DIGITAL COMMUNICATION LINK USING PULSE – CODED MODULATION TECHNIQUES

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Universiti Malaysia Sarawak
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To all my loved ones
who has been there
when I needed them most
- Mom, Dad, CYY

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ABSTRACT

Pulse-coded modulation (PCM) technique is very popular in the digital communication field. The general purpose of this project is to introduce the basic concept of using PCM technique in digital communication. In this project, PCM will be used to form an error-free high-speed digital or data communication links, using basic analog to digital converter (ADC) and a digital to analog converter (DAC) circuits. This project will demonstrate the noise immunity of PCM technique while the transmission is converted from parallel data to serial data and serial data back to parallel format. The standard being studied and used in the conversion are the RS-232, RS-422 and Transistor-to-Transistor Logic (TTL). The importance of sampling of the signal according to the Nyquist Sampling Theorem will also be demonstrated.

ABSTRAK

Teknik Pulse-Coded Modulation (PCM) adalah popular dalam bidang komunikasi digital. Tujuan projek ini adalah untuk memperkenalkan kaedah menggunakan PCM dalam komunikasi digital. Dalam projek ini, PCM akan digunakan dalam membina hubungan komunikasi digital atau data dengan kadar kelajuan yang tinggi dan bebas gangguan, dengan litar ringkas menggunakan penukar analog ke digital (ADC) dan penukar digital ke analog (DAC). Kekebalan teknik PCM terhadap gangguan juga dapat ditunjukkan melalui penukaran format data dari format sesiri ke format selari, dan sebaliknya. Piawaian yang dikaji dan diguna dalam projek adalah RS-232, RS-422 dan TTL. Kepentingan mematuhi Hukum Sample Nyquist juga dapat ditunjukkan.

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INTRODUCTION

1.1. Digital Communication

1.1.1. History

Digital communication is defined as the transfer of information as the transfer of information in digital form. An English philosopher, Francis Bacon, developed the earliest recorded concept of over 400 years ago. In 1605, Francis Bacon (1561 - 1626) developed a two-letter alphabet, where he formed a five-letter "words" using the two basic letters. These words can represent the 24 alphabet that was used in the early English alphabet system then (which excludes the letters j and v).

A = a a a a a	H = a a b b b
B = a a a a b	I = a b a a a
C = a a a b a	K = a b a a b
D = a a a b b	L = a b a b a
E = a a b a a	M = a b a b b
F = a a b a b	N = a b b a a

G = a a b b a	O = a b b a b

Figure 1.1 Binary code by Bacon for alphabets

The terminology used today for "words" is codewords and the whole system of the codewords is called a code. For the case above, the code suggested by Bacon is actually a form of binary code since only two basic letters are used.

Other scientists who had pioneered the coding system include John Wilkins (1614 - 1672) and Gottfried Wilhelm Leibniz. Wilkins had developed the M-ary codes where M is equal to 2, 3 or 5 and the code length used is 5, 3 and 2 respectively. Leibniz uses the numbers 0 and 1 to represent the integers, which is also another form of binary code. Thus, the codes by Bacon and Leibniz are basically equivalent.

Integer	Codeword
0	0
1	1
2	10
3	11
4	100
5	101
6	110

7	111
8	1000
.	.
.	.
.	.

Figure 1.2 Binary code by Leibniz for integers

Alphabet Letter	Codeword using Basic Letters Indicated		
	a, b	a, b, c	a, b, c, d, e
A	a a a a a	a a a	a a
B	a a a a b	a a b	a b
.	.	.	.
.	.	.	.
.	.	.	.
L	a b a b a	c b b	c a
M	a b a b b	c b c	c b
.	.	.	.
.	.	.	.
.	.	.	.
Y	b a b b a	b c b	e c
Z	b a b b b	b c c	e d

Figure 1.3 M-ary code by Wilkins

1.1.2. Practical Development

The digital codes proposed by the three scientists began to find its practical use in the telegraph links in the 1800s. In 1838, Samuel F. B. Morse demonstrated a telegraph machine for sending messages rapidly over long distances. The codes used in telegraph links includes the Morse code, using a binary code composed of dots and dash to represent different codewords of variable length, and later Baudot code, which uses the digit 1 and 0 instead of the dots and dashes with a fixed number of 5 digits per codeword. Works by James Clerk Maxwell and Heinrich Hertz later lead to transmission of information by radio telegraph by Marconi in 1897. However, despite having the genesis of digital framework, for about the next 100 years, communication still become predominantly analog in forms of the telephone, radio and television.

The work of Nyquist in the 1920s was perhaps the next major conceptual contribution to the development of digital communications. Nyquist was able to establish the relationship between the available channel bandwidth and the maximum pulse transmission rate that would support zero interpulse interference, which is stated in the famous Nyquist sampling theorem. Today, this theorem is used in most modern digital communication systems.

In 1937 Alec Reeves invented the most important digital techniques that it is still used widely today in transmission and storage of speech, music, visual and telemetry signals. This technique is called Pulse Code Modulation (PCM). PCM basically takes an analog signal, sample it periodically, quantize it to an one of the finite set of discrete amplitude. The amplitudes are technically the same as the codewords encoded by Bacon or Leibniz.