Lab 3 : Coded system

NTU communication laboratory

Spring 17

2017.04.12

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

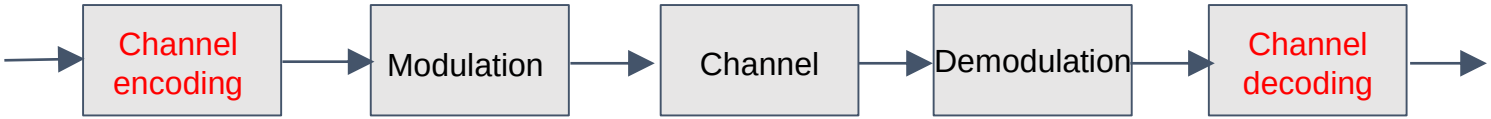
■系統架構

◆一般而言，channel coding 會在modulation前加入

◆Rate of channel code

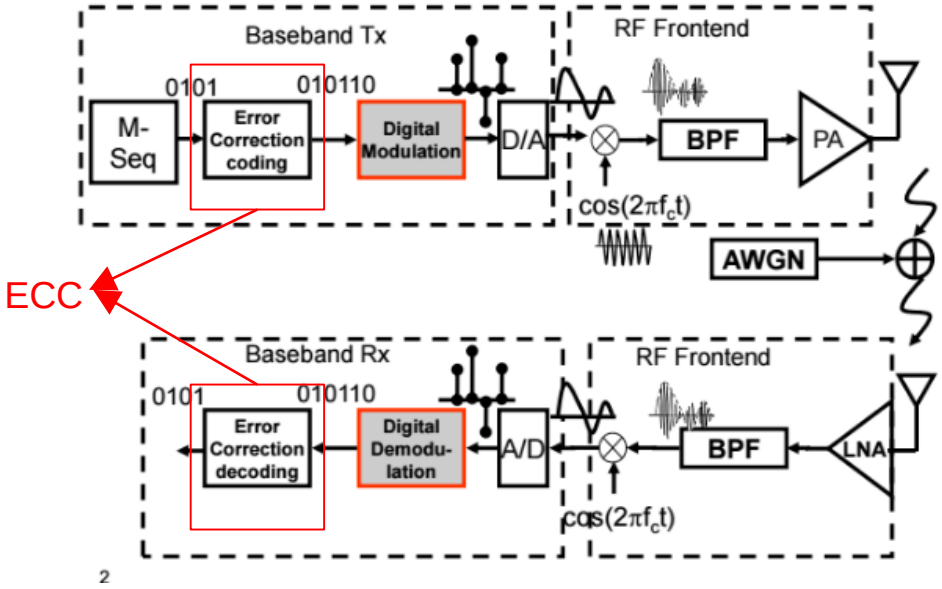
$$Rate = \frac{message\ bits}{coded\ bits} = \frac{k}{n}$$

◆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



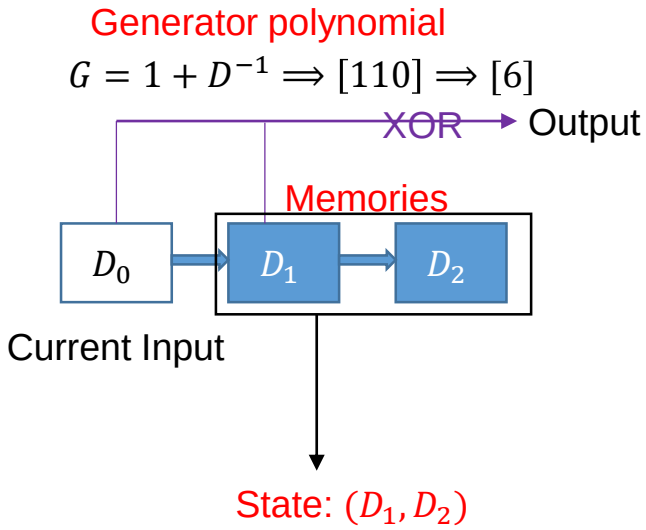
基本原理與系統架構

■系統架構



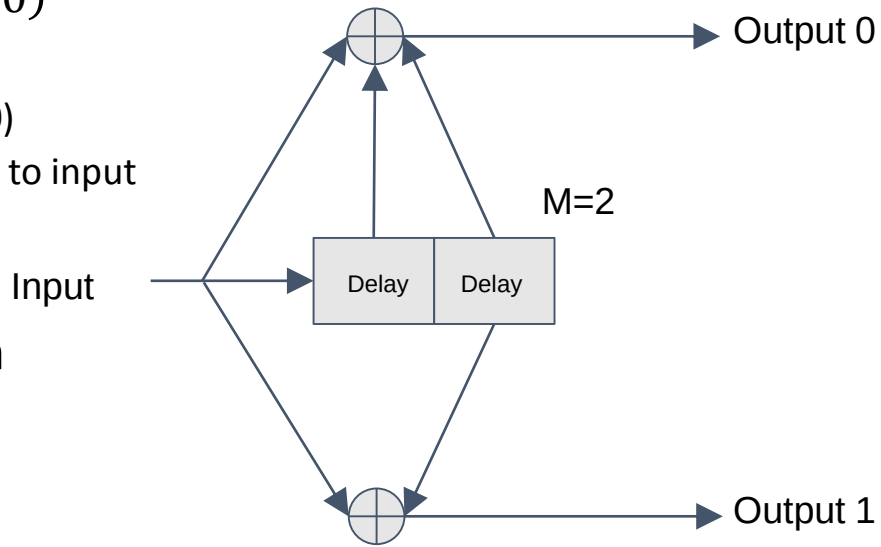
Convolutional code

- 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



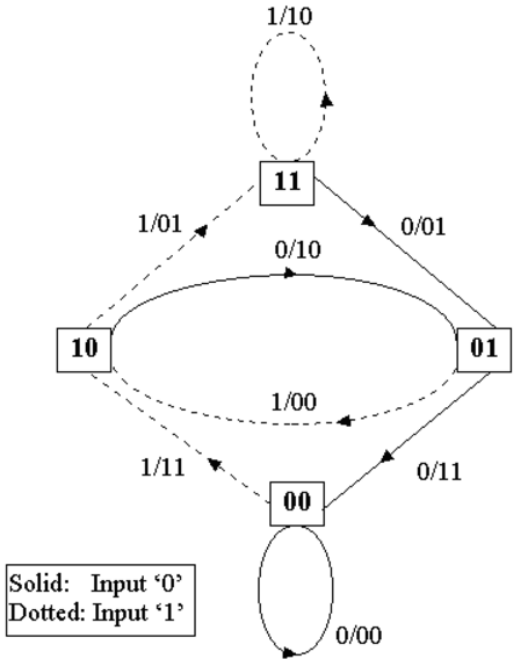
Convolutional code: Encoder

- For generator polynominal: $g_0 = [1\ 1\ 1], g_1 = [1\ 0\ 1]$
  - Initial state $(0,0)$
  - End state?
    - Return to (0,0)
    - Append zeros to input
- Implementation
  - Shift registers
  - XORs



State diagram

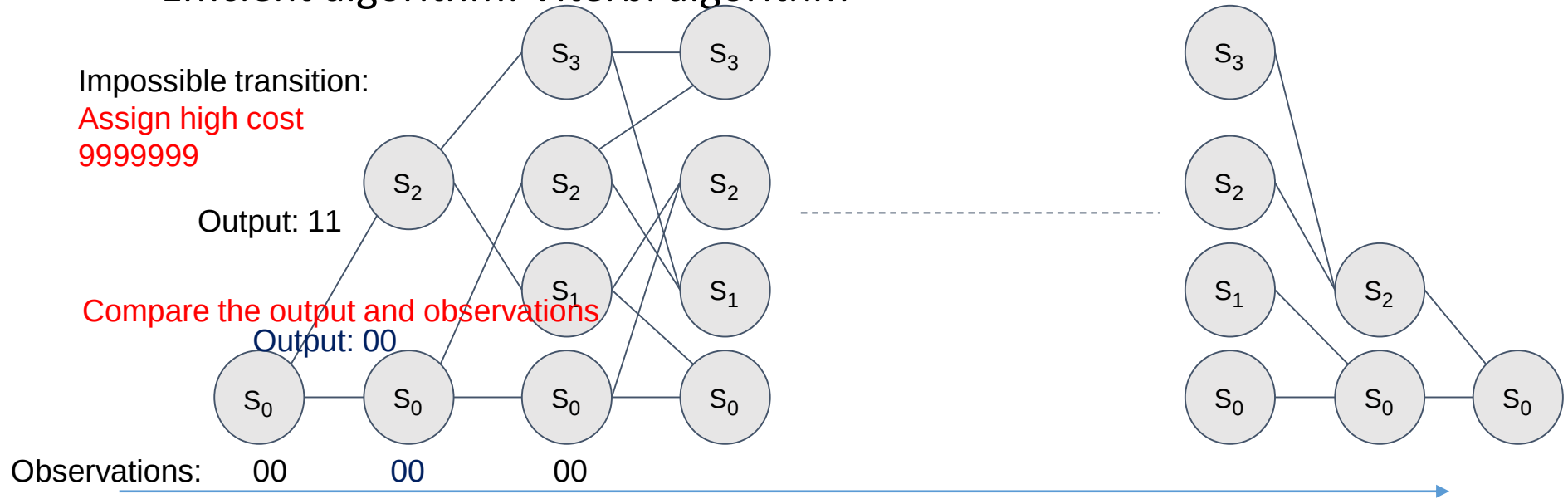
- Relation of inputs and outputs
  - Some state transition are impossible
- State transition will determine the inputs bits and output bits
  - Given an initial state
- Useful to analyze a CC code
- Useful in decoding



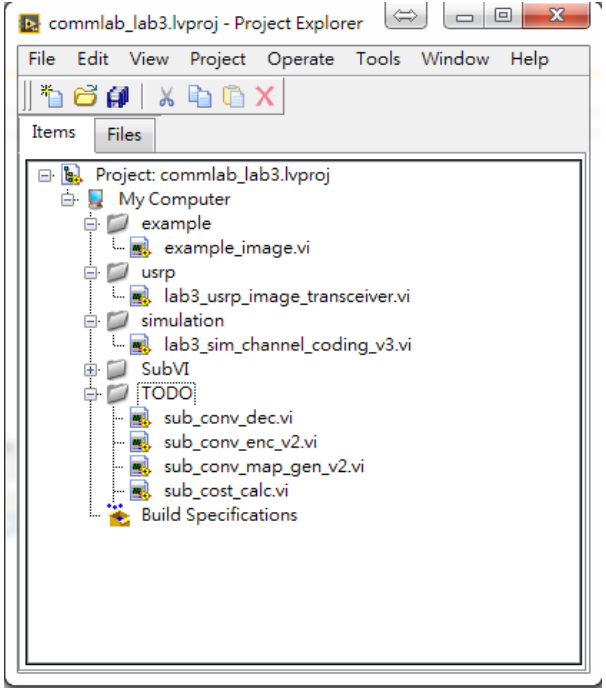
http://www.tdm.uni-oldenburg.de/2004/Material/faltung.htm

Decoding: Trellis diagram

- Efficient algorithm: Viterbi algorithm

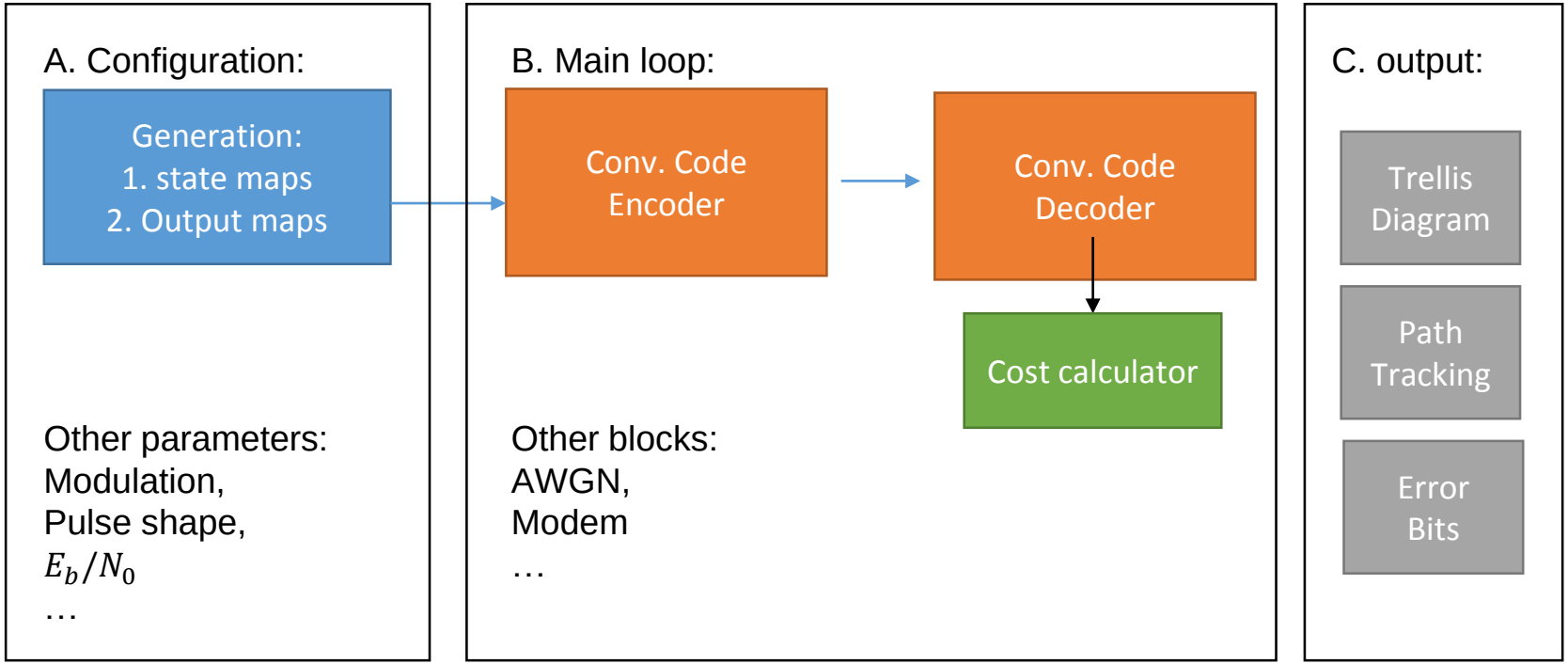


Modules for this lab



- 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: 05.05 (五) PM 9:00
- 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