

# Auto Accompaniment System



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2010005697  
융합전자공학부  
김지훈

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# 1. Motivation

- Inconvenience of practicing musical instrument with an accompaniment file

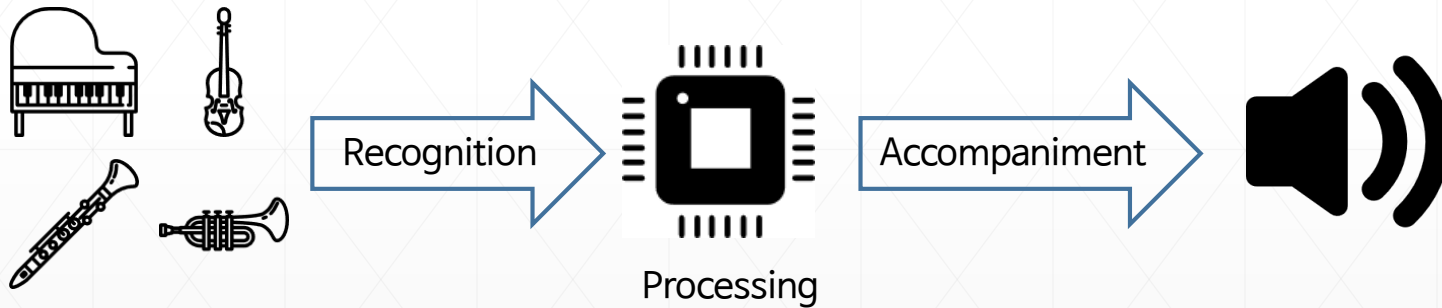


mp3, mp4, wav, flac ...



## 2. Goal

- Automatic process for playing musical accompaniment.
  - Automatic position finding and playing
  - Easy repetition



### 3. Issues

#### Time Synchronization

- Desired time cannot be searched automatically

#### Repeating Process

- Repeating should be done in manual way by a player

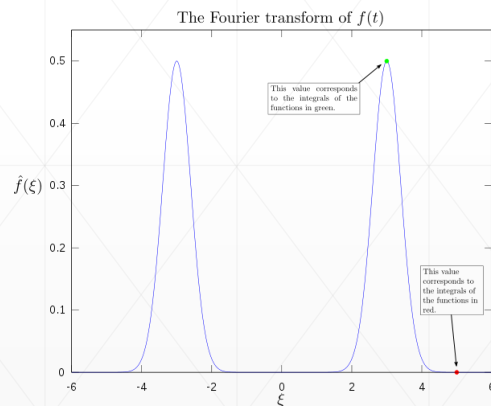
## 4. Fundamental Concepts

- Constant Q Transform
- Chromagram
- Autocorrelation

# Constant Q Transform (CQFT)

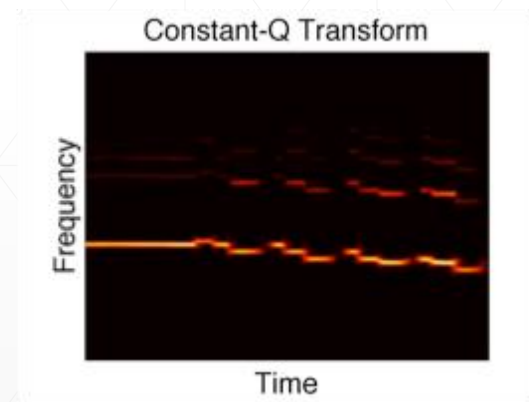
## Fourier Transform

- Representing Frequency Domain
  - Geometrically Spaced



## CQFT

- Representing Frequency Domain
  - Discretely spaced by a bank of filters

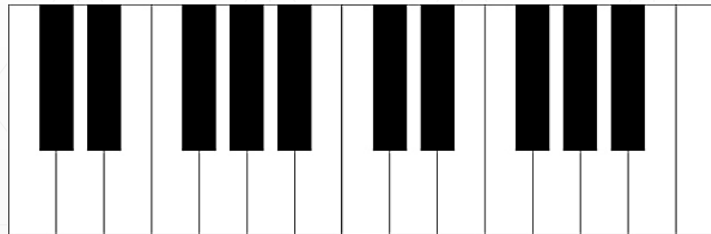


# Constant Q Transform (CQFT)

$$f_k = f_0 \cdot 2^{\frac{k}{b}}$$

$$\Delta_k^{cq} = f_{k+1} - f_k = f_k(2^{\frac{1}{b}} - 1)$$

$$Q = \frac{f_k}{\Delta_k^{cq}} = (2^{\frac{1}{b}} - 1)^{-1}$$

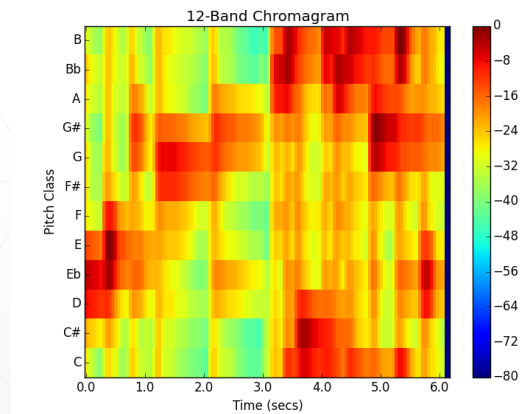
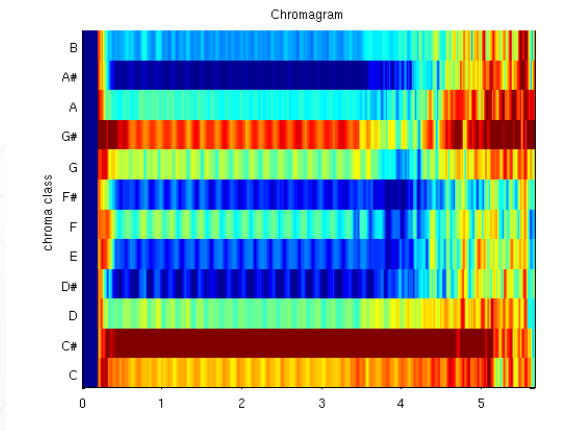


$$b = 12$$

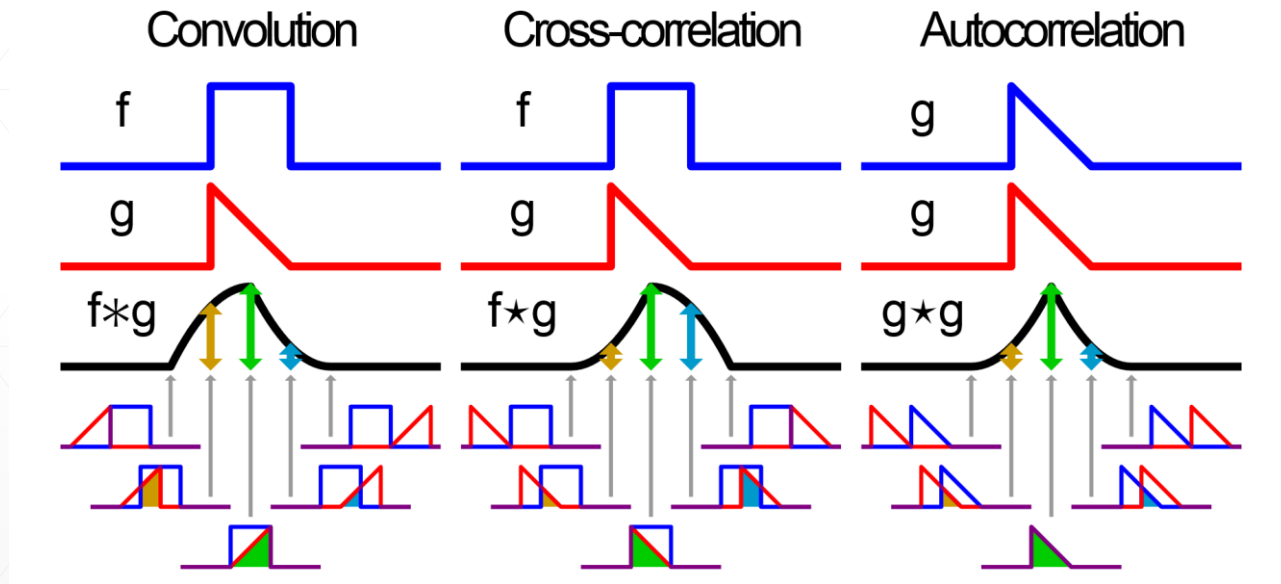


# Chromagram

- Representation for music audio in which the entire spectrum is projected onto 12 bins representing the 12 distinct semitones (or chroma) of the musical octave.
- Independent to the tone of instrument*



# Autocorrelation



## 5. Systems and Settings

- Devices
  - Raspberry Pi 2



- M



- USB Soundcard



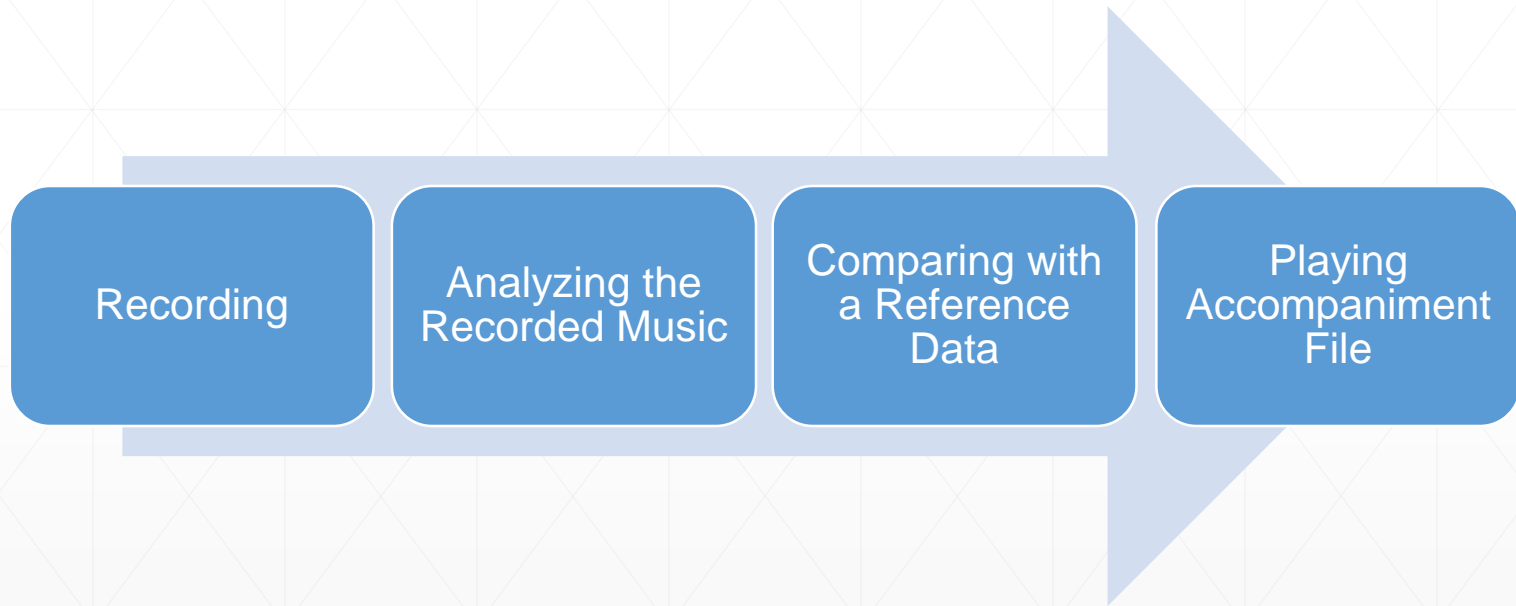
## 5. Systems and Settings

- Software



PyAudio

## 6. Procedure



# Recording

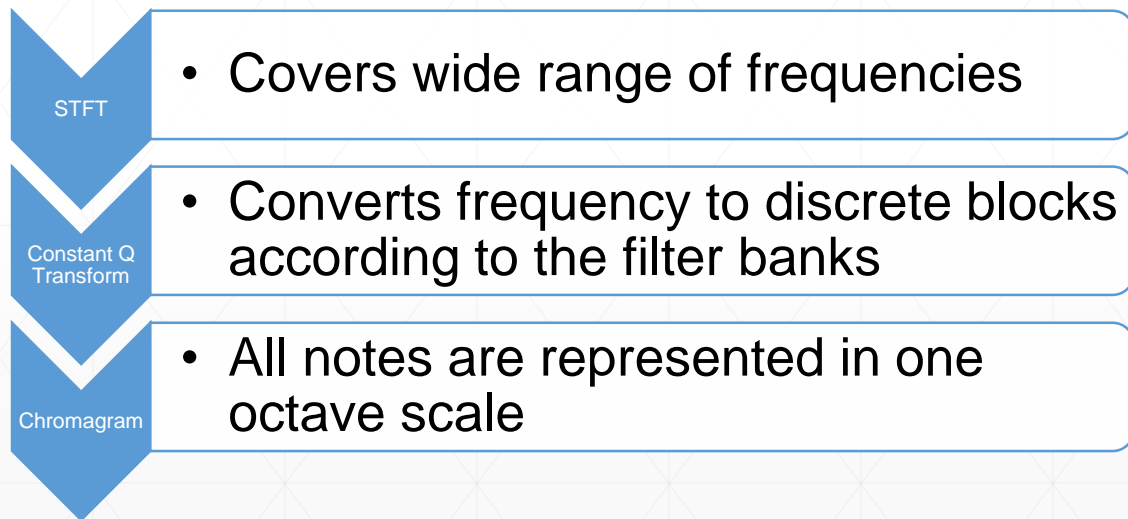
- Sampling Rate: 44100Hz
- Recording Time: 8 seconds
- CHUNK: 8192



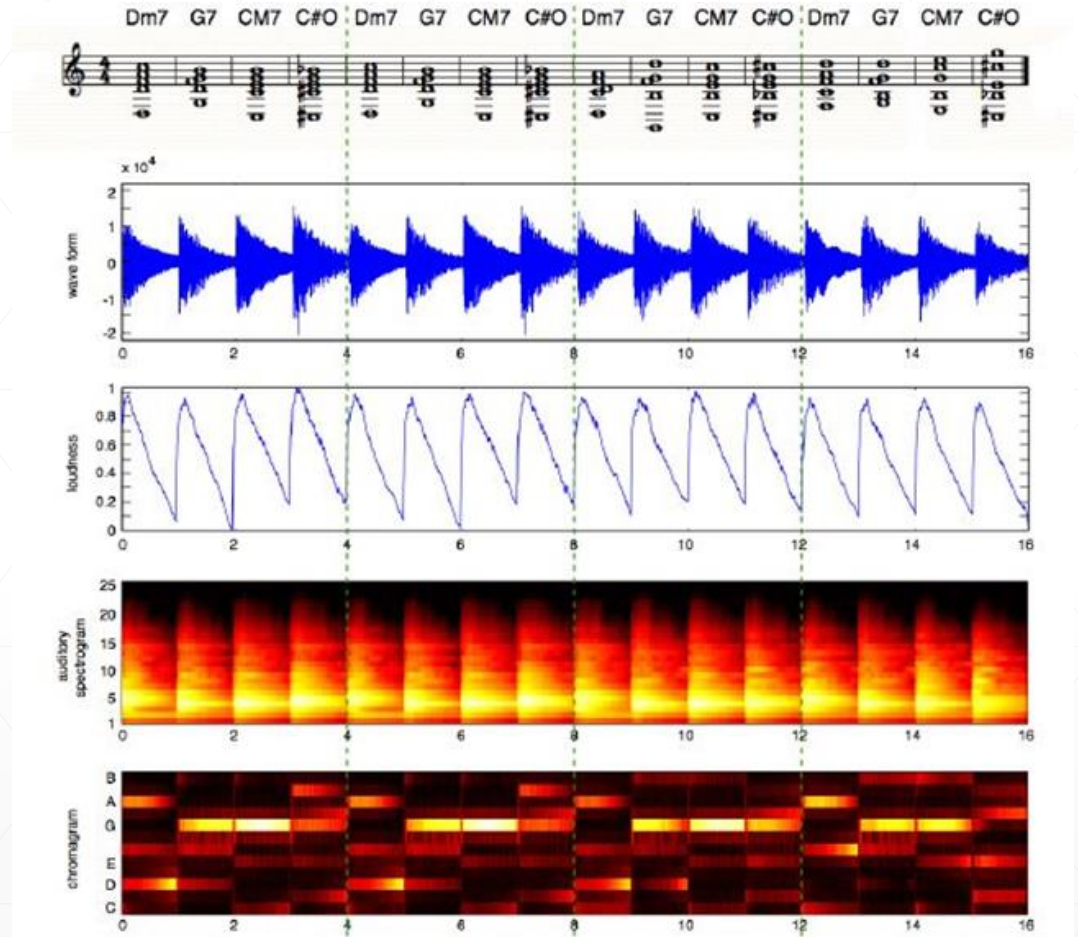
- There is a trade-off relationship between hard ware and algorithm's accuracy.

# Analyzing

- Real-time processing is a hardware demanding process.
- Requires some solution to reduce the amount of calculations



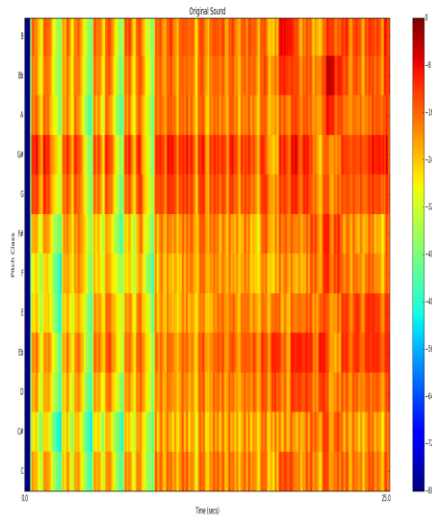
# Analyzing



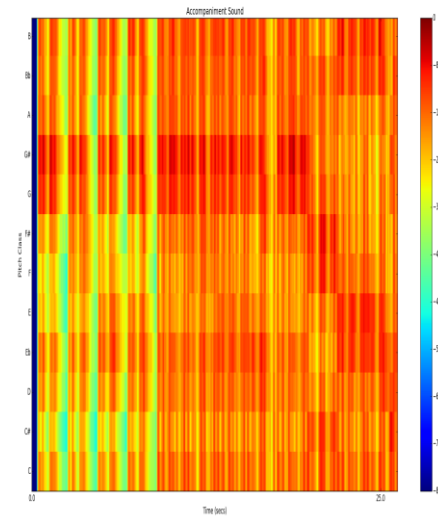


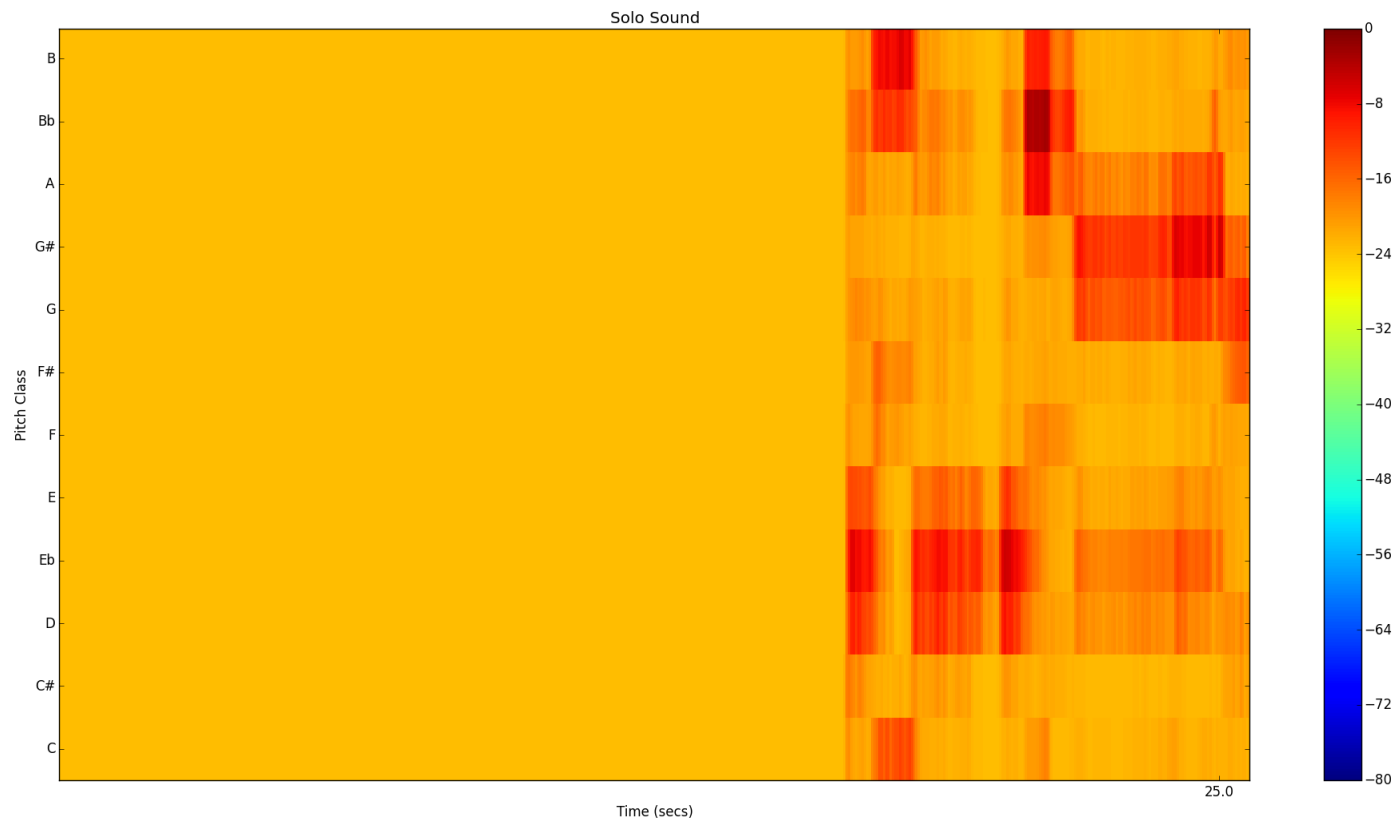
# Comparing

- Original File



- Accompaniment File





# Playing

- Start music from matching point
- Time compensation for calculating

# Demo

- All Resources of codes are available at

[https://github.com/jihoon1990/Senior\\_Project-Auto\\_Accompaniment\\_System](https://github.com/jihoon1990/Senior_Project-Auto_Accompaniment_System)

# References

1. Judith C. Brown, [Calculation of a constant Q spectral transform](#), *J. Acoust. Soc. Am.*, 89(1):425 - 434, 1991.
2. The Constant Q Transform, Benjamin Blankertz, ([http://doc.ml.tu-berlin.de/bbci/material/publications/Bla\\_constQ.pdf](http://doc.ml.tu-berlin.de/bbci/material/publications/Bla_constQ.pdf))
3. Chroma Feature Analysis and Synthesis,  
<http://labrosa.ee.columbia.edu/matlab/chroma-ansyn/>
4. <http://web.media.mit.edu/~tristan/phd/dissertation/chapter3.html>