Research on Simulation Teaching of Communication System in Higher Vocational Education Based on MATLAB

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Abstract. With the rapid development of modern computer science and technology, a new generation of visual simulation software MATLAB has been developed. These powerful simulation software make the design and analysis of communication system simulation relatively intuitive and convenient, which also makes the communication system simulation technology get faster development. Through the dynamic simulation environment of MATLAB/Simulink, we can build a digital communication system simulation platform for design and simulation, which fully shows the importance of MATLAB/Simulink in the communication system. This paper mainly analyses the application of MATLAB in communication system simulation. Then this paper analyses the basic principle of DSB signal, the simulation of modulation signal based on M file and the mdl file.

Keywords: Simulation Teaching, Communication System, Higher Vocational Education, MATLAB

1. Introduction

Communication system simulation runs through the whole process of communication system engineering design, which plays an important role in the communication system. Communication system simulation has extensive adaptability and excellent flexibility, which is helpful to study the performance of communication system. Communication system is a system with complex function and structure. Therefore, if we make any changes to the system, such as a parameter setting, a simple structure, etc., this change may affect the performance and stability of the whole system. Therefore, before improving the existing communication system or building a new system, we usually need to model and simulate the system. Through simulation, we can measure the feasibility of the scheme. Then, we can choose the most reasonable system configuration and parameter settings. Finally, we apply it to the actual system. This process is communication system simulation.

In the teaching of communication system, the theoretical knowledge of communication system is very dull and abstract, which is difficult to arouse the interest of Higher Vocational students. It is very
difficult for students to understand the macroscopic characteristics of communication system only through a single theoretical explanation. Therefore, in the teaching of communication system course in Higher Vocational colleges, teachers should try their best to make students feel that the communication system is "visible and touchable" by macro means. Simlink communication simulation module can provide great help to the teaching of communication system. Through module building, parameter adjustment and waveform simulation, students can understand the practical significance of the system macroscopically.

2. Application of MATLAB in communication system simulation

2.1. Basic principle of DSB signal

Bilateral Band Suppression Carrier (DSB-SC) Modulated Signal is referred to as DSB Signal. Its time domain expression is Formula 1. Frequency domain expressions such as formula 2.

\[ S_{DSB}(t) = m(t) = \cos \omega_c t \]  \hspace{1cm} (1)

\[ S_{DSB}(w) = 0.5[M(w - \omega_c) + M(w + \omega_c)] \]  \hspace{1cm} (2)

In the formula, \( m(t) \) is a baseband modulated signal. \( \omega_c \) is the carrier angular frequency. \( M(w) \) is the spectrum of \( m(t) \). \( S_{DSB}(w) \) is the spectrum of \( S_{DSB}(t) \).

The generation and demodulation principle of DSB signal is shown in Fig. 1. Coherent demodulation is used in demodulation.

![Figure 1. Block diagram of DSB modem principle.](image)

2.2. Modulation signal simulation based on M file

According to Formula 1, a direct programmable M file can be used, which will realize part of the DSB signal program as follows.

\[ \begin{align*}
m &= \cos(2 * \pi * f_m * t); \\
c &= \cos(2 * \pi * f_c * t); \\
u &= m * c; \\
[M, m, df1] &= \text{ffitseq}(m, ts, df); \\
M &= M / fs; \\
[U, u, df2] &= \text{fitseq}(u, ts, df);
\end{align*} \]
Running the complete program, the corresponding simulation results can be obtained as shown in figure 2. We can clearly see the time-domain waveforms and spectra of modulated and modulated signals, which are in good agreement with the theoretical results.

![Figure 2](image)

**Figure 2.** Time domain waveform and spectrum of DSB signal generated.

2.3. *Simulink simulation mdl file*

For DSB signals, the system simulation model designed according to Fig. 1 is shown in Fig. 3 (a). By setting parameters, the output of the oscilloscope is shown in Figure 3 (b). We can conclude that the demodulated signal is identical with the original modulated signal except for time delay and amplitude difference.

![Figure 3](image)

**Figure 3.** A simulation model based on DSB demodulation schematic diagram.

3. *Technological process of communication system simulation*

3.1. *Simulation modeling*
Simulation modeling is the process of establishing a simulation model based on an actual communication system. It is a key step in the whole communication system simulation process. The simulation model directly affects the authenticity and reliability of the simulation results. The simulation model is generally a mathematical model. Mathematical models can be classified in many ways, including deterministic model, stochastic model, static model, and dynamic model. The input and output variables of the deterministic model have fixed values. However, in a random model, at least one input variable is random. Static models do not need to consider time-varying factors. The input and output variables of the dynamic model need to consider the time-varying factors. Generally speaking, the communication system model is a stochastic dynamic system.

3.2. Simulation experiment

The simulation experiment is one or a series of tests for the simulation model. In the simulation experiment, it is usually necessary to change the input signal data of the simulation model many times. We need to observe and analyze the response of simulation models to these input signals. In the process of simulation, the input data we use must be representative. We can significantly change the numerical value of the simulation output signal from various angles. In the process of simulation modeling, we need to analyze the problems existing in the actual system. Therefore, we need to translate these problems and objectives into mathematical variables and formulas.

3.3. Simulation analysis

Simulation analysis is the last step in the simulation process of a communication system. In the process of simulation analysis, users have obtained enough information about system performance from the simulation process. But this information is only raw data. Generally, it needs numerical analysis and processing to obtain the scale of system performance, which will give an overall evaluation of the simulation system. The commonly used performance scales include mean, variance, standard deviation, maximum and minimum, which describe the performance of the simulation system from different angles. Charts are the most concise tool for illustration. They are very intuitive. Therefore, the results of simulation analysis are usually plotted as graphs. The simulation tools we use generally have a strong drawing function, which can easily draw various types of charts[3-4].

4. Conclusion

Through Simulink, we can build a communication system simulation experiment platform. The main advantages are as follows. Through the powerful computing function of MATLAB, we can help students establish the concept of the system. Its disadvantage is that the readability and understandability of the simulation interface are slightly poor. Therefore, Simulink simulation is more suitable for communication systems that require more complex mathematical calculations[5-6].

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