

## A microtonal tuning method: Test & discussion on the use of microtonal intervals for the performance of traditional Turkish music

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**Background in music computing:** An automatic method for tuning analysis of recordings was presented in (Bozkurt 2008). Data collected from this method have been used to develop a new microtonal tuner system implemented in Max MSP and Java (Tamer and Bozkurt 2013). The distinctive quality of the tuning method (previously demonstrated in (Bozkurt 2012)) is the use of a recording as reference instead of theoretical presets. During the process, fundamental frequency analysis is performed and pitch distributions are obtained for the selected recordings. This data is visualized via the tuner interface along with the real-time frequency estimate from the input signal to realize the tuning operation.

**Background in music performance:** Electronic tuner devices are widely used by musicians. However these devices offer only a limited number of theoretical presets and equal temperament is the primary one. Lack of consistency between tuning theory and its practice of Turkish makam music has been addressed in a number of studies such as (Ay and Akkal 2008; Bozkurt et al. 2009). In the general traditional Turkish music concept, when microtonal intervals are used, the question of how musicians interpret the theory and apply it into their tuning practices arises.

**Aims:** We investigate the relevance of tuning practices applied by three selected musicians who perform traditional Turkish music with the authentic intervals used by master musicians in selected recordings. We present the microtonal tuner application in order to provide a basic research tool for musicians and ethnomusicologists.

**Main contribution:** The manuscript presents the user tests carried out with three professional musicians who perform traditional Turkish music and discusses the outcomes. A semi-structured interview method is applied in order to test the process with the musicians. The tests contain comparisons of performances with and without the aid of the microtonal tuner application, providing insight to the musicians' regular tuning practices and discussing further possibilities on the use of the application. The tests include recordings by well-known Turkish master musicians who perform microtonal music as Turkish makam music (one example) and Turkish folk music (three examples).

**Implications:** By offering a direct access to any tuning system used by a master musician that has been captured in a recording, the application presented in this paper is suitable to serve as a computational ethnomusicology (CE) tool, thus has the potential to assist in ethnomusicological research. (Tzanetakis et al. 2007).

**Keywords:** tuner application, computational music analysis, microtonal intervals, traditional Turkish music, *makam*, maqam.

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## 1 Introduction

Commercial musical instrument tuner devices are widely used by musicians. These are introduced as either hand-held standalone electronic devices or applications that run on smartphones, tablets and computers. Most of these devices display the pitch difference of the input signal to a theoretical note from a limited number of presets. Equal temperament being the primary one, theoretical tuning presets such as Pythagorean, Just intonation, Well temperament and Meantone temperament are among popular presets. However in many folk traditions the tuning systems may vary according to the master musicians or the local culture. These variations become crucial aspects for the performance of traditional music yet may not match a specific tuning theory.

In traditional music practice, a musician with a tuning fork does not necessarily need an electronic tuner device; achieving proper tuning of the instrument is considered a part of the musicianship. However electronic tuning devices are practical to use when performing in ensembles. They can provide ease and save time for tuning instruments with many strings such as *kanun* and movable frets such as *tanbur*.

In addition, for the example case of Turkish makam music, due to the lack of consistency between tuning theory and its practice (discussed in detail in many studies such as (Bozkurt et al. 2009; Ay and Akkal 2008)), the musicians may benefit from the tuning practices of master musicians as references. The musicians that we have carried out the tests for this paper have implied that they observe a tendency towards tuning in equal temperament, due to the widespread use of electronic tuner devices. Theoretical tunings presented cannot completely correspond to the practice of master musicians (Gedik et al. 2012). The adaptive tuning approach may help to construct a database of presets reflecting master musicians' tunings and reveal stylistic variations on tuning practices and performances.

Recently, we have proposed a novel tuner software that learns the tuning reference from a user specified recording and helps the user tune her/his instrument as in the recording. The technical details involved in the design and implementation of this tuner has been previously presented in (Tamer and Bozkurt 2013) and is summarized here in Section 2. In this study, the software has been developed further with additional features such as transposition, horizontal zooming, synthetic tones for feedback etc. The aim of the current paper is to study tuning paradigms used by the experts of Turkish art and folk music and to test the usability of our software within the traditional Turkish music context.

We have selected three expert musicians to study their tuning preferences and their experience with our tuner. For the selection of the musicians, we specifically contacted experts who consider tuning as an important dimension of musical expression and have been professionally practicing traditional Turkish music for a considerable amount of time. In Section 3, method of the semi-structured interview carried with these musicians is explained and in Section 4, we provide detailed

discussions for test and tuning preferences of each musician. Finally, Section 5 concludes the manuscript.

## 2 The Tuner System

The tuner system consists of two parts. The first part analyzes the reference recordings and generates a histogram that is saved as a text file. The histogram file can be stored and shared among users of the application to form a library of presets. The work explained here is an alternative implementation to (Bozkurt 2012). For a given recording, first, frequency analysis is performed for each 10 msec. window/frame using YIN (de Cheveigne and Kawahara 2002), a popular fundamental frequency detection algorithm. Then the pitch histogram is obtained for each recording as explained in (Bozkurt 2008) with a resolution of 159 bins per octave. Since the diapason may vary in a traditional music context, it is advantageous to represent the pitch information as interval information (with respect to tonic). The tonic detection can be performed automatically (Bozkurt 2008; Salamon et al. 2012) or manually, depending on the specific music culture. In our software we use the automatic tonic detection technique of Bozkurt (2008) which can be further modified by the user if needed. The second part displays the information as an application interface to perform the tuning operation.

### 2.1 The Tuner Interface

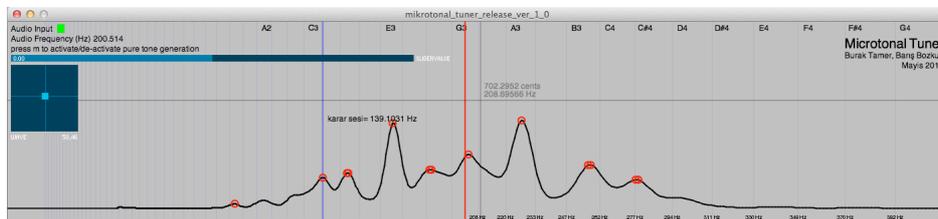
The software comprises two standalone applications, both are provided within the multimedia content of this paper. The application labeled “f0 estimation” has been developed in the object-oriented language Max MSP for real-time fundamental frequency (f0) estimation and uses the microphone input on the computer to acquire the sound signal. This application uses the “fiddle” object for FFT (Fast Fourier transform) and pitch estimation (Puckette et al. 2007) and tuning algorithm via the “zl” objects to detect the fundamental pitch (Planquette 2011).

After launching the f0 estimation application, clicking on the microphone icon activates the built-in microphone input of the computer. A level meter next to the microphone icon is provided to visualize the input signal level. This signal is compressed in order to improve the stability of the tuning process. The fundamental frequency estimation of the input signal is displayed in the number box next to the level meter. This data is sent to the microtonal tuner application using a “maxlink” object that enables data transfer between Max MSP and Java (Kriss 2011).



**Figure 1.** The f0 estimation application interface

The application labeled “microtonal tuner release ver1.0” has been developed in Java. This application serves as the main user interface for tuning. Once the application is launched, an open dialog appears asking the user to locate the histogram file to process. When the user selects the histogram file, the interface of the tuner application appears, displaying the data of the histogram.



**Figure 2.** The microtonal tuner application displaying histogram of a recording in makam *Hüzzam* by Kâni Karaca. The red line represents the real-time frequency estimation of the input signal.

The interface displays the equal temperament intervals in the background (as vertical lines) as reference. The smoothed histogram data is depicted and peaks indicating the tones of the scale used in the recording are labeled with red circles. The tonic is marked with a vertical blue line and its frequency is specified. An audio input meter is located in the upper left corner of the interface. Under this horizontal meter, the value of the audio input frequency is displayed. When the mouse cursor hovers on the tuner interface; it is represented by the intersection of two transparent gray vertical and horizontal lines. On the upper right corner of the intersection, the frequency value of the current position along the horizontal axis is displayed. Above this data, the distance from tonic in terms of cents is displayed. When the “m” key on the keyboard is pressed, the tones of the scale can be played back with synthetic tones. As the user moves the mouse cursor on the peak locations, a pure tone at the frequency of the closest peak is played back to the user. To deactivate this feature, the user presses the “m” key again. The algorithm uses Minim Audio class (Di Fede 2009) to synthesize pure tones for the peak frequencies.

There are two sliders provided on the interface. The algorithm uses the ControlP5 library to update data via graphical user interfaces (Schlegel 2012). The horizontal slider is used for transposing the scale. This is useful since the tonic of the analyzed recording may not match the proper register of the user’s instrument. Using this slider, the intervals displayed can be transposed up or down to 1200 cents. The x-axis of the two-dimensional slider is used for zooming in or out horizontally. Since the horizontal axis is a linear display, the user can adjust the zooming level after

transposition for convenient viewing of the scale. The y-axis of the slider has not been assigned to any parameter in this version.

When both applications are active, the user can use the tuner to match her instrument to the peak values that represent the tones of the scale performed in the recording used as reference. The red vertical line moves along the horizontal axis as the user plays tones from her instrument, and turns to green when it coincides with the peak values. Note that the two applications can run independently; the user might prefer to tune to the displayed intervals by ear using the synthetic tone audio output, thus might not need to activate the  $f_0$  estimation application.

### **3 Semi-structured Interview: Test & Discussion**

The outline of the semi-structured testing of the microtonal tuner is set as follows:

- As an initial step, the musician selects a piece that he is familiar and confident with in terms of performance and a recording for which he wants to explore the microtonal intervals. The analysis application is then used to estimate the pitch distribution of the recording and produce a histogram.
- Once the interview starts, the musician is asked to tune his instrument with his regular tuning practice and perform a section of the piece that was chosen. The performance is recorded using a handheld stereo recorder.
- The histogram file is loaded into the tuner application in order to visualize the intervals played in the recording.
- The musician is asked to tune to these intervals using the microtonal tuner application. He can transpose the intervals to the proper register of his instrument via the application.
- After the tuning process is completed, the musician performs the same piece again, this time with the new intervals. This performance is recorded as well.
- This interaction with the regular practice of the musician already reveals some topics of discussion throughout the process. This is encouraged, as it provides valuable technical and conceptual feedback for the efficiency of the process (Arom 1993).
- Topics decided earlier are brought into this conversation to provide answers to some critical questions regarding the research.

The recordings of performances by the participant musicians are presented within the multimedia package of this paper. The files are labeled with the performer, song title and the interaction phase info (as before or after the microtonal tuner application). If the tuning of the participant musician and the master musician coincide, there is only one recording labeled as “before/after” for that test. In this case a second recording is not necessary since the tuning does not change. Along with the histograms used in the

tests, the multimedia content also provides excerpts from the selected recordings by master Turkish musicians, which were used to extract the histogram data.

Discussions on the outcomes of the interaction with the microtonal tuning process were based on the following topics:

- Description of the regular tuning process of the musician
- The musical functionality of the microtonal tuning application presented in this paper
- The difficulties faced while using this new approach / application
- The aesthetical interpretation of tuning; the importance of performing a piece with its authentic intervals
- The effects of this tuning system on creativity, improvisation and spontaneity, the possible positive and / or negative influences of this tuning process on development of a musician's style
- The possibility of the use and need of this application within varying levels of musicianship (amateur, intermediate, professional etc.) (Nattiez 1993)
- The relationship between the authentic intervals and cultural experience

## 4 The Outcomes

The musicians who took part in the interviews are: Reha Sađbař – *Kanun*, Tolgahan ođulu – *Mikrotonal Gitar* and Erdem řimřek – *Bađlama*.

### 4.1 Interview with Reha Sađbař

Bekir Reha Sađbař is a musician of the Istanbul TRT – Turkish Radio & Television Broadcasting Corporation. He has played in the ensemble of Cinuen Tanrıkorur; a notable composer of Turkish makam music and a *kanun* virtuoso. Sađbař has taught Turkish Music classes in Hacettepe, Ankara, New York Universities and New England Conservatory. He has performed in Turkey and 27 countries abroad with master Turkish musicians and such as Baha Sreلسan, Necdet Yařar, İhsan zgen, Meral Uđurlu, Bekir Sıtkı Sezgin, Selma Sađbař and Kni Karaca. The performances of his ensemble *Llezar Trk Mziđi Topluluđu* in the United States has been released as CDs and won the *Best Of World Music* in 2002.

Sađbař (2014) explains that his regular tuning practice is based on first tuning to 440 Hz as reference. As he is an experienced and well-established traditional musician, after taking the 440 Hz reference he tunes the other intervals on his instrument by ear and adjusts tuning by testing several different makam scales by playing short phrases as cross check for the microtonal intervals. His main concern on the use of regular tuner devices is that the younger musicians performing traditional instruments tune their instruments to equal temperament intervals as these commercial tuner devices display this system as the main preset and some of them do not contain any other

intonation systems. He complains that this has now become a standard procedure amongst ensembles of TRT. Sağbaşı explains that his solution to this problem is retuning by interacting with the musicians. During rehearsals the young musicians tune their instruments to equal temperament intervals, and when they perform together he warns them about certain tones as being lower or higher in pitch in relation to his tuning. Since his tuning sounds authentic and is able to reflect the intended mood of the makam to be performed, the other musicians adjust their tuning accordingly. He tells that the other musicians cooperate since his instrument *kanun* scans a wide register due to its many strings and thus can provide a reference to other instruments in a variety of registers. Sağbaşı also informs that musicians playing fretless instruments such as violin can adjust to his tuning naturally during the performance, as the structure of the instrument is convenient.

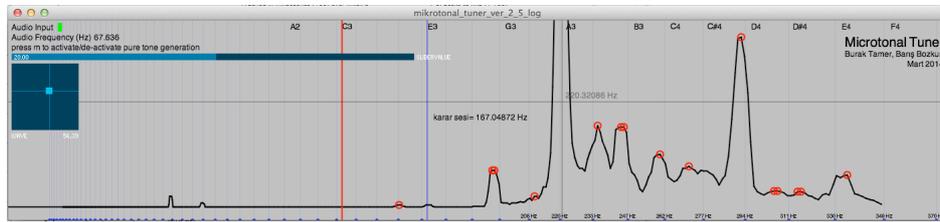
According to Sağbaşı, before the introduction of commercial tuning devices that display equal temperament, there were no such problematic issues regarding the performance of makam music as musicians listened to and interacted with each other; thus tuned accordingly, using their ears. He regards equal temperament as an “average tuning” that a musician can play any mode in, yet is insufficient in reflecting the character that a makam has to offer. He is uncomfortable with the fact that young musicians regard to these commercial tuning devices as the absolute truth.

Sağbaşı is highly careful and precise in the subject of tuning; he tells that he has some references to check his tuning for various makamlar. When playing the *kanun*, he plays the ascending and descending scales of the makam as they differ in intervals and rests on the tonic for each one of these practices without altering the pitch of the tonic (using the latches on each string of *kanun*) to see whether if it is an actual resolution or not. If the intonations of the scale are not proper, he thinks that this will affect the feel of the resolution to tonic hence there will have to be new notes introduced in the melody towards the tonic for a stable cadence. By reference of this melodic difference, he can tell whether the intonation is correct or not.

*Evening Ezan (call for prayer)* in makam *Hicaz* by Kâni Karaca was the first piece to be tested with Sağbaşı. We asked Sağbaşı to tune his instrument as if he was to play in makam *Hicaz*. After completion of his regular tuning practice, Sağbaşı played a *taksim* in makam *Hicaz*, which was recorded for documentation and comparison in the latter phases of the test. A portion of Kâni Karaca’s recording (2002, track 2) was used to extract a histogram since the piece is a solo vocal performance with no other instrument to supply a reference pitch. This produces fluctuations of tonality throughout the performance making it not possible to tune to; therefore a stable section of the performance was used as input data (the excerpt from the Karaca recording is provided in the multimedia content of this paper). After the analysis of the recording, the histogram was generated. The file was loaded into the microtonal tuner application for visualization and tuning operation. In order to match the E on Sağbaşı’s *kanun*, the tonic was transposed 20 cents upwards via the interface slider. Each tone of the makam *Hicaz* sung by Karaca was tested against Sağbaşı’s tuning via the microtonal tuner interface. For some of the tones Sağbaşı preferred to use the input frequency estimate, while for the others he used the synthetic tones generated

corresponding to the tones used in the recording and matched them by ear. This feature of the application became useful since a mouse gesture such as scanning the cursor from the left of the interface towards right made it possible to hear all of the tones in the makam consecutively, as if played with an instrument for demonstration. Sağbaşı interacted with this feature with an improvisational manner; judging each tone and its relation with the former and latter in the series.

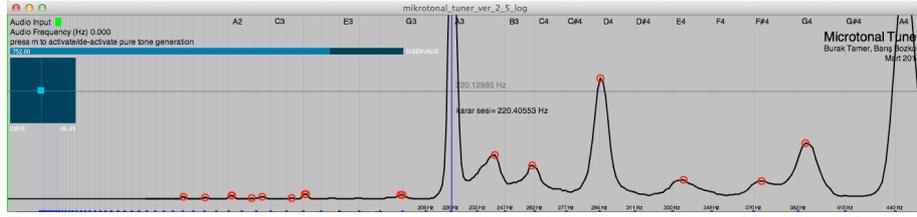
At the end of comparison between Kâni Karaca and Reha Sağbaşı's tunings, it was very interesting to see that Sağbaşı's scale matched Karaca's almost perfectly; these two musicians used the same traditional intervals of the makam. On the other hand, this perfect match may not be regarded as surprising as it seems to be because both musicians are important representatives of Turkish makam music and have performed together numerous times.



**Figure 3.** A fragment from Kâni Karaca's Evening Ezan recording in makam *Hicaz* analyzed and visualized via the microtonal tuner interface. Note the 20 cents transposition to match tuning with Sağbaşı's instrument.

Since this test was a successful approval of match between tuning of two masters, a new test was made. The piece selected for the second test was *Allı Turnam* by Hacı Taşan, this time the instrumentation included *bağlama* and vocals. The expectation of this example that represents Turkish folk music would be to encounter a certain level of diversity in tuning due to regional variations of folk music. Via a recording of the piece performed by Taşan (1999, track 1) the extraction of the pitch distribution as a histogram file and visualization of this data in real-time with the live input stages were achieved. Sağbaşı used the microtonal tuner application to tune to the intervals in the recording. The scale was transposed 752 cents upwards to A3, in order to match the register of *kanun*. There were significant differences between Sağbaşı's tuning practice compared to Hacı Taşan's for some of the pitches. After experimenting with *Allı Turnam* tune in Taşan's tuning for a while, Sağbaşı implies that the C note is "pleasantly low" and thus relates to the tempered D. He states that if a resolution in equal temperament is considered as restful, he would describe the resolution in Taşan's tuning as "incredibly refreshing". Sağbaşı's interpretation of the *Allı Turnam* tune with authentic intervals is presented in the multimedia content of this paper. Here it is useful to consider Taşan's origin and the tradition he represents when evaluating this variation in tuning. Hacı Taşan is a Turkish Folk musician from Middle Anatolia and has been a student of Muharrem Ertaş along with Neşet Ertaş and Çekiç Ali. He is a representative of the *aşık* tradition and his repertory contains Turkish folk song

forms such as: *türkü*, *halay* and *bozlak*. His distinct style refers to Keskin, a region of Kırıkkale city which houses the *Abdal* culture.



**Figure 4.** Hacı Taşan's Allı Turnam visualized via the tuner interface. Note the 752 cents transposition to A3.

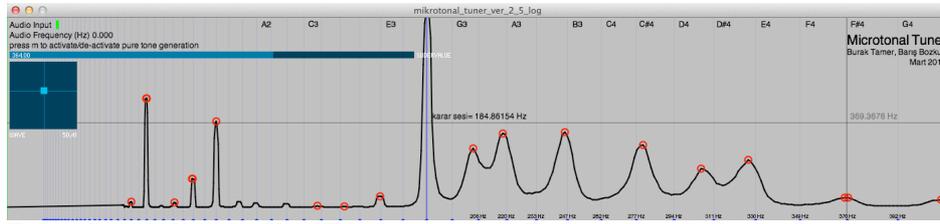
After the test session we ask Sağbaş what he thinks about his experience with the microtonal tuner application and whether he finds it musically functional or not. Sağbaş answers that this microtonal tuning approach would teach musicians appropriate intonation of the traditional scales and provide awareness of the issue. He suggests that there should be a library of certain master musicians' tunings presented with the application so that the musicians using the application will have a proper initial reference to learn from. We ask Sağbaş about the level of musicianship relevant to this tuning application and he tells that it would be of use to the intermediate and professional musician. For the possible effects of authentic intervals on creativity and improvisation; he tells that the intervals are related with the regional style and the musician tuning to a certain system from a region will be able to improvise to the local music of that region. If the musician wants to play another region's melody with this tuning it may not reflect the intended mood. He regards this feature as the subtlety of folk music.

#### 4.2 Interview with Tolgahan Çoğulu

Tolgahan Çoğulu plays microtonal music with his custom-built instrument, *the mikrotonal guitar*. He has studied classical guitar and traditional Turkish music. During his PhD thesis, Çoğulu decided to combine the two by inventing a classical guitar with movable frets for each string, so that he could tune to and play any makam without compromising the timbre and playing technique of the classical guitar (Çoğulu 2011). He designed the *Adjustable Mikrotonal Guitar* in 2008 and released his first CD with microtonal guitar in 2012. He has played and lectured about microtonal guitar music in festivals and universities such as New York, Iserlohn, Zihuatanejo, Brno, Sarajevo, Santo Tirso Guitar Festivals, Memphis, Mozarteum, Wien, Codarts, York, Bristol and Ljubljana Universities. Çoğulu has performed a repertoire of works for microtonal guitar by composers such as William Allaudin Mathieu, Christoph Charles, Nicola Visalli, Gabriel Malancioiu, Onur Türkmen and Alexander Greengarden. Due to his studies, his input provides valuable insight to the microtonal tuning process discussed in this paper.

Çoğulu selected the well-known Aşık Veysel piece *Kara Toprak* (in makam *Hüseyni*) to test the application. In order to initiate the test he accomplished his regular tuning practice by placement and movement of the appropriate frets on his mikrotonal guitar

and performed a section of the piece; the performance was recorded. After the acquisition of Çoğulu's regular practice, we proceeded to the extraction of the histogram via an original recording of the piece by Aşık Veysel (2001, track 1). The histogram data was visualized and Çoğulu used the microtonal tuner application to tune to the authentic intervals. Veysel's tonic was analyzed as approximately 39 cents higher than the equal tempered D3 note, which was transposed up to F#3 via the application to match the proper register on Çoğulu's instrument. During the re-tuning process, we encountered that Çoğulu's regular tuning method matched Veysel's for the two tones following the tonic, yet perceptible differences started after the third tone of the series. While performing the same section of the piece with Veysel's tuning, Çoğulu observed that the differences have significant influence, which alter the perception of the tune and its performance.



**Figure 5.** Aşık Veysel's Kara Toprak (in makam *Hüseyni*) intervals displayed in the tuner interface. The tonic has been transposed to F#3.

After the test, we asked Çoğulu about his regular tuning practice. Çoğulu (2014) uses the commercial tuner application *ClearTune* on his smartphone that displays equal temperament intervals. However he tells that together with his colleague Erdem Şimşek, they have been researching the sizes of microtonal intervals in makamlar using various recordings of performances. Çoğulu describes that their method is to listen to a recording of the piece by a master musician and try to match the tuning by ear, starting with the tonic. After a number of these investigations, he has developed certain knowledge of microtonal interval values in any makam, as being for instance 30 cents higher or 25 cents lower than the equal tempered value. Therefore he uses a commercial tuner displaying equal tempered notes, but does not tune directly to these intervals but uses his knowledge of microtonal intervals (as distance to equal temperament note value in cents) and tunes to these values.

Concerning the musical functionality of the microtonal tuner application, Çoğulu states that when presented the chance, he would make this process a part of his regular tuning practice & research. When we consult him about the relationship between creativity and the use of master musician's authentic intervals, he explains that this approach would make the musicians who study the traditional pieces relate to the style of the master musicians and recognize the relationship of their tunes with the tuning systems they use, thus this approach would provide awareness on the issue. He states that for a professional musician, the practice of playing the tune with its authentic intervals will help to reflect the intended mood of the piece. He indicates

that when the traditional tunes are to be arranged polyphonically, the harmonic arrangement should be determined in accordance with the authentic intervals.

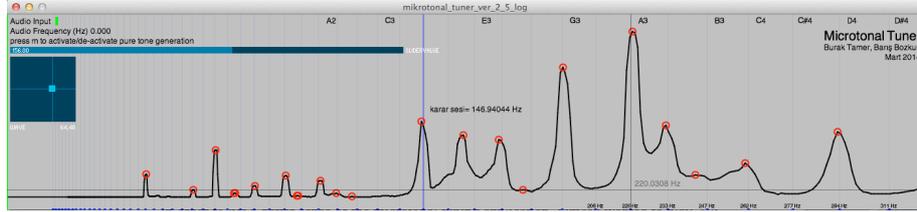
Çoğulu agrees with Sağbaş on the use of this application being practical by intermediate and professional musicians. However he thinks that an experienced musician in equal temperament (but not in microtonal music) would benefit from this application as it will also provide a direct learning experience which the musician would not be able to accomplish by ear. He speaks of his experiences where he decides to perform a piece; but despite his experience in the field, is not able to extract interval information (by ear) from the old and not well-handled recordings, therefore gives up after various attempts. He thinks that this application would facilitate the process to a very high extend in such cases.

Çoğulu points out to the fact that the microtonal tuner application can be used to collect tuning data from various regions in Turkey, which, after a statistical study; can be used to generate a “tuning map” of Turkey. This scientifically proved study would visualize the tuning variations practiced in local cultures as a whole, as well as reveal interrelationships that would not have been cognizant of.

#### **4.3 Interview with Erdem Şimşek**

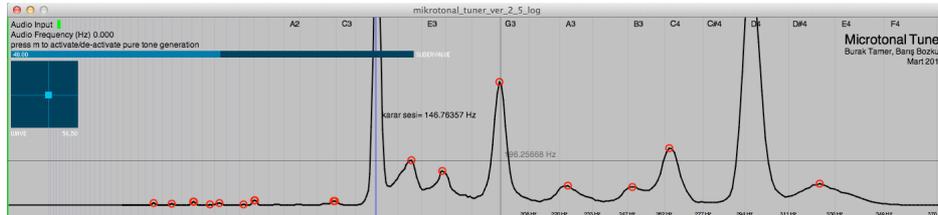
Erdem Şimşek started to play *bağlama* at an early age. He has played in the ensembles: *Bengi Bağlama Üçlüsü*, *TRT Gençlik Korosu*, *THBT Bağlama Orkestrası*, *Lâl Bağlama Topluluğu* and *Bâd-ı Saba*. He studies his PhD in the Musicology and Music Theory Department of Istanbul Technical University. Several of his solo and ensemble performances (with musicians such as Erkan Oğur, Erdal Erzincan and Musa Eroğlu) have been broadcasted by the TRT music television. He has performed in CD releases such as *DEM Ensemble Erguvan - Turkish Musical Traditions*, *Marc Sinan - Hasterim*, *Journey to Anatolia* and *Kılavuz - Dost Kervanı 2*.

Şimşek chose to perform Ali Ekber Çiçek’s *Gurbet Elde Bir Hal Geldi Başıma* with his *bağlama* for our test. After the completion of his regular tuning practice, we recorded a performance of a section from the piece. Via the chosen recording of the piece (Çiçek 2006, track 4) the histogram file was generated and processed in the application for real-time tuning operation. The tonic of the piece was approximately 45 cents higher than the equal tempered C3. Şimşek transposed the tonic to D3 and interacted with the application. We encountered that his tuning matched Çiçek’s, as it was the case with Reha Sağbaş’s tuning for Kâni Karaca’s *Evening Ezan*. When evaluating this outcome, it would be useful to consider the fact that Çiçek is a TRT musician and his tuning is almost identical with the equal temperament intervals.



**Figure 6.** Ali Ekber Çiçek's *Gurbet Elde Bir Hal Geldi Başıma* displayed in the tuner interface. The tonic has been transposed to D3. Note that except the second note in the series all of the other tones coincide with equal temperament intervals.

In order to get a better sense of the microtonal tuning application, Şimşek decided to play *Allı Turnam* by Hacı Taşan. He performed the piece once with his regular tuning practice and the performance was recorded. The recording (Taşan 1999, track 1) was used to generate the histogram file which was processed in the application for the real-time tuning operation. The tonic of the piece was detected as approximately 53 cents higher than the equal tempered C#3 and was transposed to D3 to match Şimşek's *bağlama*. Şimşek interacted with the microtonal tuner interface trying both the live input (tuning via visual feedback) and synthetic playback (tuning by ear) modes. After tuning to the authentic intervals, he experimented with the *Allı Turnam* tune but was not comfortable with the intonation of dominant tone (A3). He addressed this issue as a deviation in performance since at certain moments during the recording Taşan stops playing while singing, or the *bağlama* in the background is buried under the high intensity vocal due to the low quality of the old recording. Şimşek suggested that this problem would be overcome by analyzing a stable portion of the recording (as applied in the Kâni Karaca example with Sağbaş) such as the introduction with *bağlama*. A recording of Şimşek performing *Allı Turnam* with the authentic intervals is presented in the multimedia content.



**Figure 7.** *Allı Turnam* by Hacı Taşan displayed in the tuner interface. The tonic has been transposed to D3. The dominant tone (A3) is approximately 20 cents higher than the equal tempered A3, 720 cents higher than the transposed tonic (D3)

After the test, we ask Şimşek about his regular tuning practice and find out that it is very similar to Çoğulu's (Şimşek 2014). He uses a tuning application on his smartphone that displays equal temperament intervals, but knows the distance and direction in cents to depart from the equal temperament values when tuning microtonal intervals. For the rest of the notes, he tunes to equal temperament values. He indicates that this practice is applied by professional musicians yet amateur

*bağlama* musicians do not have such concerns as most of them may never alter the settings of their movable frets after they buy their instruments.

When asked about the musical functionality of the microtonal tuner application, Şimşek states that this practice can standardize the use of microtonal intervals within various makamlar. He tells that in the absence of a reconciled system the musicians who apply these intervals either do by experience or try to match with ear. He states that this procedure can suggest a standard through research of master musicians' tunings making each one of them a recognizable preset. Şimşek recognizes the importance of the use of authentic intervals when performing a traditional piece. He thinks that, the realization of the music in the cultural and historical context is lost when the tuning is not properly done. He agrees with Çoğulu that in order to reflect the intended mood, a tune should be performed with its authentic intervals. Yet he mentions that a through research with this application on various recordings of a piece has to be made before declaring the authenticity of a tuning.

Şimşek states that there is no direct relationship between the use of a master musician's tuning system and creativity. As for the use of the process, he thinks that it is an important mission to create a general awareness to the subject yet its wide use and spread is dependent on the application's use by professional musicians. He says that the process is too advanced for amateur musicians. Similar to Çoğulu and Sağbaş's projections, he mentions the importance of a statistical study of master musicians' various tunings from recordings; the result of such research would lead to presets and standardization. He draws attention to the fact that not every recording would serve as a beneficial basis for proper tuning, thus points out that the use of this process would yield to constructive results if conducted by professional musicians.

## 5 Conclusion

The microtonal tuner application was qualified as musically functional by the three musicians who were interviewed to test it in this paper. They all agreed that this process would be of use to the intermediate to professional musicians. The participants agreed on the importance of authentic intervals for the performance of traditional Turkish music. They consider the use of genuine intervals a crucial element for the correct realization of a traditional composition. They have also mentioned the difficulties they encounter while determining and tuning to authentic intervals.

The musicians have implied that the widespread use of commercial tuning devices that offer a limited number of theoretical presets support the shift towards equal temperament and this disregard towards tuning threatens the genuineness of traditional music. Awareness towards microtonal tuning practices should be supported. After interacting with the application, they pointed out that the process

would reinforce the research on authentic intervals and their practices. Due to the lack of standardization in this field, amateur musicians may be able to benefit from it if the process is used to create statistical scientific data of traditional tuning practices.

Şimşek and Çoğulu's regular tuning practices depend on the estimation of the deviation from the equal temperament notes in cents. During the interaction phase with the microtonal tuning application, both of them suggested that the distance of the mouse cursor position along the horizontal axis in reference to the detected tonic should be visualized (in cents) in the application as this data would provide them the ease to standardize a tuning preset so that they would be able to use it to update their regular tuning practice. Through their input, this feature has been added to the application.

Publishing this microtonal application online and sharing a database of histograms derived from historical recordings of master musicians of traditional Turkish music is among our future goals. The users will be encouraged to send the publishers recordings of performances that they wish to access the tunings of. The histograms derived from the recording input by interacting users will contribute to the expansion of the online database.

The multimedia content presented with this paper include:

- The microtonal tuning application (as tuner input and display files)
- Histograms for the pieces presented in this paper
- Mpeg-3 files containing excerpts of traditional recordings of these pieces
- Recordings of Sağbaş, Çoğulu and Şimşek performing the selected pieces with their regular tuning practices and with the aid of the microtonal tuner application

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