Communications and Network, **2013, 5, 78-80**
doi:10.4236/cn.2013.51B018 Published Online February 2013 (http://www.scirp.org/journal/cn)

Sound Card Based ASK Communication System for Teaching Communication Principle Course

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Received 2012

ABSTRACT

This paper deals with the issue of using the MATLAB tool in teaching the course of communication principles via constructing an Amplitude Shift Keying (ASK) communication system. Different from conventional MATLAB based simulations, the constructed system transmits modulated signals through a wire audio channel by exploiting sound card. Synchronization is required before the received signal being demodulated. Many practical problems should be considered as in real system. The designed system can be extended easily, and not only stimulates students' interest in communication course, but also helps them understanding the principles from system viewpoints.

Keywords: Sound Card; Communication Principles; ASK; Communication System

1. Introduction

Communication principles course is one of basic courses of electronic engineering (EE) related specialties. Communications technology is one of the most rapidly growing technologies in the telecommunications industry. As a kernel course in EE, Communication principles course plays an important role. Many universities [1-7] have established hardware laboratory which can implement all experiments involved in the course. However, to establish such labs is very expensive. With the shortage of supplement, computer aided simulations is an option.

Many Matlab/simulink based simulation program packages for communication principles course are available online. However, some packages consist of many independent script files; it is difficult for students to operate it. And some program packages are designed based on GUI or simulink. We found that these kinds of packages may not work in different computer platform or software versions. Moreover, most of available simulations are based on the ideal environment. Many practical problems, which may be encountered in hardware laboratory or real communication systems, are skipped. In [8], sound card is used in a demo of communication system. However, it is not shared for everyone.

Following the idea of [8], in this paper, we present a MATLAB based Amplitude Shift Keying (ASK) communication system which is realized by transmitting the modulated signal through a wire audio channel by exploiting sound card. Hence, it is different from the software only based simulations. And many practical problems, such as synchronization, may be encountered. In addition, the simple ASK communication system can be extended easily, and will not only stimulate students' interest in communication course, but also help them understanding the principles from system viewpoints.

2. Basic Principle of ASK

This section describes the modulation and demodulation principles of ASK digital signals. Assumed that a binary digital data $a_n = 0$ or 1, $n = 1, 2, \ldots$, need to be transmitted through ASK modulation of carrier frequency f_c. Then, the transmission digital data sequence is given as

$$d(t) = \sum_{n=-\infty}^{\infty} a_n g(t - nT) \tag{1}$$

where $g(t)$ and T are the pulse shape of each transmission digital data and the bit duration, respectively.

When $g(t)$ is trailing rectangular pulse, it is given that

$$g(t) = \begin{cases} 1, & -\frac{T}{2} \le t \le \frac{T}{2} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

The digital data sequence is modulated by multiplying a carrier frequency signal and then transmitted. The transmitted signal is given by

$$s(t) = d(t)\cos(2\pi f_c t) \tag{3}$$

The transmitted signal is contaminated by multi path fading and AWGN, and at the receiver it is received as

$$r(t) = s(t) \otimes h(t) + n(t) \quad (4)$$

where $h(t)$ is the impulse response of the radio channel and $n(t)$ is the receiver noise.

If there is no multi path, the received signal is given by

$$r(t) = s(t) \otimes \delta(t-\tau) + n(t) \quad (5)$$

Without multi path, non-coherent demodulation method can be applied. **Figure 1** shows the ASK signal generation and demodulation scheme.

3. ASK Communication System via Sound Card

In this section, the ASK communication system with MATLAB using sound card is introduced. The digital data is generated randomly, and modulated to a carrier frequency of below 22.05 kHz which is the one a half of the maximum sampling frequency in most sound card. Then the modulated signal is transmitted through sound card, and received also through the same sound card. For example, the random digital data of 10 bits is [1, 1, 1, 1, 0, 1, 0, 1, 0, 1]. The transmitted and received modulated signal with carrier frequency 4 kHz is shown in **Figure 2**.

The received modulated signal is rectifier with a full wave rectifier and filtered with low pass filter. The frequency spectrums of the received signal before and after the full wave rectifier are shown in **Figure 3**.

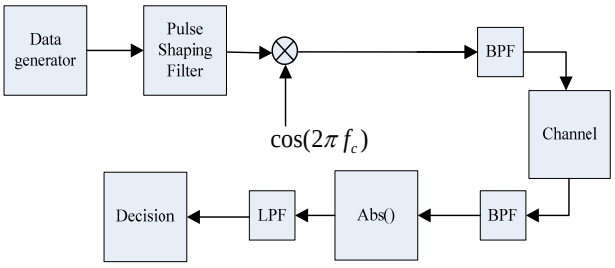
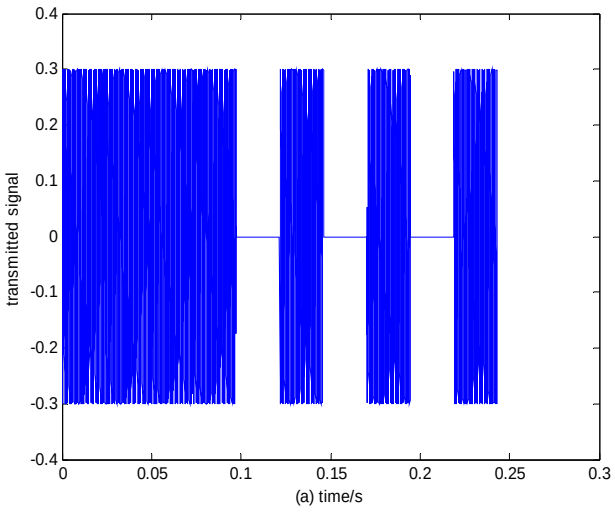


Figure 1. ASK signal generation and demodulation scheme.



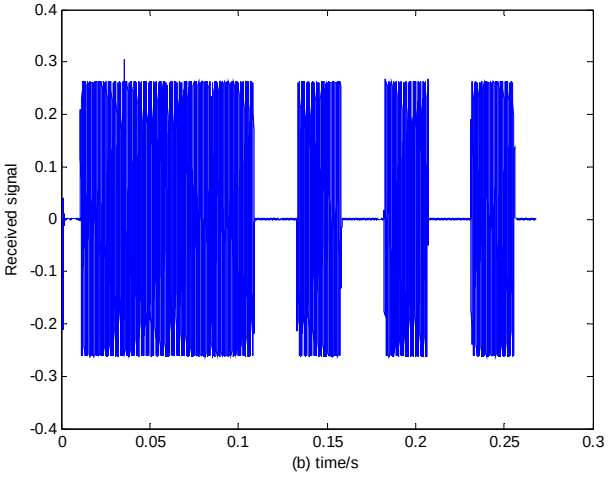


Figure 2. The modulated signal at (a) transmitter and (b) receiver.

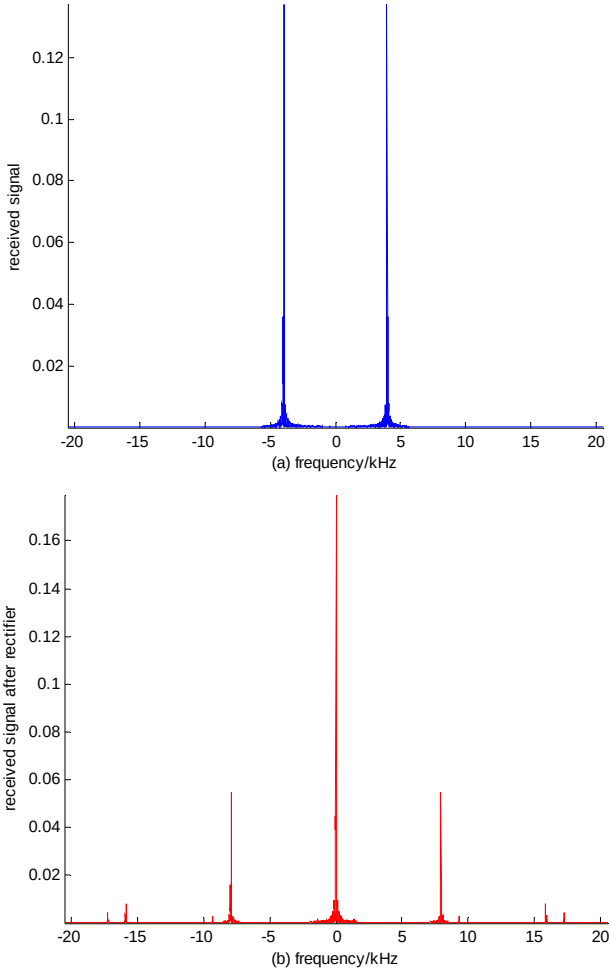


Figure 3. Frequency spectrums of received signal (a) before and (b) after a full wave rectifier.

It is shown in **Figure 3** that the signal after full wave rectifier will cause twofold frequencies. What we need is the direct-current component, which can be obtained via

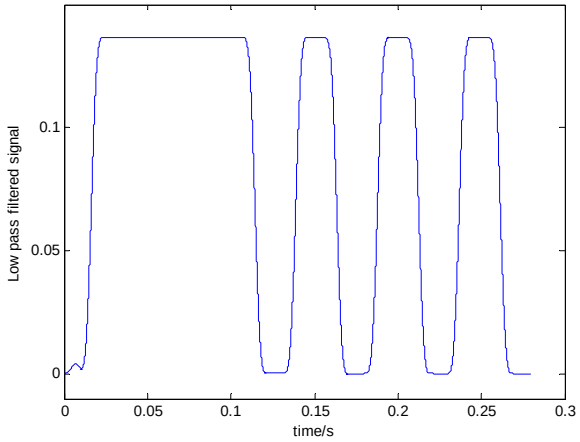


Figure 4. Low pass filtered signal.

low pass filter. The low pass filtered signal is shown in **Figure 4**. The original digital data can be recovered from the low pass filtered signal if we have its bit synchronization.

4. Conclusions

In this paper, we present a novel approach to teach communication principle course by designing a communication system with MATLAB platform via sound card in computer. In the design, many practical problems are encountered. Through this system, the students can perceive and have better understanding the points of principles.

5. Acknowledgements

This work was supported by Ningbo key construction service-oriented professionals (Sfwxzdzy200903).

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