CHARACTERIZING INTONATION IN TURKISH MAKAM MUSIC

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ABSTRACT

Turkish Makam Music (TMM) compositions are performed in different pitch ranges for aesthetic reasons or for the purpose of suiting the instrumental and vocal registers of the musicians. Several possible pitch standards (described by the *ahenk* system) are used in interpretation, in contrast to the Western tradition, in which typically only one pitch standard is used (e.g., A4 = 440 Hz). For this reason, the intervalic structure is fundamental for identifying makamler. Moreover, the compositions are notated in the same key for each makam, regardless of the actual pitch standard in which they might be performed. Albeit two notes might have the same notation in a score for different makamler, in practice, trained musicians will intonate the absolute intervals with subtle deviations depending on the makam. These variations are often critical for distinguishing between makamler with common scales and tonic. In this paper, we aim to provide a simple implementation for identifying and quantifying these intonation deviations between different makamler in the Dunya Corpora. As a proof of concept, we analyze the intonation deviations of the Neva and Uşşâk makamler in the aforementioned corpora.

1. INTRODUCTION

The melodic structure of most of the traditional music repertoires in Turkey can be described by the makam modal structures [8], which are defined by the scale and an overall melodic progression (*seyir*). In contrast to the modes in Western music, different makamler can be formed using the same scale and tonic and differ by other characteristics such as the melodic progression strategy [3]. Another prominent characteristic of Turkish Makam Music (TMM) is its monophonic and heterophonic structure [6]: several musicians simultaneously perform the same melody but with variations that might include changing the intonation of certain intervals, or inserting, repeating and omitting notes [11], among others.

TMM has been orally transmitted over centuries from masters to students, resulting in different schools which may interpret the same pieces with substantial variations (e.g., expressive timings, ornamentations). Due to this multiple interpretation variations within the same composition, the scores generally have a descriptive character and only notate basic and monophonic melodic lines [11], omitting the particular variations of each instrument. Another relevant feature of TMM performance is that the pitch scales are non-deterministic [1]: musicians will intonate intervals with common notation differently depending on the makam in which they are inscribed [7]. Moreover, several possible pitch standards (described by the *ahenk* system) are used in the interpretation of TMM, instead of a single standard, as usual in Western music (e.g., A4 = 440 Hz). As a result, all scores for the same makam are written in a single key, yet in interpretation, the key is transposed [9] to suit the instrument or vocal range of the performers or for aesthetic reasons. In other words, there is no definite tonic (*karar*) frequency [11].

The mainstream theory for TMM is the AEU theory (Arel-Ezgi-Uzdilek theory) [10] that formalizes the intervalic structure in the Turkish makam system. The TMM score representation follows an expanded Western notation that typically follows the AEU theory [10]. However, the 'availability of pitches' in the notation is still limited for representing the intervals present in the TMM practice [4]. For instance, when transposing the Hicaz tetrachord to F#, the accommodation of the tetrachord to the 'available pitches' causes the augmented second interval to go from 12 to 13 commas [7]. Moreover, some common intervals are not described by makam theory, such as those found in Uşşâk and Saba [7]. The values of the accidentals can deviate at least one Holdrian comma (22.5 cents [6]) from the common practice [7].

In this paper, we aim to characterize the intonation variations among different makamler for intervals with common notation in AEU. For this purpose, we compare the performed intervals to the theoretical intervals for different makamler in the Dunya Turkish Makam Corpora [1]. This has been already studied in [10], however, our contribution consists in a simple implementation for a rapid comparison and visualization between makamler. Due to space constrains, here we only show the results for two makamler, Uşşâk and Neva, but provide an implementation [2] for potentially comparing each makam in the dataset.

[1] https://compmusic.upf.edu/corpora

[2] https://github.com/marter0/intonation_in_turkish_makam_music

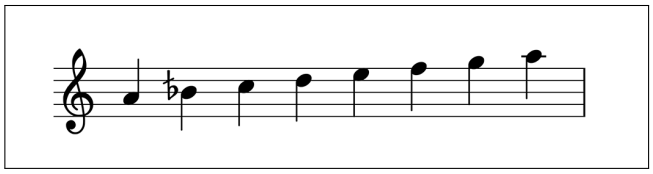

Figure 1. Uşşâk makam scale.

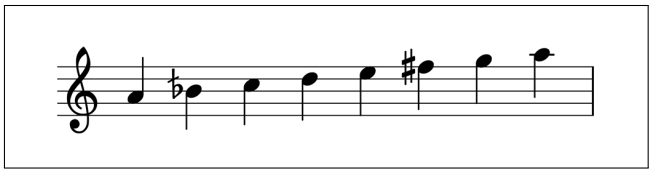

Figure 2. Neva makam scale.

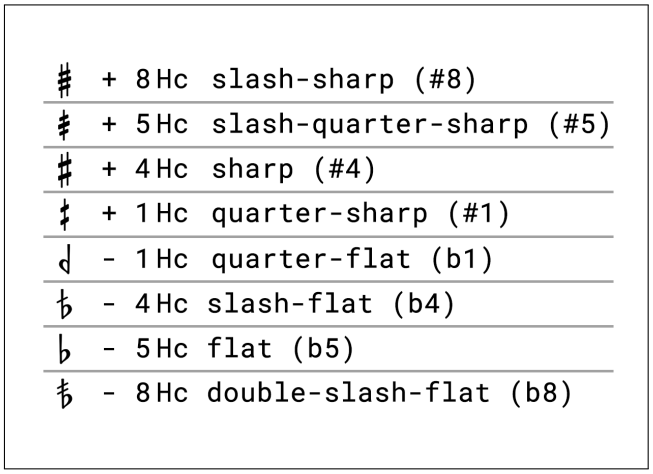

Figure 3. Accidentals notation in Turkish Makam Music (AEU theory). Hc refers to Holdrian commas.

2. METHODOLOGY

The makamler pitch analyses and scores have been obtained from the Dunya Turkish Makam Music corpora [8]. It should be noted that a direct comparison between the notated pitches in the score (according to AEU theory) and the performed pitches does not only reflect the performer's intonation but also the transposition of the tonic note. For this reason, the tuning analysis is computed using the Turkish-Ottoman Makam (M)usic Analysis TOolbox (TOMATO)[3] [10], which implements, for this task, the methodology followed in [4]. In short, this tool retrieves the frequencies at which the performed pitches are played and matches them to the theoretical frequency in the AEU theory.

The analysis pipeline can be illustrated as following [10]: first, the pitch distributions (PD) in the audio recordings are extracted with the MORTY Toolbox [5] (integrated in TOMATO). The stable pitches at which the makam notes are played are obtained through peak detection in the PD. The stable pitches' frequencies are normalized with respect to the tonic frequency, which is obtained using the last note method [2]. Next, the interval between the tonic frequency and the stable pitches is computed in cents. Simultaneously, the note symbols for each of the scale degrees are obtained from the score's key signature, which is further expanded $\pm$ two octaves. Hereby the theoretical scale degrees (or intervals) are obtained from the AEU theory and the performed scale degrees are matched with the theoretical scale degrees by a tolerance of 50 cents. As a result, both the theoretical and the performed degree of the scale are obtained in cents with respect to the tonic frequency. Finally, we compute the differences between the stable pitches and the theoretical pitches in cents.

The average and standard deviation of these variations is computed across a selection of available recordings of a makam. This quantifies the intonation deviations and informs about the consistency of the deviations inside the makam. Finally, this data is compared across makamler in order to determine the differences in intonation for the same intervals. For the purpose of demonstration, we perform this analysis for the Uşşâk and Neva makamler, since both share the same tonic frequency, A4, and their scales only differ in one accidental (see Figure 1 and Figure 2). All the intervals are computed in cents with respect to the stable (performed) tonic frequency. For this reason the deviation from the tonic (in the case of the Uşşâk and Neva, A4) is 0.

[3] https://github.com/sertansenturk/tomato

3. RESULTS AND DISCUSSION

The average intonation deviations in the makamler Uşşâk and Neva are presented in Figure 4. The deviations refer to the mean difference in cents between the intonated pitches and the theoretical pitches according to the AEU theory. Positive deviations indicate that the intonated pitches were higher than the theoretical frequencies, while negative deviations show that the intonation was lower in pitch. Error bars correspond to the standard deviation. The notes listed in the vertical axis correspond to those in common in both makamler present in at least 5 recordings of each makam. The notation used for the accidentals corresponds to the indicated in Figure 3.

In general, the deviations are negative, and the Uşşâk makam shows more substantial deviations from the theoretical intervals than Neva. The only note in which makam Neva shows larger average deviation than Uşşâk is G4 (the *yeden* or leading tone in both makamler), where the average deviation in intonation in Neva is half of a Holdrian comma.

Neva and Uşşâk both use scales formed by a tetrachord on Dügâh and a pentachord on Neva, and it is also worth mentioning that the dominant or güçlü for both makamler (D5) has the lowest mean deviation from the theoretical pitches - i.e., the intonation of this note is closer to the theoretical pitch than that of other less important notes.

Overall, the results reveal significant standard deviations, which indicates that within the same makam, variations in the intonation of notes often occur. More specifically, some notes show particularly large standard deviations (C6, B5b1).

The most prominent intonation deviation is on the note B4b1 by roughly one Holdrian comma. This deviation has

been already reported in [7], that states that the intonation of second degree of the Uşşâk (i.e., B4b1) is lowered one comma (22.5 cents) in the melodic environment of a cadential phrase. Due to the fact that the intonated pitches are obtained from pitch distributions, the temporal information is lost and the melodic environment in which a deviation of the intonation of a pitch occurs can not be identified. This will be further discussed in the next section.

4. LIMITATIONS AND FUTURE WORK

Albeit our initial selection included ~50 compositions for each makam, due to errors in the Dunya API, only a reduced number (19 Neva and 14 Uşşâk) of those compositions and their associated data could be retrieved. We expect these issues to be solved soon to expand the analysis to a larger set of compositions in the Dunya corpora.

It should be also noted that the frequencies from which the intonation deviations are computed are obtained from pitch distributions. Pitch distributions are helpful for addressing the heterophonic character of TMM, however, possible dependencies of the intonation deviations on the melodic progression can not be observed with this method. In general, variations of intonation occurring in the composition interpretation cannot be identified with this method. Pitch distributions with wide peaks could inform about this intonation variability that is not taken in account in this work and could help further characterize the different makamler in future research.

5. CONCLUSION

In the present paper, we present a simple implementation of the intonation analysis tools in TOMATO [10], for the specific purpose of comparing the deviations from the theoretical pitches between makamler. In this context, we present an intonation comparison of the makamler Neva and Uşşâk. Our implementation provides an informative visualization of the intonation differences between the two makamler, which can provide a framework for identifying similar deviations in other makamler present in the Dunya Turkish Makam Music corpora.

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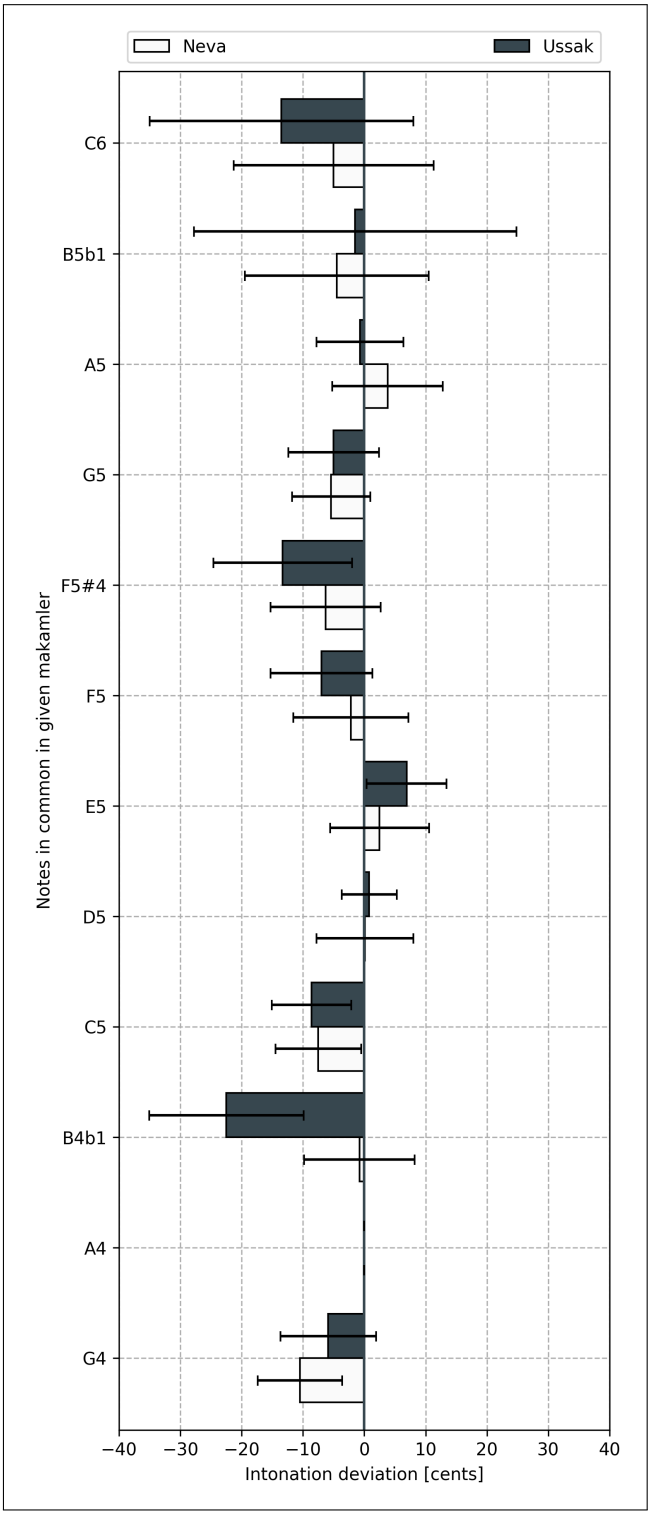

Figure 4. Average intonation deviations between the performed pitches and their theoretical frequencies (AEU theory) for the makamler Neva and Uşşâk. Only notes in common with more than 5 occurrences per makam are shown.

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