

ECE 429/529: Digital Signal Processing

§ Course Details

Choose a digital signal processing topic, implement an algorithm or hardware system, and then write a report. You are encouraged to be creative in forming a topic to study. But your project must be distinct from your thesis/dissertation project and distinct from your term projects for other courses. Of course, an easy project will have less potential for a good grade than a more complex topic will. The term project report will be due on the date specified in the syllabus. The project report must represent your own work. Any portions of text taken from elsewhere must be within quotation marks and properly attributed to the original author. The project may be one of the following:

- **Algorithm implementation.** Choose one or more published digital signal processing algorithms or techniques to implement in software. The project must include algorithms beyond the ones discussed in class. If you want to implement your own new algorithm, then you will need to include a performance analysis showing how your algorithm compares to published algorithms. The project report should include a brief summary of the theoretical foundations relevant to the project, a description of the algorithm, a description of the user interface and data file format used, a well-documented software listing, graphs of example signals, and quantitative results demonstrating the performance of the algorithm. One effective approach is to implement and compare two algorithms so that you can assess the relative performance. Vary each parameter (e.g., window size, sigma, and any thresholds) individually, and provide tables and/or graphs to show how the performance is affected. A fancy GUI is not required. You must clearly identify which portions of the algorithm you implemented yourself, and which portions were obtained elsewhere. For example, did you write your own FFT code, or did you just call an existing function? Popular programming languages for digital signal processing are C/C++, Python, and MATLAB. Qualities that make a good algorithm implementation include the following: a detailed written discussion of the practical considerations in translating the theory into working code; a concise, well-organized, and easy-to-read programming style in which the final code is easy to relate to the written description; several examples of the results of the algorithm; a discussion of possible shortcomings of the algorithm and the program; a thorough quantitative performance analysis; and a discussion of possible improvements that could be made. Explain the steps you have taken to make sure that your code works, especially if it doesn't. Discuss any bugs that may still remain.
- **Hardware implementation.** This is only for students with the appropriate experience in hardware design, implementation, and troubleshooting. Credit or co-registration for a course such as ECE 372A is very strongly recommended for those who wish to attempt a hardware project. Do not attempt a hardware project unless you have the appropriate experience and have access to adequate resources. Typical projects may involve interfacing ADCs, DACs, and/or DSP microprocessors to a digital computer. The project must be designed so that it can be completed by the due date. The written report should include a brief summary of the theoretical foundations relevant to the

project, a detailed description of the hardware design and any related software, several examples illustrating the use of the system, and quantitative results demonstrating the performance of the system. Qualities of a good hardware implementation include the following: efficient design, neat construction, complete and readable circuit diagrams, thorough documentation, and a thorough quantitative performance analysis. Also, demonstrate the working system – e.g., by including a brief video with the written report. Explain the steps you have taken to make sure that the system works, especially if it doesn't. Discuss any bugs that may still remain.

§ Project Proposal

To initiate the term project, you must submit a one-page project proposal. The proposal should include the following items:

- A description of the proposed project.
- The major references that will be used (books, journal articles, conference articles, web pages, etc.) including all the publication details such as date, page numbers, etc.
- The resources that will be required. i.e., will you need any special computing or hardware resources, or any special types of data? If so, where will you obtain them?
- Which portions do you plan to implement yourself, and which portions will you obtain elsewhere?
- Which programming language will you use?
- How will you test your program? Which quantitative measures will you use to determine the performance?

§ Project Ideas

LMS & RLS algorithms for adaptive noise cancellation, channel equalization, etc. Adaptive filtering for stock market prediction. Acoustic fingerprinting of music for content-based retrieval. Autotuning of speech/music signals for automatic pitch correction (time-scale modification, multi-rate signal processing). Simple speech recognition. Advanced filter design (e.g., IIR filters with phase constraints and/or using optimization techniques). Steganography, watermarking, data hiding, etc.