ECE 734

Final Project Proposal

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Methods of modulation and demodulation in OFDM system: implement and analysis for BER performance, hardware performance, and hardware complexity

by

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Abstract

The structure and algorithm of IDFT DFT, the conventional method used in modulation/demodulation process in OFDM system, has matured today. Researchers have developed new transforms in an effort to replace this traditional structure, such as DHT-based structure (Discrete Hartley Transform) and DWT-based (Discrete Wavelet Transform) structure. In this project, all three structures will be implemented in MATLAB to acquire their BER (Bit Error Rate) performances, and the results will be compared and analyzed along with other two aspects, hardware performance and hardware complexity to gain a complete view of their advantages and disadvantages.

Background and Prior Work

In OFDM system, IDFT DFT hardware in the transceiver is conventionally designed jointly to carry out IDFT and DFT functions for transmission and receiving processes, respectively. To date, the development of IDFT DFT structure and algorithm used in the modulation/demodulation process has reached its maturity. In the last few decades, researchers have proposed several alternative transforms to replace IDFT DFT, such as DHT (Discrete Hartley Transform) IDHT (Inverse Discrete Hartley Transform) and DWT (Discrete Wavelet Transform) IDWT (Inverse Discrete Wavelet Transform). Past research has individually compared one of the many transforms to the DFT-based structure on one or two of the performance aspects, such as BER performance, hardware performance, or hardware complexity. For example, the DHT-based structure in research [1] generates similar BER performance and lower complexity. A DWT-based structure in research [2] shows better BER performance under certain conditions. A lot of effort [3] [4] [5] was put into implementing the hardware to lower the complexity or increase the operating speed.

Motivation and Goal

As indicated in the background research review, researchers in the field of OFDM system have compared DHT-based and DWT-based

structure to DFT-based structure on either the BER performance or the hardware performance and complexity. However, I have not found research that offers an exhaustive comparison among all three structures with their respective BER performance, hardware performance, and hardware complexity. I believe by running a synthesized analysis with all three structures on all the aspects will give us more complete information and will provide a useful direction for future research to invest their research time and money.

Approach

1. Implement all three different structures in OFDM system using MATLAB to obtain their BER performance.
2. Analyze and compare the advantages and disadvantages of using each structure on their BER performance
3. Construct exhaustive comparison of hardware performance and complexity with data/outcome acquired from my own implementation and referenced research.
4. In the future, when time and ability permits, implement all three structures in Verilog to generate data on hardware performance and complexity to make an even more authentic analysis of all the transforms.

Tasks

1. 4/12 – 4/18
   Study the OFDM system and understand logics behind using different algorithms to replace the original one (DFT IDFT).
2. 4/19 – 4/25
   Write MATLAB code to implement these three algorithms in OFDM system.
3. 4/26 – 5/2
   Synthesize and analyze all data acquired; prepare comparison table and charts for in-class presentation.
4. 5/3 – 5/12
   Complete final report with feedback from the presentation.

Expected Results

I expect to find the structure, if any, which generates the best result (higher BER performance, higher hardware performance, and lower hardware complexity). If the results are not clear or cannot be judged by such comparison, I will explain the benefits and trade-offs in using one of them. All the concepts used in this project will be elaborated in the final report.

References

1. C. L. Wang and C. H. Chang, “A novel DHT-based FFT IFFT Processor for ADSL transceivers,” in Proc. 1999 IEEE Int. Symp. Circuits Syst., Orlando, FL, May 30 - June 2, 1999, pp. 51-55.

2. K. Abdullah and Z. M. Hussain, “Studies on DWT-OFDM and FFT-OFDM Systems”, SMIEEE, 2009

3. Y. Jung, H. Yoon, and J. Kim, “New efficient FFT algorithm and pipeline implementation results for OFDM/DMT applications,” Consumer Electronics, IEEE Trans., vol. 49, no. 1, pp. 14 - 20, Feb. 2003

4. D. F. Chiper and V. Munteanu, “A new design approach to VLSI parallel implementation of discrete Hartley transform”, Volume 1, 17-20 June 1996 Page(s):207 - 212 vol.1 Digital Object Identifier 10.1109/ ISIE. 1996.548420

5. Lung-Hee Suk, Dae-Won Kim, Taek-Won Kwon, Suk-Kun Hyung, Jun-rim Choi, “A 8192 complex point FFT/IFFT for COFDM modulation scheme in DVB-T system,” Proceedings of IEEE International SOC Conference 2003, pp. 131-134, Sept. 2003.

6. Lihong Jia, Yonghong Ciao, Jouni Isoaho, Hannu Tenhunen, “A new VLSI-oriented FFT algorithm and implementation,” Proceedings of ASIC 1998, pp. 337-341, Sept. 1998.