Pitch Histogram based analysis of Makam Music in Turkey

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Abstract

Compared to the volume of research on Western music, computational studies on Makam Music in Turkey (MMT) is almost extinct. In this text we present an overview of our pitch histogram based analysis methods. An automatic tonic detection method and its various applications are presented.

Keywords
Music information retrieval, tuning, intonation, makam music, Turkish music, audio analysis

1. Introduction

Analysis of music of oral traditions is a large multidisciplinary area. Analysis based on acoustic analysis of the actual audio data is one of the important dimensions in such research. The fast growing field of information technologies provide new tools every day facilitating accessing features of the acoustic signal and gathering such information in an organized way. This text discusses one such approach to analyze makam music in Turkey while the technology presented can be easily adapted to other makam/maqam/mugam traditions and hence can be used for studying the traditional music of a very large geographical region.

In oral traditions, individual and regional variations constitute an important part of richness. Such richness often results in a difficulty in analysis and mismatches between theory and practice. Information technologies have the potential to overcome some of the difficulties by providing tools for easy analysis of both individual recordings as well as methods to process large audio collections automatically and gather statistical information.

From an acoustic analysis perspective, since one of the main constituents of music is melody, the pitch space of music needs to be studied as a starting point for analysis. For makam music tradition in Turkey, the center of lively discussions on theory-practice mismatches is the tuning: how to formulate and represent interval sizes and notes in this music of many microtonal intervals (Karaosmanoğlu & Akkoç, 2003, Tulgan, 2007, Yarman, 2008).

Use of pitch histograms has been a common practice to study this problem (Akkoç, 2002, Zeren, 2003). Since recently, this research had to be carried by manual work on individual recordings. In a data pool of large variety, the amount of manual work necessary exceeds available resources; a need for automatic methods shows up immediately.

2. Automatic processing of pitch histograms

Automatic processing methods for pitch histograms of makam music has been presented in a few recent studies (Bozkurt, 2008, Gedik & Bozkurt, 2010). Due to lack of a commonly agreed reference frequency[1] such as A4=440Hz, the first step in an automatic pitch analysis is finding of the tonic

[1] In fact that there are more than a dozen possible diapasons called "ahenk"s which specify frequency intervals(not exact single frequency values as 440Hz) as reference. Ahenk is synonymous with key

frequency. In (Bozkurt, 2008) we have proposed a simple and effective approach based on matching pitch histograms to pre-calculated histogram templates. The histogram templates can be computed automatically by supervised learning in the training phase of the algorithm as explained in (Bozkurt, 2008). In figure 1, we present an example of such matching.

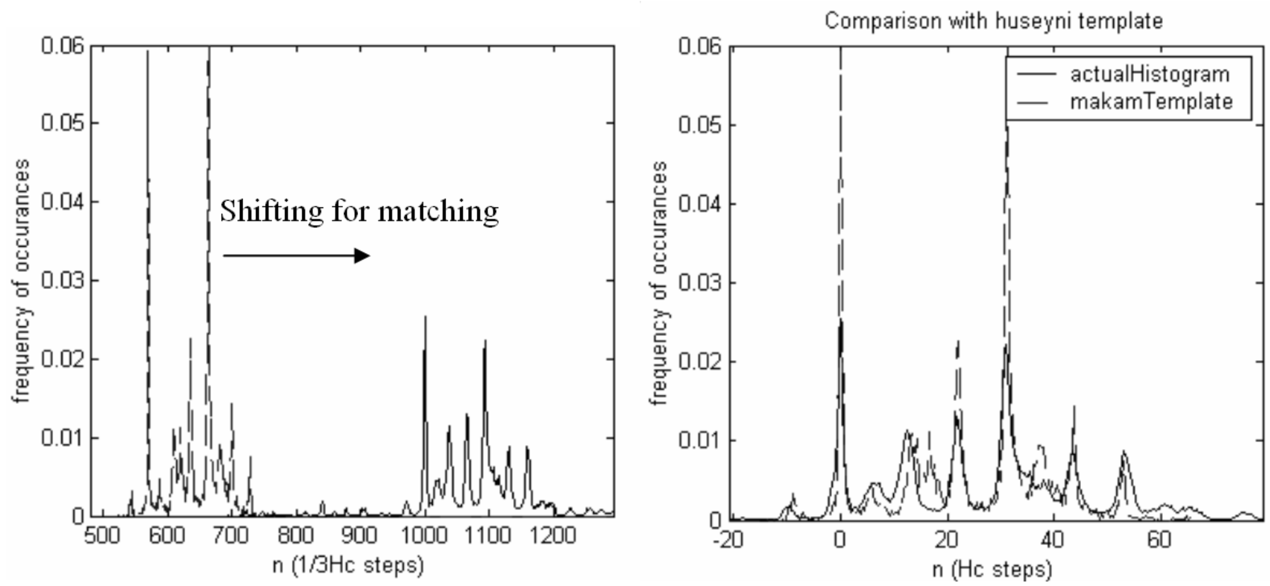

Figure 1: Automatic pitch histogram matching approach for tonic and makam detection (Gedik & Bozkurt, 2010)

Given a histogram template of the makam, the automatic tonic detection of a given recording is achieved by:

- computing the distance between the two histograms for each shift
- finding the shift amount that corresponds to minimum distance and aligning the template and the actual histogram at that point
- assigning the first peak to tonic

Various distance functions have been tested and the City Block norm:

$$d[n] = \frac{1}{K}\sum_{k=0}^{K-1}\left|h_r[k] - h_t[n+k]\right|$$

where h_r and h_t correspond to the template histogram and the actual histogram, has been found to be a good choice (Gedik & Bozkurt, 2010). In tests on 118 real recordings, a single error was observed where the dominant is confused with the tonic. Since the matching operation aims at matching the overall distribution of pitches played, tonic does not need to be emphasized in the recording. By nature, the pitch hierarchy and melodic progression rules of each makam result in certain distribution of pitches and the algorithm targets matching this overall distribution.

The same algorithm can be used for automatic classification the makam of the recording with a lower efficiency than tonic detection (confusing similar makams). In fact, in most research aiming analysis of oral traditions, automatic makam detection is not needed since it is already known by the researcher or

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transposition or diapason. Due to the fact that maqam music notes ("perde"s) are named by reference to their relative position (of the finger) on the instrument, the same perde corresponds to different pitches on different sizes of instruments. The reader is refered to (Erguner, 2007) and Appendix B of (Yarman, 2008) for detailed reviews on ahenk.

the makam information is available through metadata. Automatic makam detection is more important for information retrieval applications such as finding recordings in a specific makam in large collections where sufficient metadata is not available. Therefore, the efficiency of the makam detection algorithm will not be discussed here.

3. Applications of the automatic tonic detection algorithm

The presented methodology can be used in tuning analysis of individual recordings as well as a collection of recordings. In figure 2, we present an application where pitch histograms of recordings from two musicians (Bekir Sıdkı Sezgin and Mesut Cemil Bey) are compared. The fully automatic process applied to create this figure involves automatic detection of tonics for the two recordings and plotting the scaled histograms after matching their tonic positions as the zero reference. Such figures are potentially useful for studying individual variations in oral music traditions.

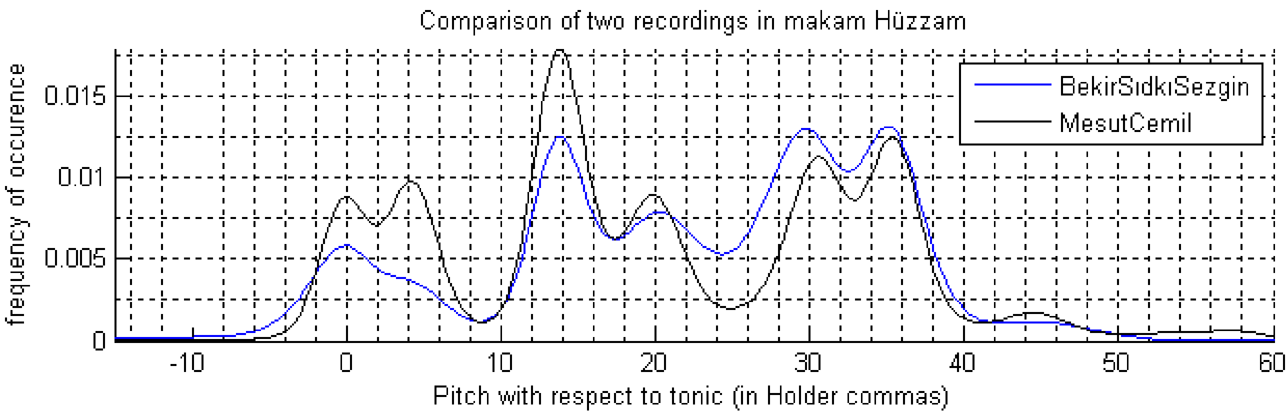


Figure 2: Pitch histogram comparison for two recordings in makam Hüzzam

The tuning in a recording can be studied individually and compared to the tuning specified in a certain theory. In figure 3, we present the pitch histogram of Hüseyni taksim by Aka Gündüz Kutbay. The theoretical intervals specified in the Arel Theory (Arel, 1930) is presented with small circle on the top of the figure and the 12Tet tones are shown as vertical lines. This automatically created figure also facilitates tuning analysis on individual recordings.

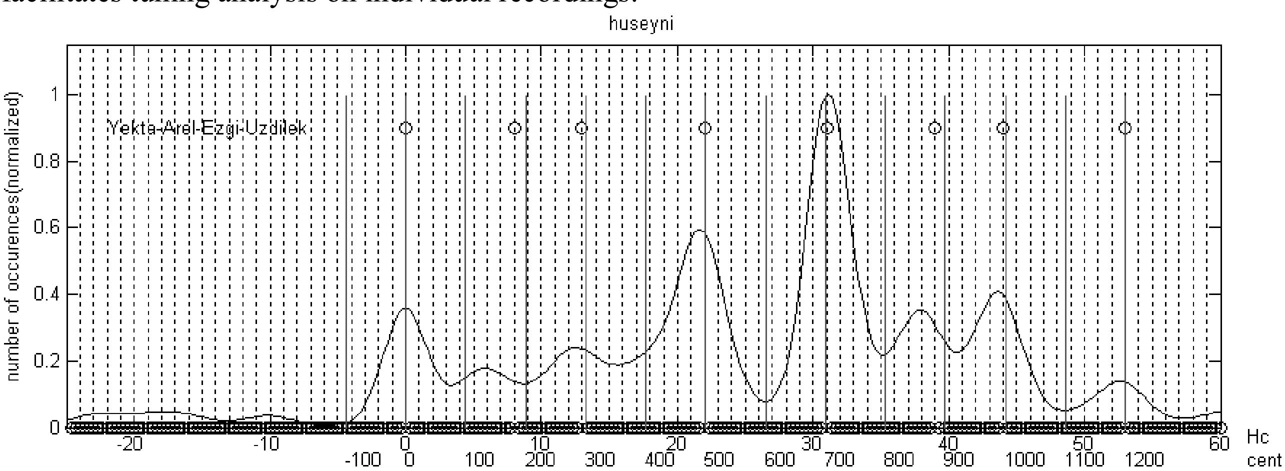


Figure 3: Comparing pitch histogram to tuning theory and 12Tet grid

Once tuning can be automatically found, pitch histograms for a large collection of recordings can be gathered automatically to obtain overall histograms. In (Bozkurt et al, 2009), we have studied the tuning problem by comparing pitch histograms of various recordings from indisputable masters to various tuning theories. One example output is shown in Figure 4 where 17 recordings in makam Hicaz was used to compute an overall histogram automatically. For merging histograms two approaches are used: simple averaging or using the maximum function (referred as the envelope histogram).

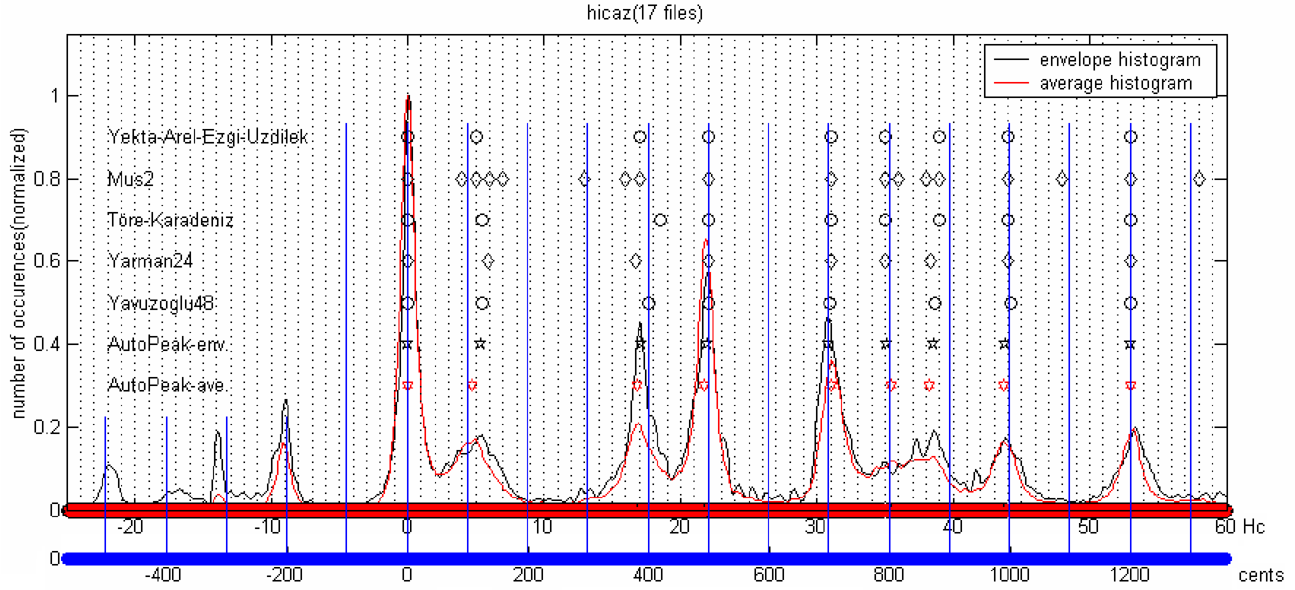
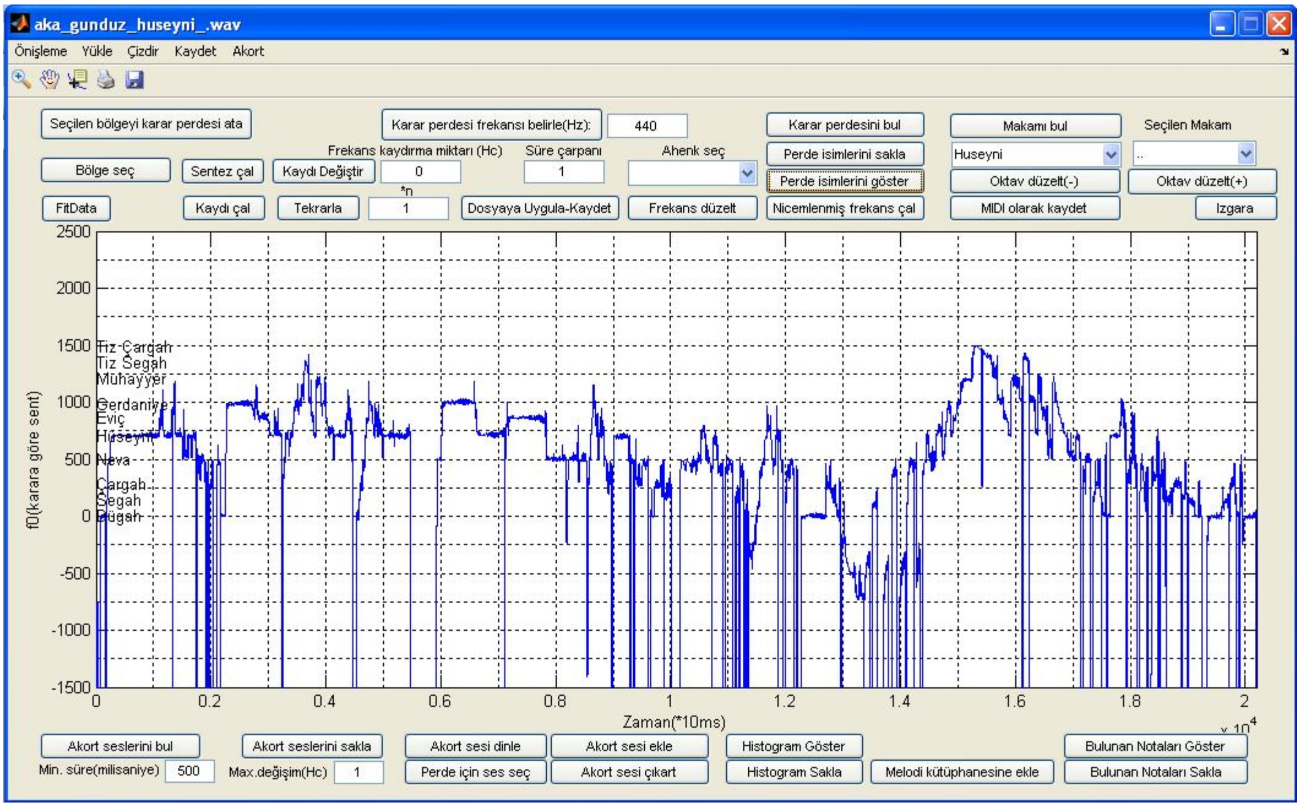


Figure 4: Pitch histograms obtained from 17 files (in makam Hicaz) are compared with several theoretical tuning systems (Yekta, 1922, Arel, 1930, Ezgi, 1933, Karadeniz, 1965, Yarman, 2008, Yavuzoğlu, 2008) and the 12Tet grid. (Bozkurt et al, 2009).

Various analysis functions have been implemented in a toolbox named the “Makam Aracı” where the first step is the presented tonic detection algorithm. The software is an early version of a comprehensive research and teaching tool for makam music. Some of the functions are: a novel tuner application (Bozkurt, 2012), automatic ahenk transposition, automatic transcription (Gedik & Bozkurt, 2012).

A snapshot of the software is presented in figure 5. The melograph (pitch time series data) of Hüseyni taksim by Aka Gündüz Kutbay is shown in the main window presented in cents with respect to tonic frequency (yaxis) where the tonic is automatically detected. The names of the pitches for makam Hüseyni are presented on the left (Dügah, Segah, etc.) at their relative positions specified in Arel Theory. Since the tool is designed for Turkish students and researchers, all labels are in Turkish. The tool has been used in various recent thesis studies in conservatories or musicology departments: Ekşi, 2011, Tan, 2011, Özek, 2011. The researcher can listen to portions of melograph, both original recording and synthetic version, transpose the recording, create histogram plots as shown in figures above, make manual corrections when there are errors in analysis, etc.



4. Conclusion

The text presents a very short review of the pitch histogram based technology and a graphical tool developed for analysis of makam music. Interested readers are invited to refer to (Bozkurt, 2008, Bozkurt, 2012, Gedik & Bozkurt, 2010, Gedik & Bozkurt, 2012) for technical details as well as test results. Starting from this early version, the tool has been used in various research activities. The development will continue in the direction of including functions for interactive learning of makam music.

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