FEATURES FOR ANALYSIS OF MAKAM MUSIC

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ABSTRACT

For computational studies of makam music, it is essential to gather a list of characteristics that constitute a makam and explore corresponding quantitative features for automatic analysis. This study is such an attempt where we address the characteristics for makams as defined in theory books and deduce a list of quantitative features. The target here is to evoke discussions on some measurable features other than providing complete analysis on the discriminative potentials of each proposed feature which could be the subject of a few larger studies.

1. INTRODUCTION

The concept of makam/maqam/mugam/muqam/… appears in music traditions of a very large geographical region and has been defined in many sources with more or less similar statements. In stead of contrasting those definitions, here we gather a list of features that is used to describe/teach a makam and investigate means of defining measurable features for computational studies.

In Turkey, most of such definitions state the two main components of a makam as a scale and an overall melodic progression. While the scale descriptions include more or less complicated formulations of a microtonal tuning system and intervals, melodic progression is explained as a path from one emphasis note to another until the 'karar' is reached.

In our previous work, pitch histograms have been used as an acoustic feature that reflects information about scale by peak locations. In addition, relative occurrence frequency of pitches (values of these peaks) provide information about which notes are emphasized. In Figure 1, we provide pitch histogram templates obtained by averaging pitch histograms of multiple files after aligning the tonics (as explained in [1]), for three makams; *Neva*, *Hüseyni* and *Muhayyer* which use the same scale.

We can observe from the pitch histogram templates that note Neva is emphasized in makam *Neva* (i.e. the frequency of occurrence of this note is higher comparatively), note Hüseyni is emphasized in makam *Hüseyni* and note Muhayyer is emphasized in makam *Muhayyer*. It appears that one of the many strategies in naming makams is to name the makam with the name of the note emphasized (usually at the beginning of the progression).

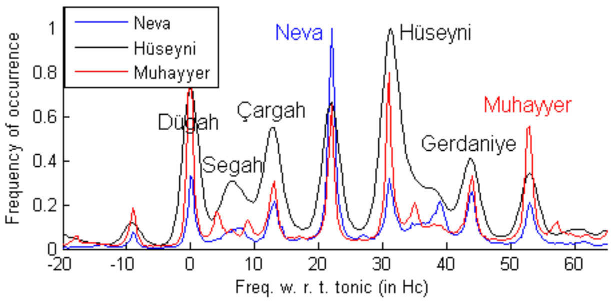

Figure 1. Pitch histogram templates of three makams: *Neva*, *Hüseyni* and *Muhayyer*. Names written close to the peaks correspond to note (*perde*) names.

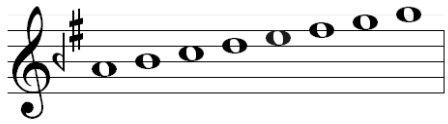

Figure 2. Scale of the three makams: *Neva*, *Hüseyni* and *Muhayyer*. Note (*perde*) names in ascending order: Dügah (A), Segah, Çargah (C), Neva (D), Hüseyni (E), Eviç, Gerdaniye(G), Muhayyer(A).

Since pitch histograms carry some information about the scale and the emphasis levels, it appears as a very useful feature and has been used in computation studies effectively in the past [2, 3, 4, 5].

However in histograms, the time variation is lost and we get very little information about the melodic progression (maybe only the relative emphasis levels of notes). A common statement in music circles of makam music is: "scale is only a skeleton and *seyir*, the melodic progression, gives it a life". As makams *Neva*, *Hüseyni* and *Muhayyer* in Figure 1 and 2, via applying different progression strategies, three different makams are formed using the same scale and tonic. That is an important the characteristic of makam that distinguishes it from the concept of mode in Western music.

Our task here is to continue our quest for new features that would help us study makam music. In the following sections we review characteristics specified in makam music theory and propose new quantitative features. Due to space limitations, data will not be provided for all features and when data is presented, preliminary investigations will be hold instead of complete tests. Where we present data, we will use makams for which pitch histogram matching based classification is problematic (due to similarity of the makam scales), with the aim of defining features that would be complementary to pitch histograms.

2. A FEATURE LIST FOR STUDYING MAKAMS

2.1 Scale, intervals and intonation of specific notes in the scale: sub-features that can derived from the pitch histogram

In music theory, it is a common practice to specify the scale of a makam as a list intervals (distance from the tonic, or the previous note). Intervals can be specified as frequency ratios, such as the fifth having a ratio of 3/2 in Pythagorean tuning. Equivalently, intervals can be specified in a logarithmic scale so that multiplication/division is replaced by addition/subtraction. In Western music, specifying intervals in whole tones or cents are such formulations. In makam music, Holderian commas (obtained by equal division of an octave into 53 partitions) is the most common basic unit to specify intervals. As a minor scale in equal tempered Western music can be defined as [1 0.5 1 1 0.5 1 1]*{whole tone}, the scale of makam Beyati in Arel Theory [6] is defined as [8 5 9 9 4 9 9]*{Holderian commas} which could be rescaled as [0.9057 0.5660 1.0189 1.0189 0.4528 1.0189 1.0189]*{whole tones}.

Using interval vectors as a feature to detect makams has been used in [7, 8]. In such an application, the choice of the distance metric is critical and defining a perceptually meaningful distance metric is one potential direction of research.

As presented in Figure 1, the relative emphasis of notes is also important for makam classification and hence can be used as a feature that can be automatically deduced from the histogram. In Figure 3, we present samples from *Hüseyni* and *Muhayyer* makams on a three dimensional feature space: relative frequencies of notes Neva, Hüseyni and Muhayyer.

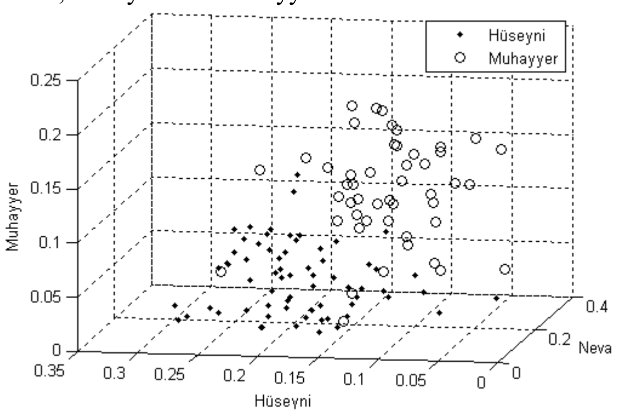

Figure 3.Samples from *Hüseyni* and *Muhayyer* classes for the three dimensional feature space: relative frequencies of notes Neva, Hüseyni and Muhayyer.

A makam classification based on comparison of pitch histograms often leads to low accuracy for separating *Hüseyni* and *Muhayyer* makams since they use the same scale. It appears that these two makams can be more successfully separated on a three dimensional feature space of relative occurrence frequencies. Compared to the pitch histogram used in [9] with 159 frequency bins in an octave (hence a min. of 159 sized vector), this representation uses only a feature vector of size 3 to potentially perform a more accurate makam classification for these 2 classes.

Another feature that can be deduced from the pitch histogram is the octave relation of notes. It appears that for some makams like Saba, all notes do not have an octave equivalent, even the tonic. We leave the definition of a feature for octave equivalence degree to our future work.

2.2 Melodic range

A recent study of repertory of Turkish music [10] has shown that the melodic range of a 1700 piece set is about 2.5 octaves (most of the pieces not extending a range of 2 octaves). Melodic range of a makam does not only refer to the size of the dynamic range but also where within the 2.5 octave this range is located. In music theory, for some makams, it is common practice to state a limit to the extension of the makam scale outside the main octave. An example is the description of makam Rast in [11]: "The makam Rast has an ascending character and is performed mainly within the low register of the scale. The scale extends below the tonic and descents as far as Yegah (D), using the Rast tetrachord ".

Two simple ways to define quantitative features for such characteristics is to use ['minimum relative frequency' 'maximum relative frequency'] or ['relative frequency of the melograph mean' 'melodic range']. In the figures below, we present samples from makam *Rast* and *Mahur* (which are again confused in pitch histogram matching based classification) for these features. This time, symbolic data (from [10]) will be used where notes are specified in Holderian commas with respect to note C1.

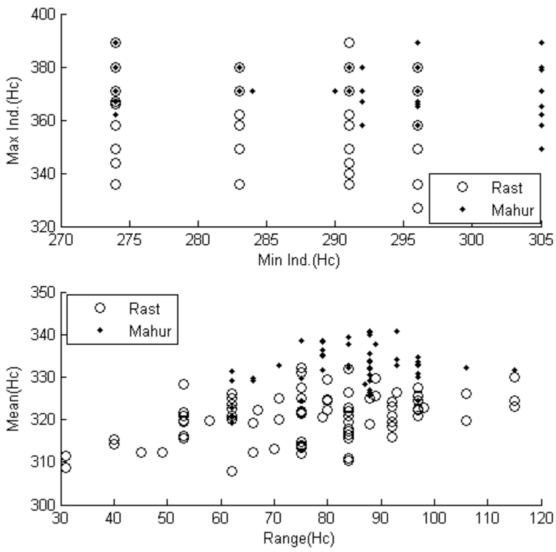

Figure 4.Samples from *Rast* and *Mahur* classes for the two dimensional feature spaces: top) ['minimum relative frequency' 'maximum relative frequency'], bottom) ['relative frequency of the melograph mean' 'melodic range'].

It appears that the second set of features is potentially useful. However, we should state here that in the existence of instruments playing at two different octaves, reliable estimation of melodic range related features from audio would be problematic.

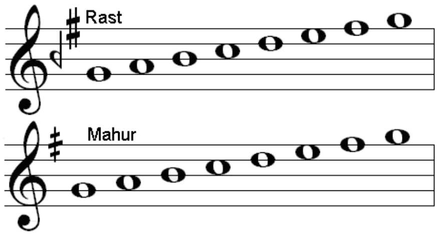

Figure 5. Scales of makam *Rast* and *Mahur*

2.3 Overall melodic progression, *seyir*

The overall melodic progression is often stated to be the most important makam specific characteristics. In the teaching process, the overall progression is explained as a road map and practiced by solo improvisations, namely *taksim*. An example is the seyir of makam Rast as explained in [11]: ”The melodic progression begins with the Rast flavor on Rast (G) due to the makam’s ascending character. Following the half cadence played on the dominant Neva (D), suspended cadences are played with the Segah flavor on Segah and the Dügah flavor on Dügah (A). The extended section is presented and the final cadence is played with the Rast with Acem (F) flavor on the tonic Rast (G)”.

There are typically three types of progressions stated almost all theory books: ascending, ascending – descending (or alternatively “*seyir* in the mid-register”) and descending. To observe it on the data, we can refer to melographs of improvisations. In the example below, we have used one example for each type of progression. In theory, makam Uşşak is considered to have an ascending *seyir*, makam *Hüseyni*, ascending – descending and makam *Muhayyer* descending.

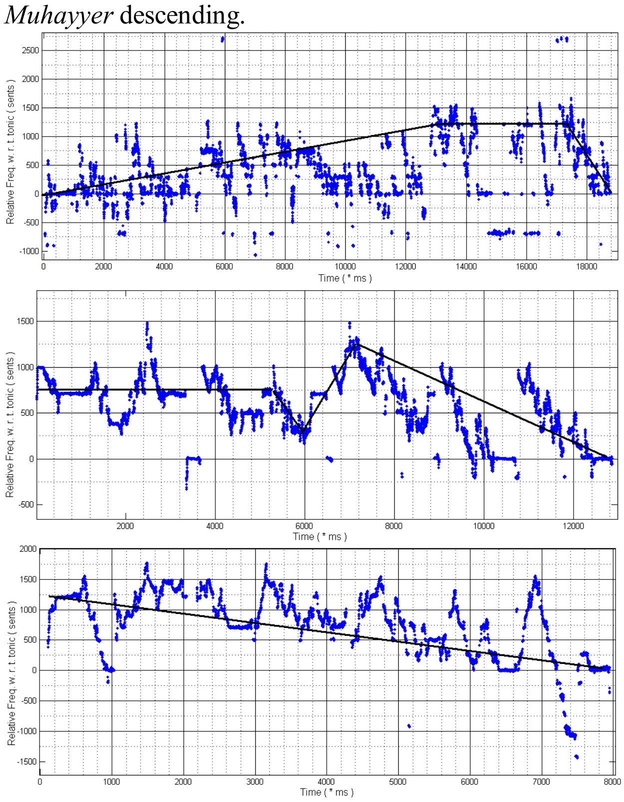

Figure 6. Melographs from three makams: *Uşşak* (taksim of Yorgo Bacanos), *Hüseyni* (taksim of Fahrettin Çimenli), *Muhayyer* (taksim of İhsan Özgen). Straight lines are indicated by the author and is based on observation of shapes in several examples.

In an attempt to obtain the *seyir* curves automatically from audio, we present histograms computed for windowed sections of the melograph (short-time histogram view) and the center of gravity of each histogram is connected with a bold line in Figure 7.

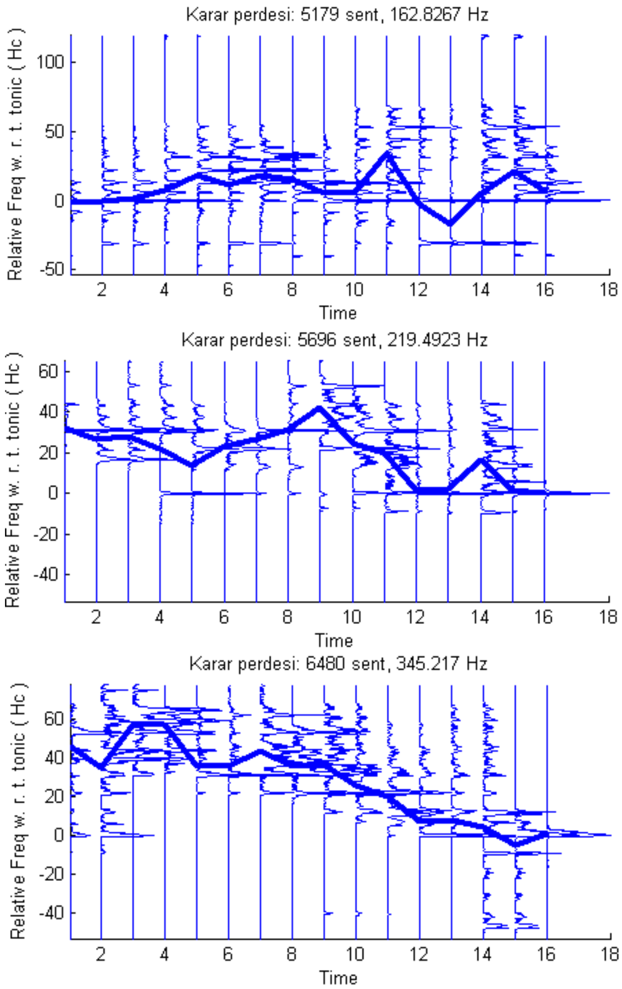

Figure 7. Short-time histogram view of the examples in Figure 6. Bold-line connects the center of gravity of each histogram.

Although some similarity is achieved between Figure 7 and Figure 6, this stays as an early demonstration.

A similar attempt has been made using the symbolic data. In order to observe the general melodic progression, we down-sampled the melodic contours of each piece so that they have the same length (of 20 points) and plotted these as points in Figure 8. The solid line shown in the figures are obtained by averaging all melodic contours. Figure 8 presents the obtained average melodic progression for makam *Muhayyer* and *Hüseyni*. The highest differences of the two progressions are observed during the first quarter. Similar observations are made for other very close makam couples which use the same scale but have different *seyirs*.

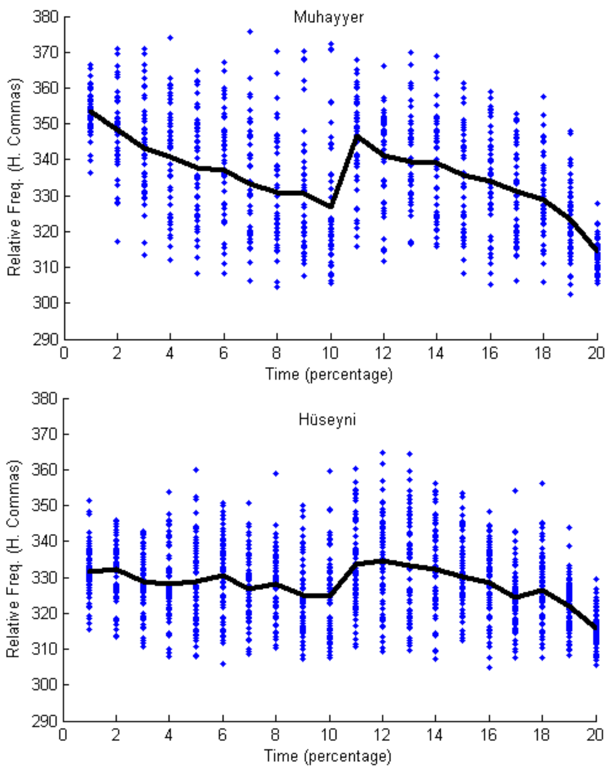

Figure 8. Melodic progression of makam *Muhayyer* and *Hüseyni* (from symbolic data).

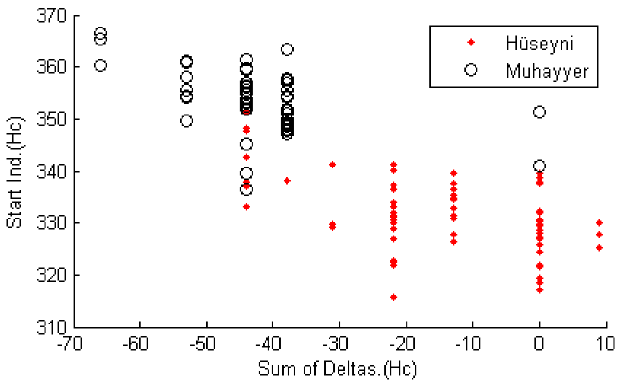

Figure 9. Seyir features: starting region and sum of deltas for makams *Muhayyer* and *Hüseyni*.

As observed in Figure 8, the starting region (the first value of the down-sampled melodic contour) for progression is a potentially discriminating feature for comparing two *seyirs*. As an additional feature of *seyir*, the sum of deltas of consecutive notes (i.e. summation of all melodic intervals of the piece) can be used as in [12]. In Figure 9, we present *Hüseyni* and *Muhayyer* data on this two dimensional feature plane. It is obvious that these *seyir* features (starting point and sum of melodic intervals) are potentially useful for discriminating such close makams and studying *seyir* computationally.

2.4 Typical phrases

Even though overall melodic progression is emphasized very often as the most important element in defining a makam, one observes that musicians recognize the makam of an improvisation without having to listen more than 10-15 seconds of the improvisation. In addition, the author observed in various occasions that the intermediate level musicians or listeners perform makam recognition by matching short segments of melody to the melodies they already know. This suggests that typical phrases used to emphasize specific notes are critical in makam recognition. Studying features to detect typical phrases will be part of our future research.

2.5 Typical transitions and/or flavors

An improvisation or composition in a certain makam rarely contains melodies only from that specific makam. Transitions to other flavors (*çeşni*) is a common way of creating variations in music. Although there is to some level freedom of the composer to make a transition from one flavor to another, there exists general rules for each makam on which flavors to use. “Improper” uses may be considered to “destroy” the makam feeling.

For computational studies of makam music, analysis of flavors is one of the important topics of research. Due to unavailability of automatic segmentation strategies (for transitions to different flavors), no automatic analysis is reported in literature. It is among our future goals to develop the tools for automatic analysis in this domain.

2.6 Tetra-chords, penta-chords constituting the scale and notes defined as tonic, dominant, leading tone

One last characteristics to list from those defined in theory books is the formulation of scales being composed of tetra-chords and penta-chords. Most theory books would start introducing a makam by defining the scale in this manner and also specify the leading note, the tonic and the dominant.

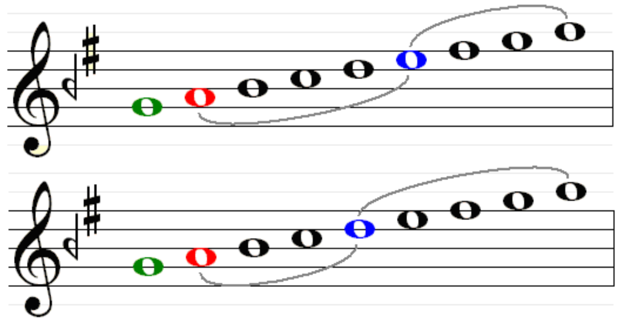

Figure 10. Scales for makams: top) Hüseyni, Muhayyer, Gülizar, bottom) Neva, Gerdaniye, Tahir. Colored notes: green) leading note, red) tonic, blue) dominant.

In Figure 10, we present two scales for six makams. The main difference between the two scales is the first being composed of a penta-chord continued by tetra-chord and the second being composed of a tetra-chord continued by penta-chord. While most of the theory books would specify the first note of the second n-chord (marked as blue) as the dominant, *güçlü*, the function of a dominant is open to discussion and excepts exist to the said formulation.

Automatic detection tonic has been studied in [8] in depth. Once the tonic is known, leading tone can be automatically found as the first peak of the pitch histogram within 1.5 whole tones lower than the tonic. Dominant can be detected again from the pitch histogram by finding the peak with highest amplitude around mid-points of the scale (pitch histogram of one octave). The usefulness of tetra/penta-chord formulation of scales is open to discussion. It is among our future goals to study these features most of which could be deduced from the pitch histogram.

3. CONCLUSIONS

In this study, a list of makam characteristics deduced from theory books and a set of new features to quantitatively study these characteristics are presented. We show that some of the proposed features provide complementary information to pitch histograms for makam classification tasks.

Acknowledgments

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4. REFERENCES

[1] B. Bozkurt, "An Automatic Pitch Analysis Method for Turkish Maqam Music," in J. of New Music Research, 2008, 37(1):1–13.

[2] G. Tzanetakis, A. Ermolinskyi and P. Cook, "Pitch Histograms in Audio and Symbolic Music Information Retrieval" in J. New Music Research, 2003, 32:2, pp. 43-152.

[3] B. Bozkurt, O. Yarman, M. K. Karaosmanoğlu and C. Akkoç, "Weighing Diverse Theoretical Models on Turkish Maqam Music Against Pitch Measurements: A Comparison of Peaks Automatically Derived from Frequency Histograms with Proposed Scale Tones," in J. of New Music Research, 2009, 38(1), pp. 45–70.

[4] E. Özek, Türk müziğinde çeşni kavramı ve icra teori faklılıklarının bilgisayar ortamında incelenmesi, PhD. Thesis, Istanbul Technical University, 2011.

[5] O. Tan, Ney açkısının tarihi ve teknik gelişimi, PhD. Thesis, Istanbul Technical University, 2011.

[6] H. S. Arel, "Türk Musikisi Nazariyatı Dersleri, Hazırlayan Onur Akdoğu," Kültür Bakanlığı Yayınları /1347, Ankara, 1991, p.70.

[7] J. Six, and O. Cornelis, "Tarsos—A Platform to Explore Pitch Scales in Non-Western and Western Music." In Proc. of the Int. Society for Music Information Retrieval (ISMIR), 2011.

[8] A. C. Gedik and B. Bozkurt, "Automatic Classification of Taksim Recordings in Turkish Makam Music", in Proc. Conf. on Interdisciplinary Musicology (CIM08), 2008.

[9] A. C. Gedik, and B. Bozkurt, "Pitch-frequency histogram-based music information retrieval for Turkish music," Signal Processing, 2010, 90(4), pp. 1049-1063.

[10] M. K. Karaosmanoğlu, "A Turkish makam music symbolic database for music information retrieval: SymbTr," in Proc. Int. Society for Music Information Retrieval (ISMIR), 2012.

[11] M. Aydemir, Turkish Music Makam Guide, Pan Yayıncılık, Istanbul, 2010.

[12] A.C. Gedik, C. Işıkhan, A. Alpkoçak, Y. Özer, "Automatic Classification of 10 Turkish Makams", in Proc. Int. Cong. on Representation in Music & Musical Representation, İstanbul, 2005.