**Lab 5: 802.11a Image Transmission and Reception**

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| **Introduction(SYH)**  In this lab,  **Theoretical analysis**   1. **Introduction to functions(SYH)** 2. **ResizeImage.m** 3. **createPSDU.m** 4. **createTxWaveform.m** 5. **createAWGNChannel.m** 6. **ReceiverProc.m** 7. **reBuildImage.m** 8. **L-STF sequences in Non-HT format(ZXD)** 9. **Generating formulas**   L-STF, means L-STF(short training field), whose function including detection of packet arrival, coarse time synchronization, coarse frequency offset estimation and adaptive gain control. The formula is  Where   1. **Composition of sequences**   The frame structure of L-STF is    The first six subframes is used for energy detection and the last four subframes is used for coarse frequency offset correction. The total time of L-STF is     1. **Generation process of sequences**   The MATLAB code of generating the L-STF sequence is as below:    Firstly, a sequence of virtual subcarriers whose length is 11 is created. Then is inserted between the sixth element and the seventh element of virtual subcarriers to construct short preamble slot frequency. After that, do inverse Fourier transform for short preamble slot frequency to get short preamble slot time. Finally, take the first 16 elements of short preamble slot time and copy them for 10 times to obtain L-STF sequence by multiplying the copied sequence by 20.     1. **L-LTF sequences in Non-HT format(ZXD)** 2. **Generating formulas**   L-LTF, means L-LTF(long training field), whose function is channel estimation, fine time synchronization and fine frequency offset estimation. The formula is  Where   1. **Composition of sequences**   The frame stucture of L-LTF is    L-LTF consists of three parts, including cyclic prefix, OFDM symbol 1 and OFDM symbol 2. The duration of cyclic prefix is , which make convolution cyclic convolution. Cyclic prefix is the second half of OFDM symbol. The duration of OFDM symbol 1 and OFDM symbol 2 is and the second half of OFDM symbol 1 can ba treated as the cyclic prefix of OFDM symbol 2.     1. **Generation process of sequences**   The AMTLAB code of generating L-LTF sequence is as below:    The process of generating L-LTF sequence is similar to that of generating L-STF. Firstly, a sequence of virtual subcarriers whose length is 11 is created. Then L\_k is inserted between the sixth element and the seventh element of virtual subcarriers to construct long preamble slot frequency. After that, do inverse Fourier transform for long preamble slot frequency to get long preamble slot time. Finally, take the second half of long preamble slot time as cyclic prefix and concatenated with two long preamble slot time to obtain L-LTF sequence by multiplying the concatenated sequence by 10.   1. **L-** **SIG sequences in Non-HT format(ZXD)**   L-SIG consists of 24 bits, which includes the rate, length, parity check and tail. The formula for generating L-SIG sequence is  The frame structure of L-SIG is    The rate, which contains 4 bits, represents modulation and coding scheme. Different sequences of bits represents different modulation and coding schemes. The relationship between the two is as follows.    The length field represents length of the PSDU in octets in the range of 1 to 4095. The P field represents parity check.  **Lab results & Analysis**   1. **Method of generating training sequence of Non-HT format PPDU(SYH)** 2. **Using wlanWaveformGenerator** 3. **Using createSTF(S\_k) and createLTF(L\_k)** 4. **Verification of waveform consistency** 5. **receiverProc function signal processing flowchart(ZXD)**   The signal processing flow chart of **receiveProc** function is as below    First, information contained in PSDU should be obtained, including L-STF, L-LTF and L-SIG. The processing is done using **wlanFieldIndices** function. This function returns a structure, ind, containing the start and stop indices of the individual component fields that comprise the PPDU, given a format configuration object. It only supports generation of field indices for OFDM modulation. If **field** is specified, the function returns **ind** as a 1-by-2 vector consisting of the start and stop indices of the PPDU field.  The second step is to downsample received signal and generate FCS for MPDU. After that, computation of EVM and receive loop processing is to be done.  In the process of receive loop processing, the first step is to packet detect and adjust packet offset. Then the Non-HT domain is extracted to perform coarse frequency offset correction using **wlanCoarseCFOEstimate** function. This function returns a coarse estimate of the carrier frequency offset (CFO) given received time-domain L-STF samples and channel bandwidth. After that, symbol timing synchronization is performed.  Immediately after symbol timing synshronization, fine frequency offset correction is performed using **wlanFineCFOEstimate** function. This function returns a fine estimate of the carrier frequency offset (CFO) given received time-domain L-LTF samples **rxSig** and channel bandwidth **cbw**.  Then, using L-LTF to do channel estimation by using **wlanLLTFDemodulate** function and **wlanLLTFChannelEstimate** function. The **wlanLLTFDemodulate** function returns the demodulated L-LTF waveform given time-domain input signal **x** and channel bandwidth **cbw**. The **wlanLLTFChannelEstimate** function returns the channel estimate given channel bandwidth cbw. The channel bandwidth can be used instead of the configuration object. After doing channel estimation, noise estimation is performed.  Besides, L-SIG field is recovered using **wlanLSIGRecover** function. The **wlanLSIGRecover** function returns the recovered L-SIG information bits, **recBits** and the status of a validity check, **failCheck**, given the time-domain L-SIG waveform, **rxSig**. Specify the channel estimate, **chEst**, the noise variance estimate, **noiseVarEst**, and the channel bandwidth, **cbw**.  After that, parameters of packets is recovered and the whole packet is corrected using CFO.  What’s more, the bit sequence of PSDU is recovered with the result of channel estimation by using **wlanNonHTDataRecover** function. The **wlanNonHTDataRecover** function returns the recovered **Non-HT-Data field** bits and the equalized symbols, **eqSym**, given received signal **rxSig**, channel estimate data **chEst**, noise variance estimate **noiseVarEst**, and wlanNonHTConfig object **cfg**.  Finally, FCS is removed from the head field of MAC and update the index of searching. When duplicated packet is detected, the processing ends.   1. **Validation under AWGN channel model(SYH)** 2. **Validation under HiperLan/2 channel model(ZXD)** | |
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