Pitch Shifting With C++

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Honors CS315

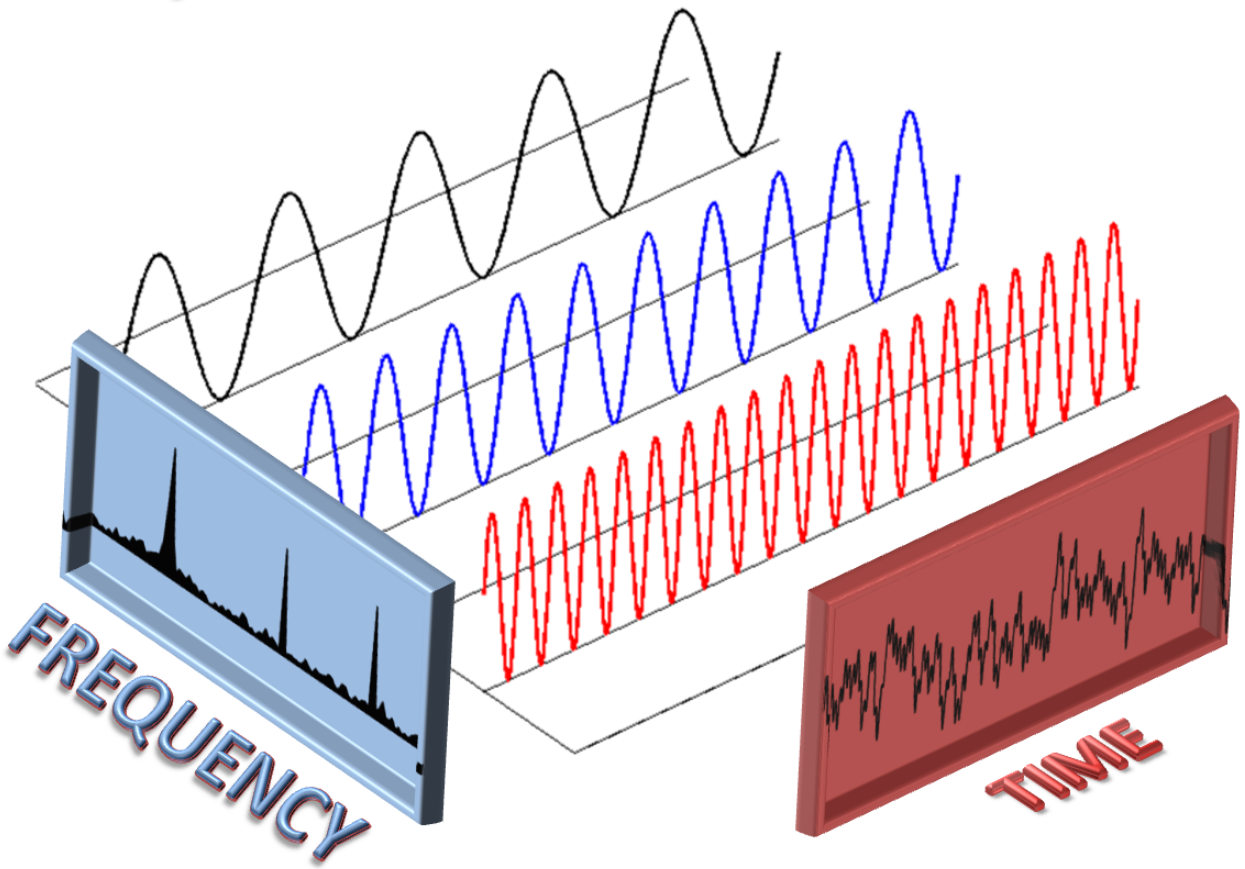
12/12/2017

Abstract

- Pitch shifting requires transforming time domain data into the frequency domain
- Data is then pitch shifted with processing
- Data is moved back to the time domain
- The program conveniently handles .wav files, a common audio format

Problem Statement

- Practice music and want to pitch shift
- Wanted easy pitch shifting without Audacity
- How does it work? This can't be done with a single FFT, but requires many over small chunks of data
- This is very useful to me, and would be very useful to many musicians



http://people.csail.mit.edu/haitham/Pictures/sFFT.png

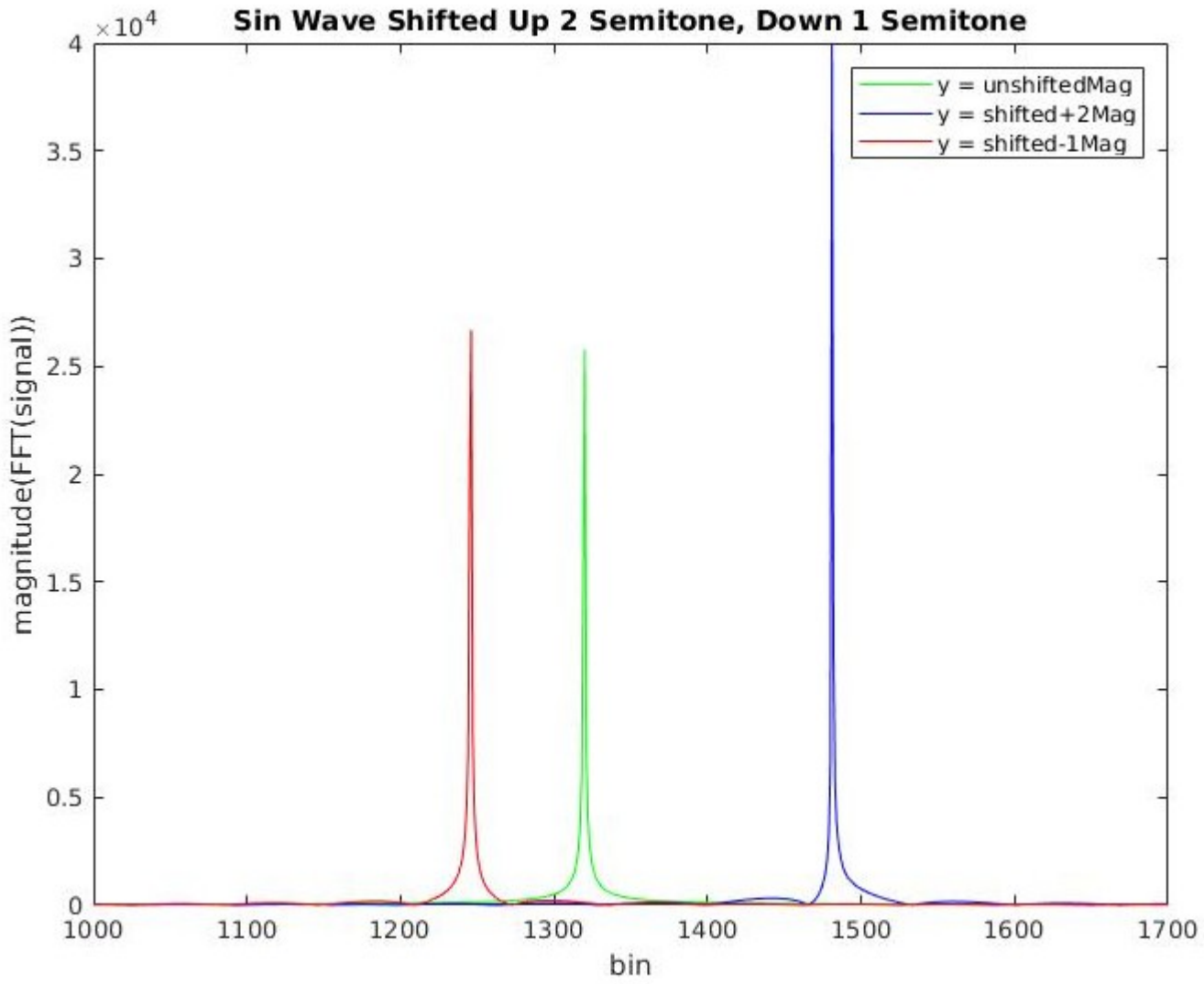
Why Is it Important?

- Audio and music professionals use pitch shifting all the time.
  - Autotune
  - Synthesizer Vocoders
  - Anonymity (warped voices)
  - Enhancement
- For me to pitch shift a recording without this tool, it takes around 15 to 20 clicks in Audacity and I still have to wait for it to render. This takes three words on the command line and works very simply.

Examples

Here, a simple sine wave was shifted down one key and up two. It is clear that the dominating frequency has been shifted as I intended.

-What causes the amplitude jump?



Solution

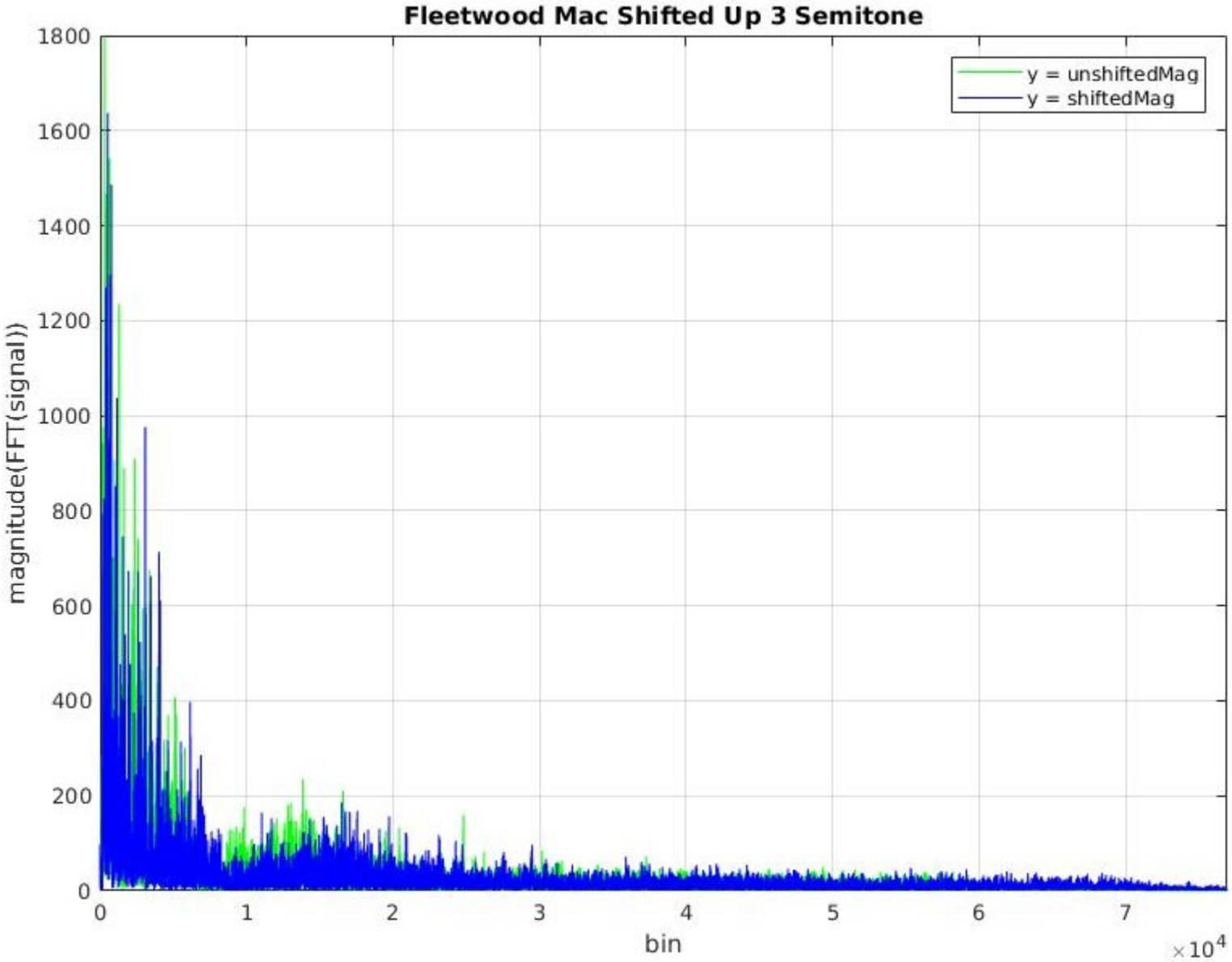
1. Load .wav data using File IO into an array
2. Pass the array to the pitch shifting algorithm
3. Use frames to analyze small pieces of the data such that the wave will look to have a constant frequency inside of that frame
4. Pitch shift the frame by the constant multiplier
5. Pitch shift *all* the frames
6. Write data with File IO to new .wav file and free memory

Complexity

- If this used a Discrete Fourier Transform instead, complexity would be $\vartheta(n^2)$.
- This algorithm uses the Fast Fourier Transform (Cooley-Tukey algorithm) which reduces complexity to $\vartheta(\frac{N}{2} log_2(n))$ by taking advantage of the symmetry of the Discrete Fourier Transform.

Fleetwood

Example: Clip from "Second Hand News" by Fleetwood Mac shifted up 3 semitones. Notice the frequency shift.



What's Next?

- Test performance vs. the Sigpack FFT algorithm
- Make a GUI for layman use
- Add ability to give it an entire file, but only shift part of it and output it to a new file