CHAPTER II

PROPOSED IDEA

2.1 The Design Method of the Courseware

The main objective of this thesis is to provide teaching materials for undergraduate student class of real-time laboratory in Chulalongkorn University and National University of Laos. Through the help of this laboratory, students will have a decent opportunity to gain better understanding on certain important theories concerning digital communication.

In this real-time communication laboratory course, undergraduate students are about to experience two parts of experiments composed of using MATLAB to describe the digital communication in the first four topics of teaching, and implementing a simple modem on two TMS320C6711 DSKs in the advance topic. For the first part, we will simulate some important digital communication theories required for the actual implementation of QPSK digital communication system by using MATLAB program. The main topics include signal and linear system, baseband digital transmission, digital transmission through bandlimited channels, and digital transmission via carrier modulation. In the second part, they will be encouraged to become familiar with TMS320C6711 DSK by implementing the basic program such as sine generation, getting the data output to scope, using interrupt or polling to CPU, using codec to be input and output device for real-time implementation, and etc. In the final step, we are going to implement some small block functions of modem system such as input bit generation, digital modulation/demodulation, synchronization, filtering, and etc. In both parts, there will be a step by step analysis for the better understanding of students.

2.2 Topic Selection

The topics used the experiments in this thesis are carefully selected from a wide range of academic work such as research papers, books, and contents of laboratory courseware applied in renowned universities. The experiments are designed in such a way that they would cover all the basic and necessary theories used in undergraduate level.

2.3 The Expected Outcome for Students

The objective of this course is to give students knowledge about hardware, software, and digital communication theory used in TMS320C6711 DSK, which will enable them to have an ability to design their own modem at the end of this class.

2.4 Experiments on MATLAB

2.4.1 Signal and Linear System

This experiment is demo simulation of the basic techniques from linear system analysis used in the analysis part of communication system. Therefore, we will simulate Fourier series of the signal, PN generator and convolution.

2.4.2 Baseband Digital Transmission

This experiment is concerned line code and power spectrum density analysis. The line coding generates transmitted signal to be sent through communication channel from a stream of bit 0 and bit 1.

2.4.3 Digital Transmission through Bandlimited Channels

This experiment concentrates on digital transmission through bandwidth limited channels. We will begin by describing the spectral characteristics of PAM signals. Later, we will consider the characterization of bandlimited channels and the problem of designing signal waveforms for such channels. The main experiment is about pulse shaping.

2.4.4 Digital Transmission via Carrier Modulation

This experiment includes two types of modulation signals that are suitable for bandpass channels: binary phase shift keying (BPSK), and quadrature pahse shift keying (QPSK).

2.5 Experiments on TMS320C6711 DSK

2.5.1 Experiments to Test the DSK Tools

These experiments are very important for becoming familiar with both the software and hardware tools. Undergraduate students have to complete the following simple implementations before proceeding to their experiment in next level.

First, sine generation is one of initial experiments for editing, building a project, accessing the code generation tools, and running a program on the C6711 processor.

Second, the code composer studio (CCS) is able to plot in both time and frequency domains, eye diagrams, and image.

2.5.2 BPSK Transmitter and Receiver with Phase Lock Loop (PLL) on Single Board

This experiment still to be basic for using CCS and DSK but it is more complete system. The BPSK transmitter and receiver simulate on single C6711 DSK for showing controlling the components in the board and describing the digital communication by software and hardware.

Next, we will describe the detail of both parts. First, we have to generate some input bit to feed to the modulation. The PN bit generator is input part of the system. We use 16 shift registers to generate difference 2^{16}-1 binary bits. After that, these bits will be modulated in the BPSK signal for sending to codec, which is the medium in this system to receiver. The system is close loop by using audio cable connect to IN and OUT of codec together for transmitter the signal for transmitter part to receiver part.

The receiver gets the digital signal from (analog to digital converter) ADC of codec part. The information will demodulate from carrier and distinguish between difference the phase of signal to get the answer bit 0 or bit 1 that is sent transmitter. Therefore, the phase lock loop technique is used to determine the correction of bit detection in this system.

2.5.3 QPSK Modem

An advanced experimentation of this thesis is to implement a TMS320C6711 DSKs to be a transmitter for sending analog signal through codec to other DSK, which is implemented as a receiver. The synchronization appears to be the hardest obstacle for the receiving part. Therefore, in this thesis, we aim to use phase lock loop (PLL) to solve this problem.

One of the distinguished features of this thesis is that it employs 2 DSKs; one functions as a transmitter and the other as a receiver. This implementation facilitates the real-time experiments in the laboratory and enables sending the real analog signal from one board to other board. This benefit gives more reliable experiment for teaching in the laboratory and the undergraduate students will gain more knowledge from working on hardware and software. The real-time communication laboratory will become an interesting subject for studying in elective course, which supply better understanding about digital communication system by real practice on real components(see figure 13).

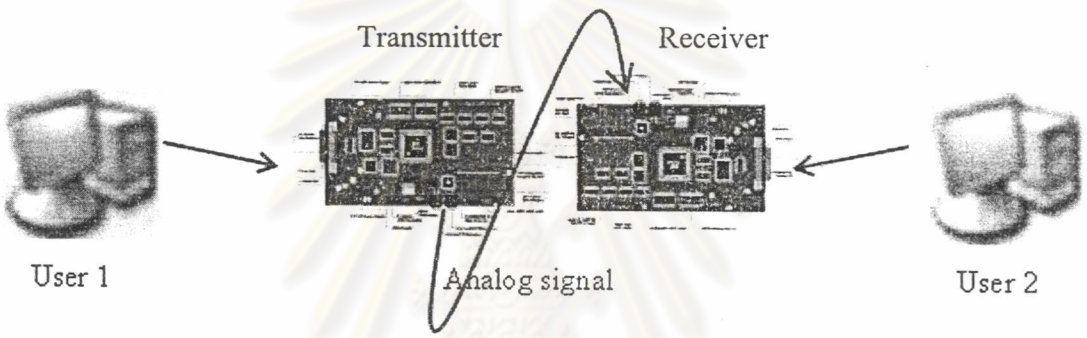

Figure 13 QPSK Modem on C6711 DSKs.

The user 1 uses a PC to control the transmitter (Tx), which consists of PN bit generator as input part, QPSK symbol, QPSK modulation, filtering, and DAC. At the same time, the user 2 also uses the other PC to control the receiver (Rx), which receives an analog signal from the first DSK, and then the ADC converts an analog signal into a digital one. Consequently, digital signal will be demodulated by QPSK demodulator, as well as filtered by receiver filtering and following by timing synchronization which is an significant part for detecting the right constraint bit. The last part of receiver will calculate bit error rate by comparing the differences between the signals from PN bit generators and receiving bits. Finally, the output will be illustrated on monitor of second PC (see in figure 14).

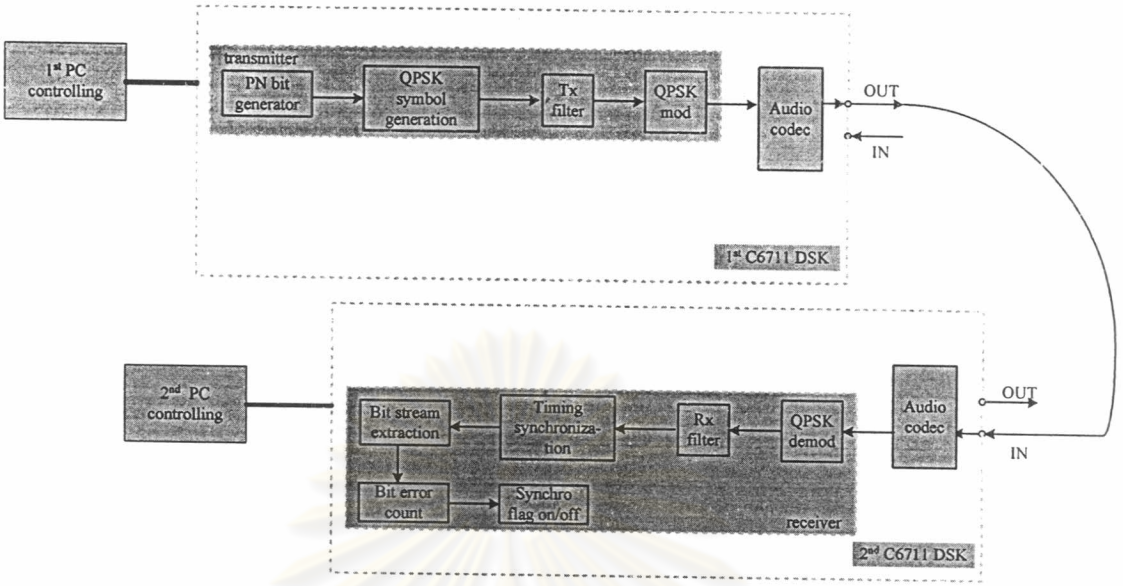

Figure 14 QPSK modem on two DSKs diagram.