Realization of Communication System with Remote Access Using LabView

Harsh Anand, Shravan Cunchala, Debdatta Biswas and Soumyasree Bera

Abstract The aim of the paper is to develop a communication system using LabView (Laboratory Virtual Instrument Engineering Workbench). With the help of remote sensing, any system can be controlled by PC wherever placed without operating the required instruments. The goal is to implement the system in a way which will have minimal cost, and the system is accessible anywhere.

Keywords Transmitter · Receiver · Modulation · Demodulation · BER · Random fading · Multipath delay spread

1 Introduction

When information is exchanged between two points, it is known as communication. A communication system consists of transmitter, transducer, channel, and receiver. The message is transmitted from the transmitter, and it is received at the receiver. A message is transmitted through the channel. This will allow communication from any place across the world using small devices.

The message is originated from the source which can be voice, picture or data. The input transducer helps to convert the message signal to electrical signal which is known as baseband signal. The transmitter is used to convert the baseband signal to channel friendly signal. The baseband signal is transmitted through a medium known as channel. The channel could be a wire, a coaxial cable, an optical fiber, wireless, etc.

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Based on the channel type, communication is of two types: wired communication and wireless communication. The signal is received at the receiver and further processed. The message signal is extracted from the noisy signal. The receiver output is given to the output transducer which converts the electrical signal back to its original form [1, 2].

2 Extraction of Message Bit and BER Calculation

Triggering is another important aspect of communication. Triggering is used to identify the start bit (start of the message signal) and the stop bit (end of the message signal) in the message signal. In the process of triggering a particular trigger level is chosen. It is also used to extract the signal at the receiver side. The triggering level shows the start of the signal. One frame of a signal consists of sync bit (start of signal), training bits, message signal, and sync bit (end of the signal after that there is another frame of message signal). Initially, we know the length and the time duration of the sync and the training bits. So for extraction of the training bit, we add up the time duration of the sync bit and specify the length of the training bits we are able to extract the training bits, and the same process is followed for extraction of message signal [3–5].

3 Modulation

Modulation is an important key in the transmission of message from transmitter to receiver. Modulation is of two types: analog modulation and digital modulation. Modulation techniques should be chosen in such a way that it gives better spectral efficiency also less bit error rate. Higher the number of bit gives good spectral efficiency (transmission of more number of bits within the given bandwidth) but has higher bit error rates Modulation is the process in which the property (amplitude, frequency, and phase) of a signal is varied. Modulation is done to achieve better spectral efficiency, reduction in the height of antenna, avoiding mixing of signals [3, 6].

Some of the digital modulation techniques used are ASK, PSK, FSK, etc. Out of ASK, PSK, and FSK, PSK is the most advantageous to use. ASK is more sensitive to noise, as noise affects the modulation so in ASK the amplitude gets distorted. PSK requires higher bandwidth to transmit the data. PSK overcomes the disadvantages of ASK and FSK. PSK has constant amplitude and frequency. For modulation through PSK, 8 PSK is most widely used. For calculation of bandwidth of message signal, the circuit was designed [7].

4 For Calculation of Bandwidth of Message Signal, Circuit Was Designed

To design the circuit for calculation of the bandwidth of the message signal, the P4 code signal is taken as input which is converted from time domain to frequency domain by taking its fast Fourier transform. After passing through the FFT block, the absolute value of the signal is taken using the abs block and then a unit converter is used for conversion to dB scale, which is attached to a graph indicator which displays the output waveform. Here, the sampling frequency considered is 100 Hz and the code length of P4 is taken as 100.

5 Methodology

5.1 Block Diagram

- Message signal (P4 code) is generated in LabView.
- The message signal is modulated using 8 PSK modulation technique; this step is carried out in LabView.
- The modulated message signal is dumped in hardware for generation. Hardware used for generation of the signal is function generator.
- The generated signal is viewed through digital signal oscilloscope (DSO).
- Signal from DSO is taken back (data acquisition) to LabView for further processing.
- The received signal is demodulated and output is received in LabView (Fig. 1).

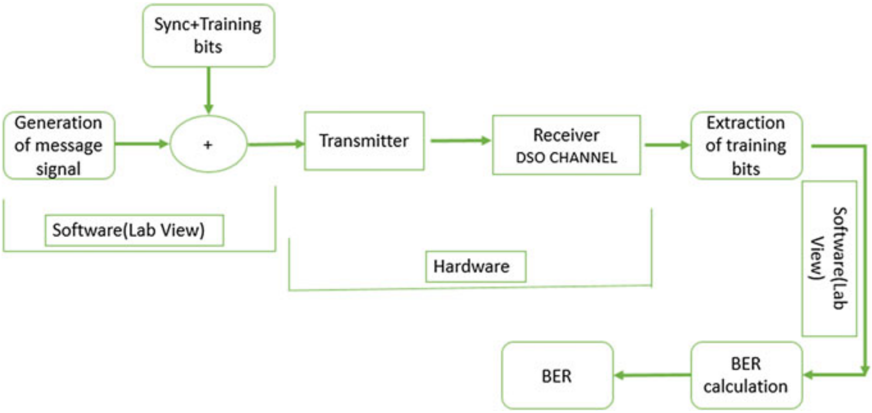

Fig. 1 Block diagram of the proposed system

6 Result Analysis

6.1 Generation and Transmission of Message Signal

While designing a communication system our first task is to establish communication between transmitter and receiver. So for this purpose before transmitting any message signal (Fig. 4), sync bits are appended with the message signal. Doing so the receiver comes to know that data is coming toward it and same sync bit is also present at the receiver so that the receiver should only accept the desired signal and not any other signal. In the system, the sync bit is developed by the developer which is fixed and the message signal is generated by the user which can be varied. If there is any change in the sync bit at the transmitter the same should be informed at the receiver for proper synchronization of the message signal. A message signal directly cannot be used for synchronization because the message signal is not fixed. The sequence of the sync bit is “0101” (Figs. 2, 3, 4 and 5).

6.2 Extraction of Message Signal and BER Calculation

To find the efficiency of the system BER is calculated. Higher the BER, lesser the efficient our system. So for calculating BER along with message and sync bit training bits are appended. At the receiver side, the training bits are extracted, and it is compared with the reference bits which were appended at the receiver side. The extracted training bits and the reference bits are compared and BER of the system is calculated. The sequence of the training bits is “1011” (Fig. 6).

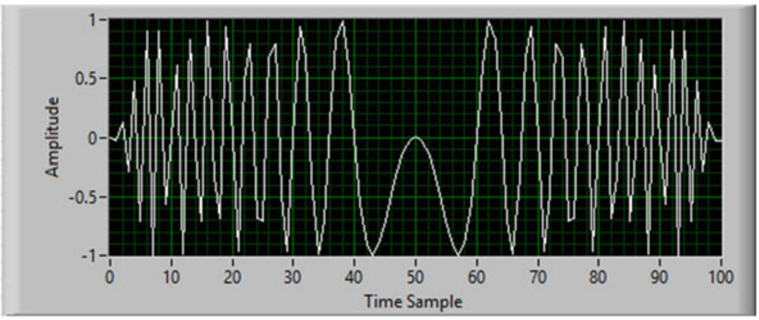

Fig. 2 Transmitted message signal (P4 code)

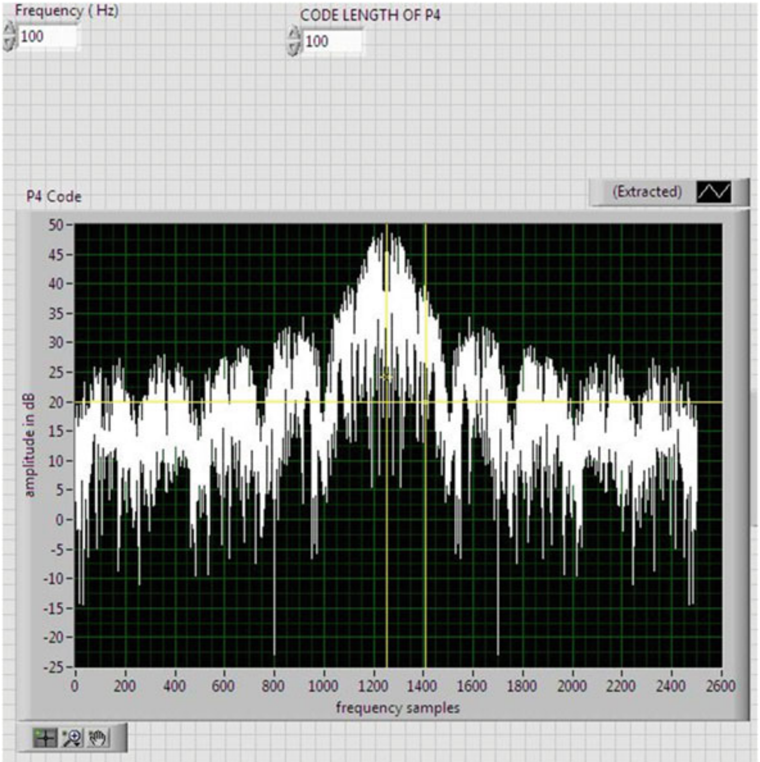

Fig. 3 Spectrum of the message signal

Fig. 4 Transmitted message frame

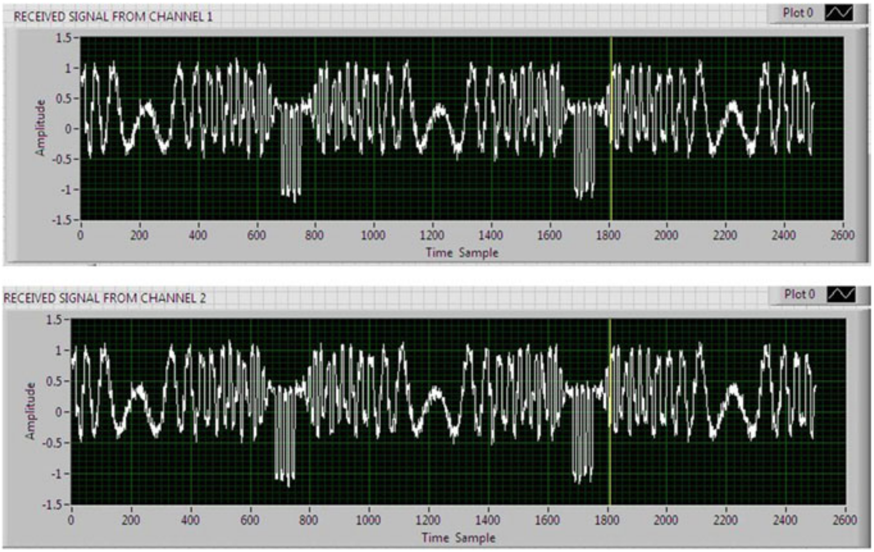

Fig. 5 Received message signal

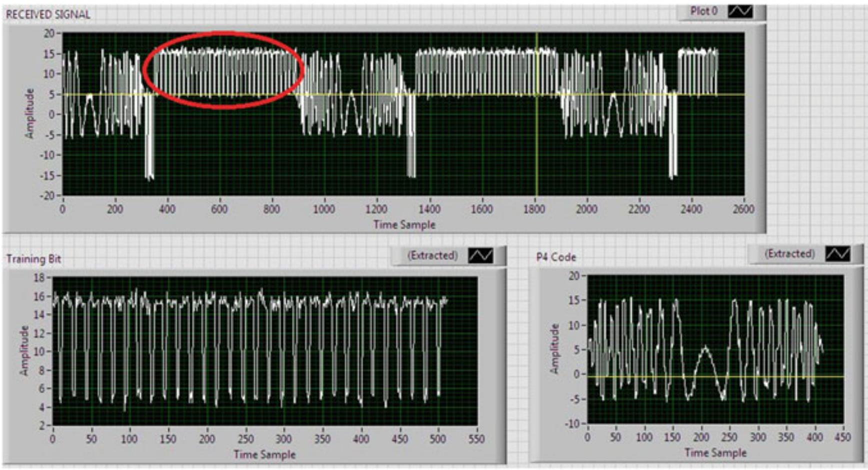

Fig. 6 Extraction of message and training bits from received signal and BER calculation (noise amplitude—0.1 V, BER—0.0110156)

7 Modulation

Figure 7 shows the user input panel. The user giver input to the modulator and gets output from the demodulator.

Figure 8 represents the constellation diagram for 8 PSK modulation. 8 PSK has less bit error rate and also it gives good spectral efficiency. In 8 PSK modulation, 3 bits are transmitted in a symbol. The symbols are mapped to complex sequence. In the demodulator side, the complex sequence is taken as input and the bits are demodulated. PSK overcomes the disadvantages of ASK and FSK. PSK has constant amplitude and frequency.

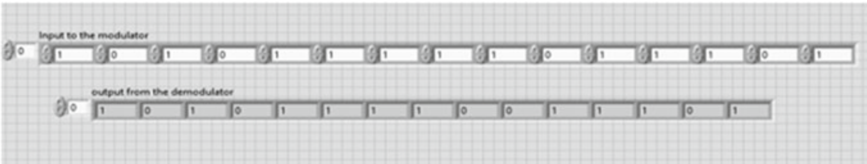

Fig. 7 Input and output of modulator and demodulator

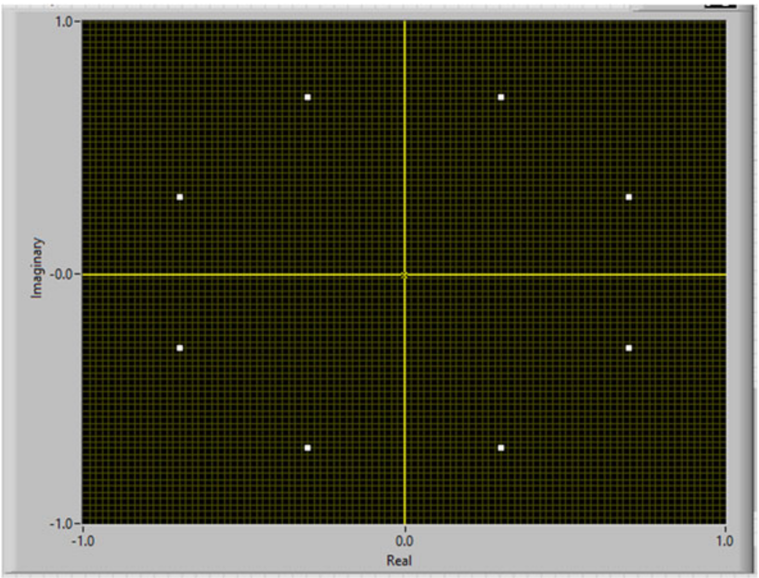

Fig. 8 Constellation diagram for 8 PSK

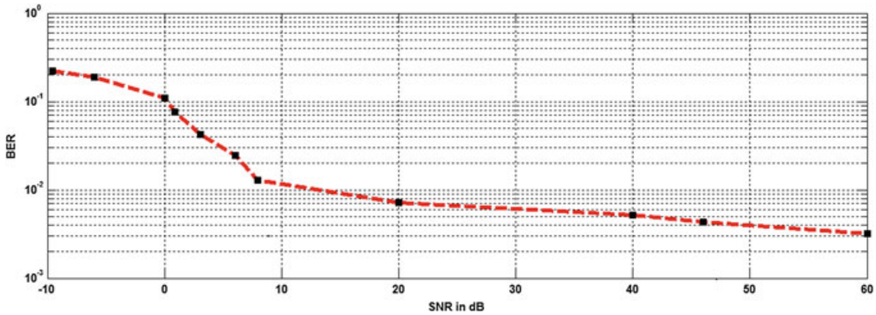

Fig. 9 SNR versus BER plot

7.1 SNR Versus BER Plot

SNR known as signal-to-noise ratio is the ratio of signal power to noise power. It is an important factor for comparing the BER (Bit error rate) of any system using any modulation technique. For the relation between SNR and BER, SNR is inversely proportional to BER, i.e., as the SNR increases, BER decreases for an efficient system. SNR of any system is represented by (Fig. 9)

$$\mathrm{SNR}\,(\mathrm{dB}) = 10\log_{10}\frac{S}{N} \tag{1}$$

where S is signal power and N is noise power.

8 Conclusion

From this paper, it is seen that communication is established between transmitter and receiver. The message signal is generated in LabView. Proper synchronization was observed between transmitter and receiver by the help of sync bit appended with the message signal. The efficiency of the system was observed by calculating the BER, and it observed that the BER was found to be 0.0032 at SNR 60 dB, which shows that the system has good efficiency. From the SNR vs. BER plot, it was observed that SNR is inversely proportional to BER, last but not the least remote access of the communication system was established through PC in LabView.

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