Green University of Bangladesh

Department of Computer Science and Engineering (CSE)
Semester: (Spring, Year: 2025), B.Sc. in CSE (Day)

Line Encoding and Decoding Simulator

Course Title: Data Communication Lab
Course Code: CSE 312
Section: 231 D1

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Lab Project Status	
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Comments:	**Date:**

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Chapter 1

Introduction

1.1 Overview

The Line Encoding and Decoding Simulator is a C-based tool that demonstrates how binary data is converted into signal formats using various encoding schemes. It supports both encoding and decoding operations through an interactive menu. A MATLAB version is also available for visual representation, making the project ideal for both technical demonstration and academic learning in data communication.

1.2 Motivation

In the field of data communication, line encoding plays a vital role in ensuring that digital data can be effectively transmitted over physical media. While the theoretical understanding of encoding schemes like NRZ-L, NRZ-I, Manchester, AMI, and others is covered in textbooks, many students find it difficult to visualize how binary data is transformed into signal patterns and back. The abstract nature of signal levels, transitions, and synchronization can make it challenging to fully comprehend these concepts through lectures alone.To enhance the educational experience, a MATLAB version was also developed to offer visual representations of signal waveforms. This addition caters to visual learners and adds clarity to the dynamic nature of line encoding, making it especially helpful in classroom environments or presentations. Overall, this project is motivated by a desire to make learning more interactive, engaging, and practical—transforming a foundational topic in data communication into an experience that's both informative and accessible.

1.3 Problem Definition

1.3.1 Problem Statement

In digital communication, transmitting binary data over physical channels requires it to be converted into signal forms that can be interpreted correctly by receiving devices.

This conversion is handled by line encoding schemes, which vary widely in how they represent binary data through voltage levels and transitions. While these techniques are fundamental to understanding data transmission, they are often difficult for students and learners to visualize and grasp from theoretical explanations alone.This project aims to address that gap by developing in C that supports multiple line encoding and decoding schemes. The tool allows users to experiment with real binary inputs and understand how each scheme affects data representation. Additionally, a MATLAB version provides optional signal visualization to enhance conceptual understanding.

1.3.2 Complex Engineering Problem

Table 1.1: Summary of the attributes touched by the mentioned projects

Name of the P Attributess	**Explain how to address**
P1: Depth of knowledge required	Digital Communication Fundamentals, Algorithmic Logic, C Programming, MATLAB for Visualization.
P2: Range of conflicting requirements	The project balanced simplicity with technical complexity, educational clarity with accuracy, efficiency with functionality and text-based graphical visualization.
P3: Depth of analysis required	Encoding and Decoding Logic, Efficiency of Algorithms, Error Detection and Handling.
P4: Familiarity of issues	Encoding Scheme Efficiency, Complexity of Data Decoding, Algorithm Optimization, MATLAB Visualization Issues.
P5: Extent of applicable codes	The project involves coding of various encoding and decoding schemes, menu for user input, implementing signal manipulation algorithms and optionally using MATLAB for visualizing signal waveforms, covering a broad range of programming concepts and techniques.
P6: Extent of stakeholder involvement and conflicting requirements	—-
P7: Interdependence	The project relies on the interdependence of digital communication theory like C programming, encoding/decoding algorithms, MATLAB visualization; where each component's performance is closely tied to the accuracy and efficiency.

1.4 Design Goals/Objectives

1.5 Objectives

The primary objectives of this project are:

- To develop a Line Encoding and Decoding Simulator that supports multiple encoding schemes such as NRZ-L, NRZ-I, Manchester, Differential Manchester, AMI, and Pseudo-Ternary.
- To provide an interactive platform where users can input binary data, encode it into signal patterns, and decode the signals back to the original binary form.
- To demonstrate the differences between various encoding schemes and how they affect data representation, transmission, and error detection.
- To create an educational tool that helps users understand the principles of data communication by visualizing and interacting with encoding/decoding processes.
- To extend the project with MATLAB to provide graphical visualization of encoded signals, enhancing the learning experience and making the concepts easier to grasp.
- To ensure accuracy and correctness in both encoding and decoding processes, with built-in validation to check the integrity of results.

1.6 Application

The Line Encoding and Decoding Simulator has a variety of practical applications, particularly in the fields of data communication. It serves as an educational tool for students to better understand digital communication systems by allowing them to interact with and visualize how different encoding schemes work. By integrating MATLAB for signal visualization, it enhances conceptual learning and helps users grasp the impact of encoding on data transmission. The simulator is also useful for network protocol simulation, digital system design, and troubleshooting communication systems, making it an excellent resource for both students and professionals. Additionally, it can be used to experiment with data integrity and error detection, providing valuable insights into the performance and reliability of different encoding methods in real-world scenarios.