Analysis of Extracting Vocals from Music under Four Different Methods

Abstract—Signal Processing is prevalent across different platforms. Its application ranges from scientific fields, such as medicine, to entrainment. In particular, the field of vocal extraction is becoming relevant. Therefore, this paper examines four different methods in terms of extraction performance, technicality, and fine-tuning.

Replicating Acoustic Spaces Using Approximate Models of Convolution Reverb

Abstract—In the world of digital audio effects, the convolution reverb serves as a mechanism to manufacture sounds to resemble being played in a certain acoustic setting. Simulation of reverb is most accessible through systematic designs that implement finite and infinite impulse responses through a series of filters, thus integrating delays and gains in encompassing transfer functions. In this study, a dataset of impulse responses of rooms in the Computer Music Center was aggregated and analyzed to test generalized and original reverb models. Through a series of sampling techniques, correlational observations, and error approximations, computational models of reverb were thoroughly explored, depicting strong potential for the ability to replicate acoustic spaces through digital signal processing

Modeling of Digital Guitar Effects Rig

Abstract—In this report we present the design and modeling of a guitar effects rig audio plugin using Digital Signal Processing techniques in MATLAB. Various sigmoid functions were used to model the distortion effect and the results were compared to commercially available digital distortion effect. Furthermore, tone control used in a typical guitar pre-amps was modeled using IIR filters, and complex frequency response of guitar speaker cabinet was modeled using impulse response and convolution. The sound quality and usability of our final plugin was evaluated by processing real time dry guitar signal and comparing them with other commercially available plugins.

Music Genre Classification using Mel Spectrograms and Deep Convolutional Neural Networks

Abstract—Audio signals are some of the most widely used signals in our daily life. They are also the ideal signals to apply our course material to since they are one dimensional and time-dependent. In our course project, we preprocessed sound signals from a dataset with songs of labeled genres. We then generated a mel spectrogram for each sound clip using Short Time Fourier Transform (STFT) to localize the frequency response and visualize the song data. Lastly, we implemented a music genre classification system based on a convolutional neural network. Our system classifies ten music genres with 33% accuracy.

Understanding Functional Neuroimaging with Ultrasound

Abstract—Functional ultrasound imaging (fUSI) is a recent development in brain imaging techniques. fUSI has the potential to be able to image blood flow through the vascular tissue surrounding the brain, to the ends of understanding responses to stimuli in vertebrates [5]. We applied the fUSI technique to images of the brain of a mouse acquired during electrical stimulation of the hindlimb from our lab [1]. We use singular value decomposition (SVD) filtering [3] [2] to produce images of the hemodynamic activity in the brain and attempt to validate the efficacy of our signal processing by correlating the hemodynamic changes with the electrical stimulus.

Image Denoising

Abstract - This project focuses on digital signal processing image denoising. We will explore 4 different filter techniques and their performance for different types of noise reduction to learn about their advantage and trade-off in image processing.
We will also explore Wavelet Transformation and Histogram Equalization in a later category, all useful techniques to image enhancement

Masked Face Dataset Generation and Masked Face Recognition

Graph Cut Algorithm and Texture Synthesis

Optimal statistical filtering of noisy data using Wiener filter

Abstract—This project demonstrates that the Wiener filter can be used for estimation of random noisy signals in cases where the signal is wide spread stationary. An optimal FIR filter was implemented to estimate three different input signals which were compared to the corresponding target signals to evaluate the performance of the estimation. The first part of the work was to check whether the noise corrupted signal is widespread stationary or not and then apply the statistical filtering method for estimating the signal. Good matches between the input and target signals were achieved in both time and frequency domain. However, the most interesting result appeared when an attempt was made to implement this type of filter in random voice recordings that do not satisfy the wide-spread stationary condition. The results of this implementation showed that the Wiener filter approximated efficiently our initial signal, even when it was not wide-spread stationary.

Pitch Detection

Abstract—In this project, we explore fundamental pitch detection via spectral analysis and autocorrelation. Specifically, we implement the YIN algorithm using both direct convolution and convolution via the Fast Fourier Transform (FFT).

ELECTROCARDIOGRAM SIGNAL PROCESSING

OCT Image Denoising

Smoothing Filters for OCT Images

DeCoR: Learning New Sound Features with Delayed Codebook Regularizer

Taal: An Experimental Analysis of Beat Detection Techniques

Audio Denoising by the ICA Algorithm

Abstract—The audio denoising design is accomplished by python. A mixed source of human voice and rambling subway noise is collected. After adding random noises to the original sound track, Independent Component Analysis is applied to the mixed source. Human voice and subway noise are successfully separated.
Keywords—denoising, ICA

Removal of Watermarks and Unwanted Elements in Photos

Abstract—The removal of watermarks or unwanted characters on a photo would require a multi-step process of color detection, masking, and image inpainting. This project describes such a process conceptualized and performed through MATLAB. The program was executed using different photos with different types of opaque watermarks. Throughout the process, parameters such as watermark selection shape, number of quantized colors and dilation were varied so as to determine which would provide the best result. Resulting inpainted photos show that the algorithm works best for any kind of opaque watermarks.

Curve fitting based on an image of a plot

Abstract—Manufacturers usually provide data that are shown using a plot, to give a quick and clear idea about how their product works and performs. However, these data may be needed to feed a model or a tool, in which case it is necessary to extract the data presented in a plot. The processing of plots showing a linear curve and axes using cross-correlation is addressed in this project

Tumor Segmentation by K-Means Clustering and Edge Detection

Guitar Effects Simulation

Abstract— Amplifiers have been used for a number of years by musicians to achieve various effects on their instrument's main tone.
However, amplifiers and other effects are not always the most practical solution to achieving the desired output due to a variety of reasons
like cost and the space they take. This is where digital signal processing for audio signals comes into picture. In this project, we have
proposed two methods of processing sound capture from an electric guitar. The first method involves the use of an audio interface to capture
the sound, whereas the second method discards this. The output obtained from these methods is then compared against an established
simulation software to test their performance. The audio obtained from these methods is also compared against each other to see if the
second method has potential. Future extensions of this work are also discussed

Denoise Audio Using Short Time Fourier Transform

Abstract—Short-Time Fourier Transform (STFT) is a type of Fourier transform and signal analysis tool that has various uses in audio sampling. This experiment is testing one of the well-known applications of STFT, by using it to denoise different input audio files. We use STFT and spectral subtraction to filter out the noise spectrum from the original signal. Further noise reduction is done by adding a median filter over the spectral subtraction result, to get the denoised output signal. Audio processing and

Fourier transforms and data plotting are all coded in Python. The purpose of the experiment was to test the efficacy of this denoising technique, and the overall results proved relatively successful in removing noise from the three different input audio files tested.

Highway Car Detection

Musical Key Detection Algorithm Using Krumhansl-Schmuckler algorithm

Abstract—By using the Krumhansl-Schmuckler algorithm, we built a key detection algorithm in Python to help with classification, retrieval, and further music analysis

Student ID Card Identification Algorithm Based on Image Recognition

Abstract—This project provides a specified image processing algorithm on MATLAB that can detect and recognize Columbia University students' ID cards. The algorithm is used for template character generation, card locating, character segmentation, and character recognition. Simulation result for one student card's information extraction is demonstrated.

Low-light image enhancement method based on exposure fusion framework

Abstract—In this project, we focused on some real life signal processing problems of low-light image enhancement. We applied traditional low-light enhancement techniques to process images, and implement a new technique based on the improvement of the traditional ones, then compare the enhancement result from each technique

Camera Shake Removal with Deconvolution Filter

Abstract—In this project, we develop a motion deblurring method based on the Wiener filter. The goal of the method is to restore a blurry image that has been degraded by camera shake or other types of motion blur. To estimate the blur kernel, we employ a motion detection algorithm that uses the gradient of the image and the properties of the blur to infer the direction and extent of the blur. We then use this estimated blur kernel to design a Wiener filter, which is a type of linear filter that can be used to deblur images by removing the blurring effect while preserving the details of the original image. The developed method is evaluated using a metric-peak signal-to-noise ratio (PSNR). The experimental results show that the developed method can effectively deblur images with motion blur and achieve high performance in terms of both objective and subjective measures of image quality. Overall, this project demonstrates the effectiveness of the Wiener filter for motion deblurring and provides a promising solution for restoring blurry images degraded by motion blur

Photography Blurring Control

Abstract— In the world of photography, what makes a crisp portrait image is a subject and a great depth of field. The depth of field is the range of the scene that appears focused on an image. Essentially is the 'bokeh" (blur in the background in portrait photography). But described in a previous study, the problem with conventional cameras is that they are limited by two factors: depth of field (DOF) and the signal-to-noise ratio (SNR). The SNR is the ratio of appropriate to irrelevant information in an interface. For a dark scene, the aperture must be widely open to maintain SNR, which conversely, causes DOF to reduce. For SNR to be maintained light must be high (lower aperture) to output a clearer photo. No matter what you choose, the objects that are not in focus will be blurred. In this report, we introduce a method to deblur certain objects in a photo using a given point spread function (PSF).

Motion Blur

Depth-based 3D Imaging