University of Moratuwa

Department of Electronic and Telecommunication Engineering

EN2054 - Communication Systems and Networks

Assignment 1

Instructions

- This is a group assignment. A group can have a maximum of three students.
- Please submit a single report as a PDF from your group with answers to the following problem. Attach all the codes with comments where necessary.
- Please clearly indicate any assumptions that you make.
- There are 10 marks available for the successful completion of this assignment. All parts carry equal marks.

Problem

The parity check codes used for error detection in most data link control layers (DLCs) today are cyclic redundancy check (CRC) codes. The parity check bits are called the CRC. Cyclic codes are special linear block codes with one extra property. In a cyclic code, if a codeword is cyclically shifted (rotated), the result is another codeword.

(a) You have been asked to develop a CRC encoder and a decoder using Matlab or any other programming language that you prefer. To that end, you need to develop two separate functions, *encode* and *decode*, to handle the encoding and decoding tasks, respectively. The encoder and decoder should be able to handle datawords and divisors with variable lengths.

(b) Given the dataword 101001111 and the divisor 10111, what is the codeword generated by the encoder that you developed in part (a).

(c) Assuming that the codeword generated in part (b) receives at the decoder without any errors, what is the syndrome generated by the decoder that you developed in part (a).

(d) Now assume that the codeword generated in part (b) is transmitted through a binary symmetric channel (BSC) with error probability p. Integrate the BSC between the encoder and decoder that you developed in part (a). p should be a variable.

(e) Transmit the codeword that you generated in part (b) through the BSC with $p = 0.5$. What is the syndrome generated by the decoder that you developed in part (a). Repeat the experiment for 10 times and briefly explain your observations.

(f) Generate 10^4 random 9-bit datawords. Given that the divisor is still 10111, you need to transmit the generated codewords through a BSC with error probability p. Assuming that p changes from 0 to 10^{-1} with 10^{-2} increments (i.e., $p = 0 : 10^{-2} : 10^{-1}$), calculate the average codeword error rate at the decoder for each p. Plot your observations.

(g) Now you need to implement the stop and wait ARQ algorithm using the CRC-8 divisor 100000111. You can assume that the data-field of the 4-byte frame is variable but has a maximum length of 2 bytes, and the sequence/ request number (SN/ RN) of the frame has a length of 1 byte. In the feedback direction, you can assume the same frame characteristics as in the forward direction. The transmission delays in the forward and feedback directions are 25 μs (i.e., $D_{TP} = D_{TA} = 25$ μs) and propagation delay is 15 μs (i.e., $D_P = 15$ μs). You can also assume a reasonable value for the timeout duration of your algorithm.

(h) Now generate 256 random 2-byte datawords. Convert each dataword into a frame by adding the respective SN/RN and CRC. Then transmit the 4-byte frames through the BSC when $p = 10^{-5}$ in the forward direction. In the feedback direction, you can assume the same frame and BSC characteristics as in the forward direction. Using simulations, find the expected number of retransmissions required to successfully transmit a codeword.

(i) Repeat part (h) when $p = 10^{-4}$ and discuss your observations.

(j) Using simulations in parts (h) and (i), calculate the efficiency of the stop and wait ARQ in each case.

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