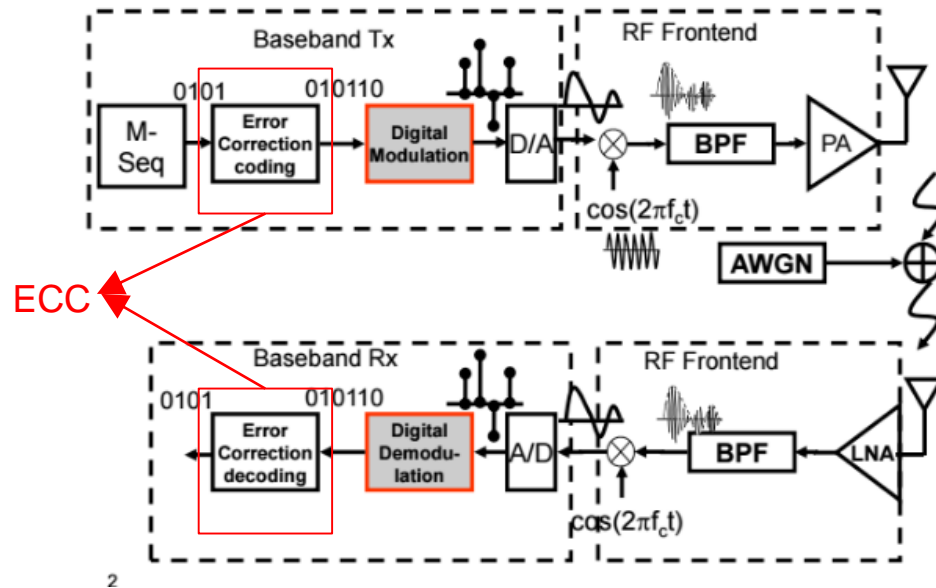
$$Rate = \frac{\text{message bits}}{\text{coded bits}} = \frac{k}{n}$$

◆Channel coding 增加額外的資訊，使通信對通道雜訊具更高之抵抗能力



基本原理與系統架構

■ 系統架構



Convolutional code

■ Memories:

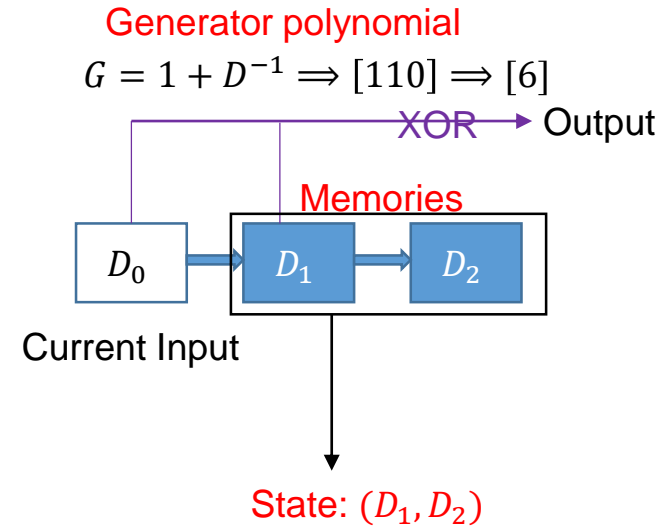
- ◆ Delay of previous input
- ◆ This lab: $L=2,3,4$

■ Generator polynomial:

- ◆ Locations of bits to be “XOR”
- ◆ This lab: up to four outputs

■ State:

- ◆ Residual bits in memories at certain time
- ◆ At most 2^L states



Convolutional code: Encoder

■ For generator polynomial: $g_0 = [1\ 1\ 1]$, $g_1 = [1\ 0\ 1]$

◆ Initial state (0,0)

◆ End state?

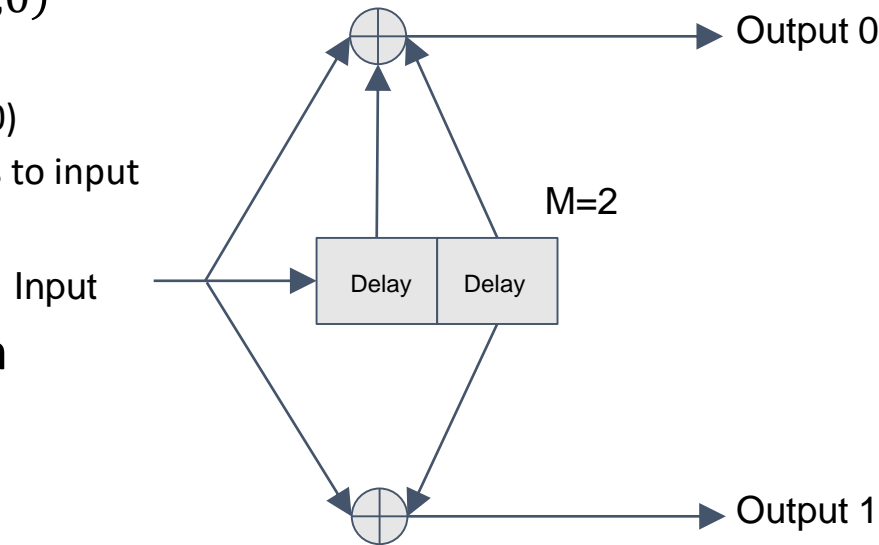
□ Return to (0,0)

□ Append zeros to input

■ Implementation

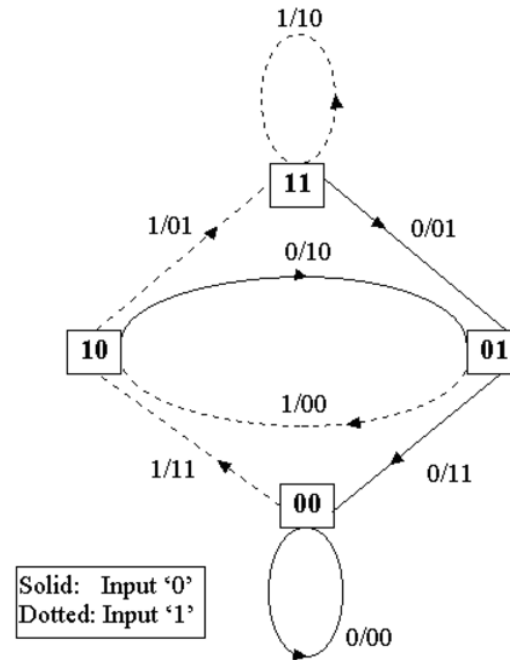
◆ Shift registers

◆ XORs



State diagram

- Relation of inputs and outputs
 - Some state transition are impossible
- State transition will determine the inputs bits and output bits
 - Given an initial state
- Useful to analyze a CC code
- Useful in decoding



Decoding: Trellis diagram

■ Efficient algorithm: Viterbi algorithm

Impossible transition:

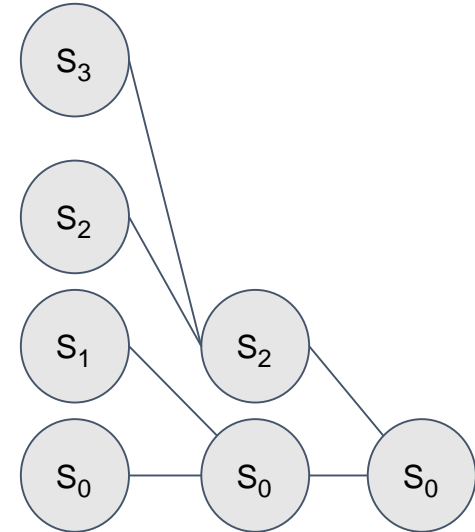
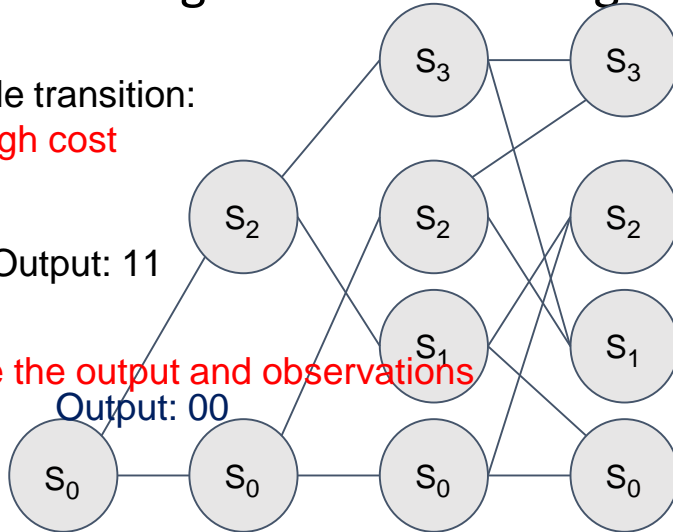
Assign high cost
9999999

Output: 11

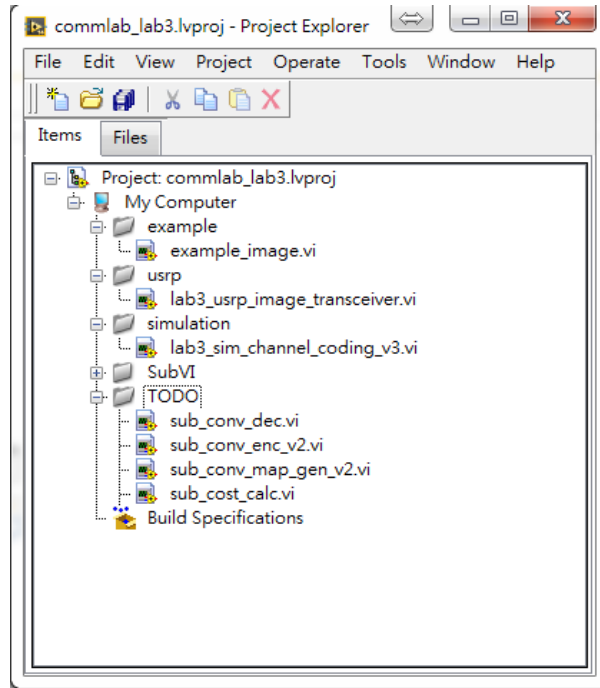
Compare the output and observations

Output: 00

Observations: 00 00 00

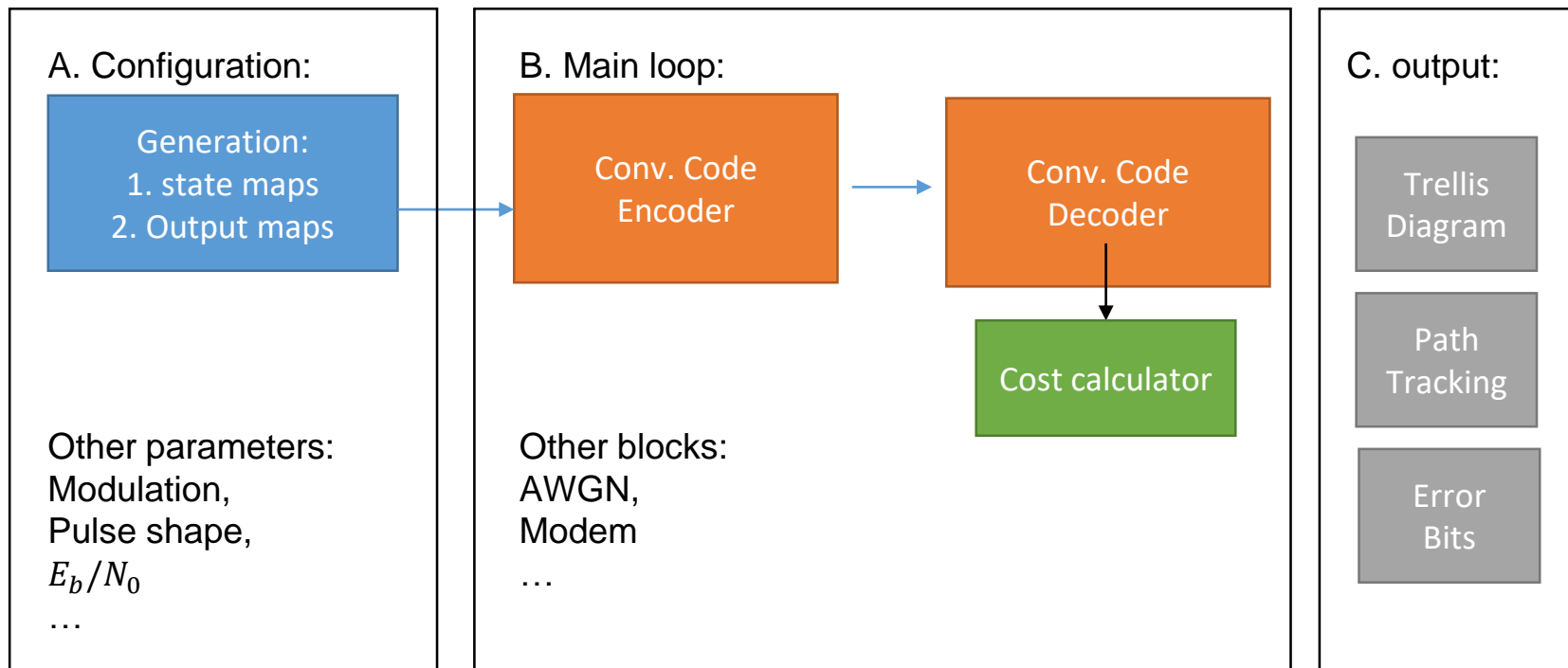


Modules for this lab



- TODO: 4 files in total
- Simulation:
 - All connected
- USRP:
 - Image transceiver
 - All connected
- Example:
 - How to read images in LabVIEW

System structure



LabVIEW 模擬

■ 模擬內容:

◆ 實作3種convolutional code 之encoder與decoder

- Hard-decision: Minimum Hamming distance

- Soft-decision: Minimum Euclidean distance

■ 結果呈現:

◆ 各channel code的BER

◆ 有無使用channel code之BER

◆ 相同rate之Conv. Code

- hard decision 與 soft decision解碼後之BER

USRP 實作

■ 實驗內容:

◆ 圖片傳輸系統

- 沿用Lab1之封包系統，Lab2之modulator and demodulator
- 資料形式改成圖檔(.bmp, .png or .jpg)，以USRP傳輸
- 為封包加上編號，並且能夠即時確認封包接收狀態
- 傳輸系統須加上自己實作之channel encoder, decoder

■ 觀測重點:

- ◆ 比較在高中低SNR與有無使用channel coding的情境下，接收到之圖片品質差異
- ◆ 比較不同的rate在同頻寬下傳輸的速度

實驗問題

■Labview:

1. Correctness of your implementation
 - ❑Decode 50 random bits correctly.
2. BER (理論、模擬) under different decision
 - ❑Code types: [5,7], [13,17], [23,27,33,37]
 - ❑Modulation: QPSK

■USRP:

1. 試著解釋經壓縮之圖片(如jpg)的標頭(header)
2. 觀察不同傳輸功率下，Image的品質(如lab2 請自行實作)
3. 如何量化衡量圖片的品質?

注意事項

■ Due: 05.02 (五) PM 24:00

■ Encoder 部分已經完成[5,7] code 作為範例

■ 本次lab最花時間的部分為convolutional code decoder

- ◆ 建議在實作過程中，觀察Viterbi algo. 之 Trellis方便除錯
- ◆ 請在conv_dec.vi 中右鍵create indicator 來觀察Trellis
- ◆ 請盡早開始進行

■ USRP 之IQ rate(Bandwidth) 請視電腦運算能力調整

- ◆ 建議在2MS/s 以下

Q&A

A large, solid yellow rectangular block is positioned below the 'Q&A' text, spanning most of the width of the slide.