

## ALGORITHM BASED AUTOMATIC MUSIC CHORD RECOGNITION FOR ORGAN

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### Abstract

*This paper is concerned with the automatic analysis of music chords from a piece of recorded audio played by an organ. The goal of this study was to design a program that recognize and display the chords present in recorded musical pieces which played by organ instrument automatically, so ease the identification of chords rather than using conventional method like taking down music chords by listening to the piece of music and write down the music notation. Thus the developed algorithm incorporates chords and knowledge about the common frequencies of chord changes. The algorithm consists with three main stages. First a frequency spectrum is acquired for a given signal. Next, an array of notes per time is built and then it converts to binary. Finally those notes converted in to binaries are used to extract the chords in the given piece of music.*

**Keywords:** Chords, Organ, Recognition, Music Notation, Frequency spectrum

### Introduction

Chords are everywhere in music, from the complex chord varieties of rich harmonies to the simple chords. With so many different types and uses of chords, the possibilities for training are naturally just as endless and wide-ranging. In the view of musical learning, there is a motivation to the creation of a recognizer music chords, as many beginners do not know the correct chord for each position of the organ instrument, and also the ears are less trained for identifying the chords of a recorded music file. A system capable of helping in the recognition of music chords would be of great help to the learner to abstract the musical patterns and to ease musician's role to inform chords and notes. This is very good because it would replace partially the use of sheet music, tablature and figures as well as function as a great guide to amateurs. The recognition of musical chords is inherently complex in the computational point of view.

The idea behind the title is to develop a desktop application for identifying the music chords of recorded piece played by an organ. This is a set of useful features that helps in identifying played chords within an organ music file and displaying the identified chords.

Chord detection has been widely studied using different algorithms. Lensen and Needell in 2013 has discussed the use of mathematics in algorithms that can extract chord information from recorded music [7]. They introduce the use of Fourier analysis in audio processing. In this work, the Fourier transform is used to convert the time domain input signal into a frequency representation which can be analyzed for intensities of specific pitches. The relationship between the pitches at a given time is then analyzed to determine the chord that is being played.

Sheh and Ellis developed a Chord Segmentation and Recognition model using EM-Trained Hidden Markov Models [8]. In this work, they have used the Fast Fourier Transform (FFT) to transform the input signal to frequency domain. Then it is mapped to the Pitch Class Profile (PCP) domain by summing and normalizing the pitch Chroma

intensities, for every time slice. These features are then used to build chord models via EM. Finally, chord alignment/recognition is performed with the Viterbi algorithm. Wang and Zhang’s chord recognition method based MPCP (Mel Pitch class Profile) feature [9] and also the prior work of Fujishima’s (1999) chord recognition using “pitch class profiles” (PCPs) [2] can be mentioned as related work to this paper. The structure of this paper is organized as follows.

Second chapter presents the problem background, third chapter presents project objective, fourth chapter discuss the methodology used, fifth chapter is the results and discussion, in chapter six conclusion of the paper is discussed and finally in the chapter seven the references used for this paper is presented.

### **Problem Background**

Some people don’t know the chords but they play organ just by hearing. And also for the music composers when they write music chords they have to record the chords by writing down each chord separately, which takes long time.

### **Project Objective**

This work aims to develop a computational solution to recognize and display musical chords.

Specific objective has been implementing the solution to develop computational solution for extraction of the music chords.

## **Methodology**

For developing procedure iterative and incremental methodologies were used. The project was developed using the MATLAB (MATLAB stands for matrix laboratory), on a Windows 8 operating system. Testing also was performed using MATLAB. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Signal transforms and spectral analysis, digital system design, digital filtering, coding and compression algorithms are the features which supported by MATLAB. The procedure which used to implement the system will explain through the following steps.

When music file is inserted as the input to the proposed system, it should recognize music chords present in a recorded piece of music played by an organ instrument. The proposed algorithm which was used to develop the system can be divided in to three main stages. Those steps are, calculate frequency spectrum for a given audio signal, acquire frequencies of notes and finally extract the chords.

### **Step 01**

After the sound signal is loaded into a MATLAB vector that already exists, it must be transformed in monaural. Mono audio signal is one with only one channel. After this conversion, every second of the signal is divided into 5 parts of equal sizes with 1 second range but displaced in 0.2 seconds. This process is to find the most likely chord within 1 second time interval, making transition chords or noisy are suppressed.

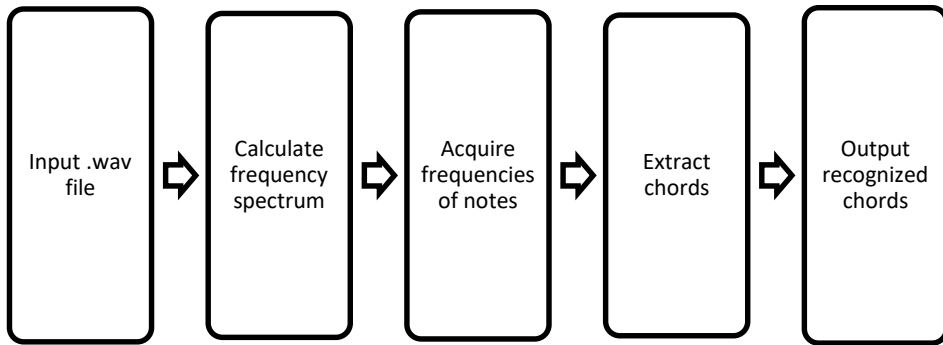


Figure 1. Overview of the algorithm

**Step 02**

The method of multiplying each of the windows over time by a Blackman window was used to minimize the distortions arising from jangles.

**Step 03**

The next step is to acquire the frequency spectra derived from the calculation of Discrete Fourier transform. The calculation is done for each of the 5 parts of windows. In this procedure, first a variable is allocated to hold the five frequency spectrum for each of the windows. Then signal is undergo a transformation of subsampling. Then the Fourier transform module is calculated and the same vector passes by recognition of slots in such a way each slot behaves like one unit of hertz.

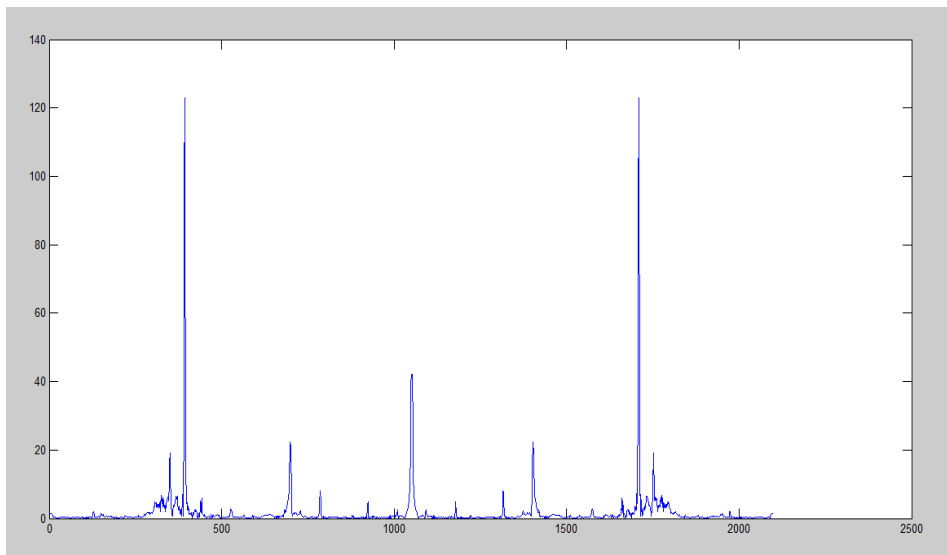


Figure 2. Frequency spectrum for a given signal

#### **Step 04**

In this procedure each frequency spectrum correlated with a set of musical notes in a given set of frequencies that are present in them. The first activity is to load the database of musical notes which giving an array of 60 notes per 1500 frequencies.

Then each set of notes related to the window parts are correlated from a multiplication operation. At the end an array of notes per time is built for each five parts.

#### **Step 05**

This step comprises the process of converting the notes per time which acquired from the previous step in to binaries in order to determine whether a chord played or not.

At the beginning of the procedure a loop is highlighted for each part of the windows. At the end of the procedure a set of musical notes is gained in only two values 1 or 0.

#### **Step 06**

In order to determine bass chords, first a variable is assigned over the parts of the windows. Then each of these parts will be analyzed to find out most recurring notes. After this analysis bass chords are extracted with the first occurrence of 1 as the notes are converted in to binaries.

#### **Step 07**

Input of this procedure is the chords which turned in to binaries. At the beginning of this process there is a loading of music chord database then all notes are summed with respective octaves which generating a variable for 12 positions.

This variable is then subjected to a process to derive the chords from the database. At the end of this procedure chords will have its corresponding binary and then maximum binaries are extracted to acquire the set of chords.

#### **Step 08**

The input of this procedure is the set of chords which acquired from the previous step. The output is the fundamental chords with the elimination of five window parts. At the beginning of this procedure there is an assignment of the variable for five parts.

Then chords in the all parts undergo a procedure to extract the most recurring chords to acquire fundamental chords.

#### **Step 09**

This procedure aims to form the inverted chords from the input of the fundamental chords and bass chords. First load the dictionary of chords each with a chord name.

Then fundamental chord and bass chords are associated by building pairs of chords to map played chords with the loaded chord dictionary. Output of this procedure is set of inverted chords and augmented chords.

## Results and Discussion

After implementing the software the results which can be seen, are as the following.

### Main Interface

The main interface provides a function to load the music piece in to the system.



Figure 3. Main interface

The system automatically display only the files in .wav file format.

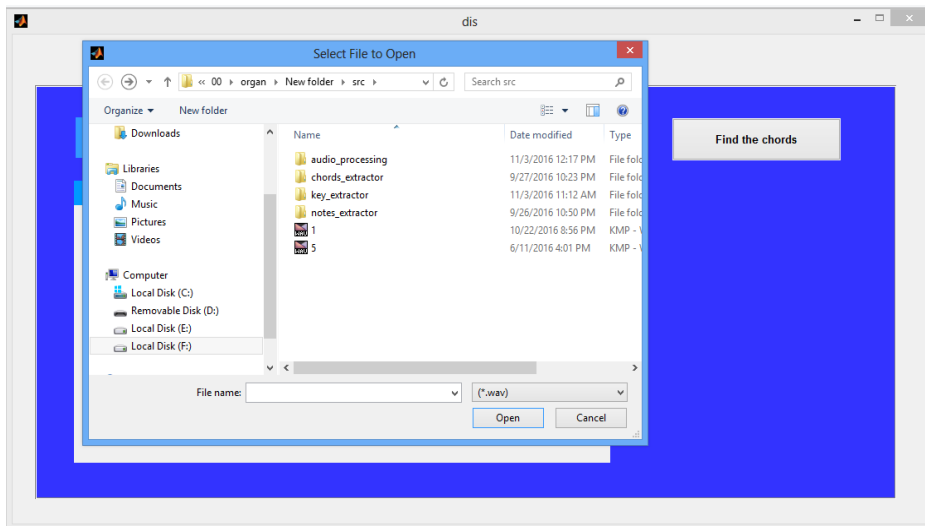


Figure 4. Select the a piece of recorded audio played by an organ

After select the file to be recognized the recognized chords display as the figure shows.



**Figure 5. Display the recognized chords**

In this paper, we investigate automatic chord recognition and specifically focus on the evaluation of chord recognition algorithms. Automatic chord detection is part of the growing research field of Music information retrieval (MIR) [5], which has attracted attention of many researchers and deals with all kinds of information extraction from audio signals [1].

Fourier transform converts waveform data in the time domain into the frequency domain. The Fourier transform accomplishes this by breaking down the original time-based waveform into a series of sinusoidal terms, each with a unique magnitude, frequency, and phase. Plotting the amplitude of each sinusoidal term versus its frequency creates a power spectrum, which is the response of the original waveform in the frequency domain.

By examining the spectrum resulting from performing a Fourier transformation on a chord's waveform, it is possible to identify which notes are present in it algorithmically. A digitizer samples a waveform and transforms it into discrete values. Because of this transformation, the Fourier transform will not work on this data. Instead, the discrete Fourier transform (DFT) is used. The fast Fourier (FFT) is an optimized implementation of a DFT that takes less computation to perform but essentially just deconstructs a signal.

When frequency content of a signal is computed, errors can and do arise when we take a limited-duration snapshot of a signal that actually lasts for a longer time. Windowing is a way to reduce these errors, though it cannot eliminate them completely.

To minimize the effects of performing an FFT we use a method called windowing because, when frequency content of a signal is computed, errors can and do arise when we take a limited-duration snapshot of a signal that actually lasts for a longer time. Blackman Windowing is a way to reduce these errors, though it cannot eliminate them completely.

## Conclusion

This work aims to develop a computational solution to recognize musical chords from a piece of recorded audio played by an organ. For laid the foundation to achieve the goal the fundamentals which had to done were, developing a computational solution for a given audio signal to acquire frequency spectrum, acquire frequencies of notes and to extract chords.

In this project automatic music chord recognition for organ was successfully implemented by achieving aforementioned fundamentals by following the algorithm presented by this paper. This application is easy to understand and use as it provides a well implemented GUI. Every action on the interface can be performed without extra learning.

In view of the threats and limitations of the work, the analysis exposed for recognition chords in recorded samples separately was made only for the organ; this analysis was not made for other musical instruments. It is expected that, other musical instruments, may have some different results, requiring new implementations of the system solution to achieve adaptation to other musical instruments.

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