BER and Voice Quality Performance for Digital Modulation Schemes Under Periodic OFDM Signal

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Abstract—In this paper, we evaluate a performance of digital modulation schemes under a periodic jamming signal using Universal Software Radio Peripheral (USRP) and Laboratory Virtual Instrument Engineering Workbench (LabVIEW). Digital modulation schemes include Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Minimum Shift Keying (MSK), and Gaussian-Minimum Shift Keying (GMSK). To disturb the wireless communication, we used jamming signal that is periodic OFDM signal and we change the radiation time and period of jamming signal. To analyze performance of schemes, we use metrics such as Bit Error Rate (BER) and Short-Time Objective Intelligibility (STOI) that is a method of measuring the voice quality. As simulation results, it is possible to determine an appropriate modulation scheme according to the channel and jamming environment.

Keywords—Interference signal, Jamming signal, modulation schemes, USRP

I. INTRODUCTION

Recently, jamming signal cause a serious damage to various fields using wireless communications such as base stations (BS), ships and aircraft. There are two ways to minimize and prevent jamming signal. One is analysis of the characteristics of the jamming signal [1] and the other is quickly identified the jamming signal and then remove jamming signal [2, 3]. In [1], analysis of the effects of jamming in the efficiency of data transmissions is required to find an adequate anti-jamming method. However, in [2], modulation scheme are setting only one, and only BER is indicated as an evaluation metric. Also, in [3], various digital modulation schemes were used, but the simulation was performed using only MATLAB.

In this paper, we evaluate a performance of digital modulation schemes under Orthogonal Frequency Division Multiplexing (OFDM) based jamming signal. For digital modulation schemes, we considered PSK, FSK, MSK, and GMSK. We also assumed that jammer radiates periodic OFDM signal to affect a wireless communication system. To evaluate the performance of modulation schemes under jamming environments, we built test-bed platform using USRP and LabVIEW. As performance metrics, we consider BER and STOI that is indicator of voice quality [4]. By this simulation result, it might be useful in the reliability analysis of wireless communication system.

II. SIMULATION ENVIRONMENT

To build a test-bed of wireless communication system for voice service, we use LabVIEW and USRP. It modulates, transmits / receives and demodulates voice data according to various modulation schemes. The distance of the jammer and transmitter from the receiver is 10m and 20m, respectively as shown in Fig. 1. The power of the transmitter and the receiver are fixed at 20dBm. However the power of the jammer is changed from -20dBm to 30dBm.

QPSK, QFSK, MSK and GMSK are used for digital modulation and Pulse Code Modulation (PCM) is used to digitize forms of analg voice data. PCM is a voice codec used to convert an analog signal into a digital signal and consists of a sampling step, quantization step and encoding step. In this simulation, the sampling rate of the analog signal is 8000samples/s, which is converted into a digital signal.

Jammer disturbs the transmitted signal using periodic OFDM signal in the 915MHz center frequency. The OFDM signal radiates one symbol as radiation time, \( T_{\text{rad}} \), and then do not radiate for a certain time. Though each radiation time of jamming signal is different, the total time that affects the wireless communication system is same.

Between the begin of first \( T_{\text{rad}} \) and the begin of next \( T_{\text{rad}} \) is set to period of OFDM jammer, \( T_{\text{period}} \). \( T_{\text{rad}} \) is set to 51.2ms.
jamming to signal ratio increases, BER increases. BER of the each modulation scheme reaches 0.2 the order of 4FSK, QPSK, GMSK and MSK and STOI. Also, if jamming to signal ratio is higher than a certain value, the BER increases sharply.

Figure 3. shows when $T_{rad}$ is 51.2ms or 102.4ms, STOI of each modulation scheme according to jamming to signal ratio. As jamming to signal ratio increases, STOI decreases. The performance of STOI, when $T_{rad}$ is 102.4ms, is better than when $T_{rad}$ is 51.2ms. That is, though the total time of radiation time of the OFDM signal is the same, the result of the STOI value is different according to $T_{rad}$. In case of modulation scheme, MSK, GMSK, QPSK and 4FSK are less affected in that order. BER of the each modulation scheme reaches 0.5 the order of 4FSK, QPSK, GMSK and MSK and STOI reaches 0.5 is the same as the order of BER.

IV. CONCLUSIONS

In this paper, we evaluated the BER performance and voice quality using PSK, FSK, MSK and GMSK schemes under periodic jamming environment. From the result of the simulation, we concluded that MSK is the best modulation scheme for BER and STOI under OFDM sweep jamming. Because OFDM jamming signal affects the power of the transmitted signal and MSK modulation scheme is least affected by power of the signal. Also the performance of BER and STOI, when $T_{rad}$ is 102.4ms, is better than when $T_{rad}$ is 51.2ms. By simulation results, we can select an optimal modulation scheme in a given jamming environment, and it might be useful in the reliability analysis of wireless communication system for voice services.

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