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Line Encoder and Decoder Project Report

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1 Project Details

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Project Link: https://lineencoder.vercel.app/
Code: https://github.com/SF404/Line-Encoder-and-Decoder

2 Introduction

This project focuses on encoding and decoding techniques for both digital and analog signals. Techniques covered include PCM, Delta Modulation, NRZ, NRZL, NRZI, Manchester, Differential Manchester, AMI, B8ZS, and HDB3.

3 Implementation

The project utilizes JavaScript and Chart.js for dynamic signal visualization. Users can input binary streams, select encoding schemes, and visualize real-time results on an updating chart. Analog signal processing includes sine, cosine, triangle, square, and sawtooth waveforms with adjustable sampling rates and quantization.

4 Digital Coding Schemes

4.1 NRZ (Non-Return to Zero)

NRZ encoding represents binary values using two different voltage levels. A high voltage level may represent one, and a low voltage level represents zero.

4.2 NRZ-L (Non-Return to Zero Level)

Similar to NRZ, NRZ-L also uses different voltage levels to represent binary values. The voltage level is constant during the bit period.

4.3 NRZ-I (Non-Return to Zero Inverted)

NRZ-I inverts the signal for each 1 bit, providing better bit transitions and aiding in clock recovery.

4.4 Manchester

Manchester encoding combines phase encoding and amplitude encoding. It ensures a bit transition in the middle of each bit period, facilitating clock recovery.

4.5 Differential Manchester

Differential Manchester encoding ensures transitions at the middle of the bit period. The presence or absence of variations indicates 0 or 1, aiding in synchronization.

4.6 AMI (Alternate Mark Inversion)

AMI encoding alternates between positive and negative voltages, with zero represented by no voltage. It is commonly used in long-distance communication to balance DC components.

4.7 Scrambling: B8ZS

4.8 Scrambling: HDB3

5 Analog Signal Processing

5.1 PCM (Pulse Code Modulation)

PCM digitally represents analog signals by discretizing the amplitude at regular intervals. It quantizes continuous amplitude values into a discrete set of levels.

5.2 DM (Delta Modulation)

Delta Modulation is an analog-to-digital signal conversion method. It encodes the difference between successive samples, simplifying the representation of the signal.

5.3 Sinusoidal Signals

Generate sinusoidal analog signals with adjustable frequency and amplitude. Sinusoidal signals are characterized by their smooth, periodic oscillations.

5.4 Cosine Signals

Generate cosine analog signals with adjustable frequency and amplitude. Cosine signals are similar to sinusoidal signals but have a phase difference.

5.5 Triangle Waves

Produce triangle wave signals with customizable frequency and amplitude. Triangle waves exhibit linear, symmetric rising and falling slopes.

5.6 Square Waves

Create square wave signals with adjustable frequency and amplitude. Square waves alternate between two discrete voltage levels, typically high and low.

5.7 Sawtooth Waves

Generate sawtooth wave signals with customizable frequency and amplitude. Sawtooth waves have a linear rising slope and an abrupt fall back to the baseline.