Subjective Evaluation Of Different Error Correction Schemes For Application With A 900 Mhz Frequency Hopper Communication System

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1. INTRODUCTION

Wireless communication systems are required to communicate over selected frequency ranges. Each channel has a limited bandwidth or frequency range in which it must operate and the frequency spectrum is becoming increasingly more congested.

Spread spectrum is a modulation scheme that uses the spectrum efficiently and operates with a minimum amount of interference. In a spread spectrum system, the signals are spread over a wide range of frequencies by using a variety of broadband or frequency hopping techniques. Interference is present and subjectively noticeable in some circumstances with the use of frequency hoppers. The effect of having many users utilizing the same frequency bandwidth promotes a special problem since it becomes possible for one user to jam the signal of another. This creates noise or other user perceived anomalies that considerably degrade the audio quality. Errors, caused by jamming and other sources, can be introduced into the signal from anomalies inherent in the transmit and receive modes of a wireless communication unit transporting digital information. These errors are quantified through the bit error rate (BER). An error can occur in transmission from the receiver to transmitter, from transmitter to receiver or from transmitter to transmitter. The bit error rate (BER) is the probability of an error occurring in a bit, or a change in the transmitted information.

Subjective testing was performed on two types of interference associated with such a frequency hopping system. In this article we analyzed two of the simplest techniques used to correct corrupted data. The first correction method studied, called 'repeating', used the previously sent block of data picked up by the receiver and then repeated it. A second correction method used, called 'muting', simply muted any erroneous data that was picked up by the receiver.

2. EXPERIMENT

Digital speech transmission systems can generate degradation's that involve difficulty in the listening path. These degradation's can be perceived to the end user as clicks, pops, distortion, fuzziness, etc. in the receive listening audio path. Since the listening transmission path is involved. we created a test for subjective listener's. Each test person would listen to the same audio file each time creating a consistent test base. The results from this series of tests helped the designer's choose the best error correction scheme that was available to them. To assist the designers in making the correct decision from the results, a method of assessing the subjective listener's opinions on the various audio samples was used. This technique is called the Mean Opinion Score or MOS method [3]. The speech samples used in the listening tests contained audible errors created by software that simulated conditions where jamming and various levels of BER had occurred.

Test 1 determined the type of correction scheme and the threshold of correction for errors preferred by listeners for corrected jammed signals. The threshold determines the level of correction for errors the software is using. Test 2 threshold levels were based on the results from Test 1. For Test 2, since jamming was of more concern for audio quality, the threshold parameters of Test 1 for jamming were incorporated into several selected BER's. Test 3 is based on the chosen threshold and error correction schemes determined from Tests 1 and 2. Test 3 determined when the audio quality would degrade for jamming as the numbers of users increased. It compared two different scenarios that might occur in a jamming situation. The listeners evaluated the audio quality when the jams occurred as users interfered with each other at the same time or when the interference occurred at different times.

3. RESULTS AND DISCUSSIONS

3.1 Test 1

In this project, jamming contributes to the quality of the audio signal to a greater degree than does BER, meaning, if a signal is jammed, it is much more noticeable to a listener than the BER factor. Therefore, Test 1 was performed to find out whether jamming using a correction scheme called muting or using the repeating method of a previous block was preferable. The listeners would find which threshold level was most acceptable using the DCR MOS subjective test method. From Test 1 it appears from Figure 4 (shown on the next page) that Thresholds 1, 2 and 3 have the highest DCR MOS scoring.

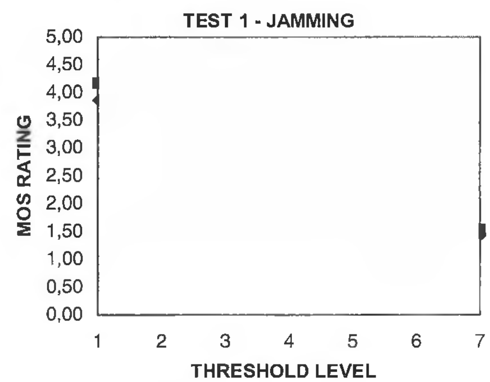

Figure 4 Test 1. Jamming from Threshold's 1 to 7.

3.2 Test 2

Test 2 will use the chosen threshold value and error correction scheme from Test 1 with the selected bit error rates. Since jamming and the BER can only be corrected with one chosen threshold, the need to see how the parameters chosen from Test 1 for jamming compared to the selected BER's became apparent. This became the testing performed for Test 2.

Testing was accomplished by comparing a speech sample that was corrected to the original uncorrected speech sample. All of the samples were corrected using the muting correction method at Threshold's 1, 2 and 3 chosen from Test 1. The threshold test values were so close in Test 1, you cannot really say that a threshold of 2 is completely superior, so 3 threshold's were chosen.